SEPTEMBER • 1957 25 CENTS

PF REPORTER

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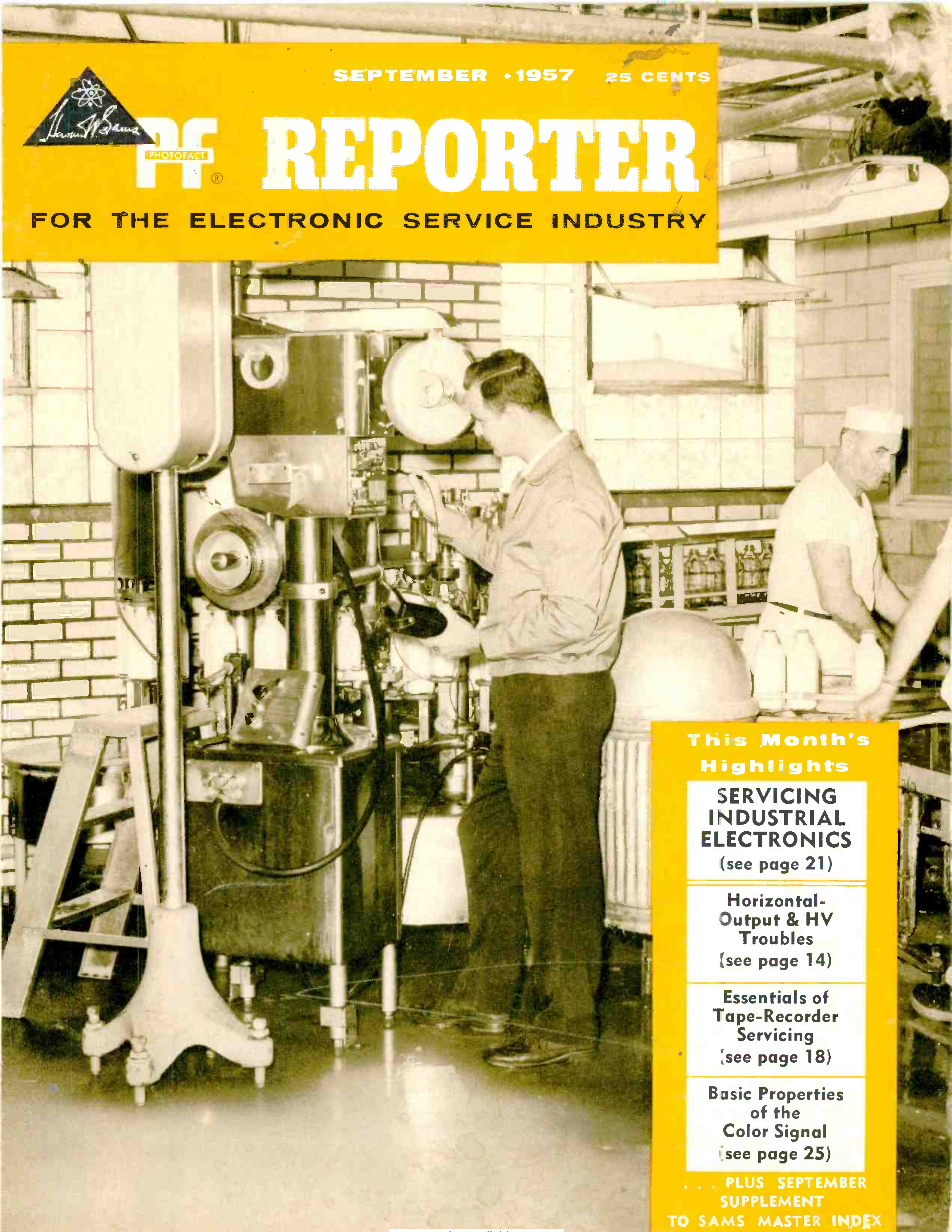
FOR THE ELECTRONIC SERVICE INDUSTRY



This Month's Highlights

SERVICING INDUSTRIAL ELECTRONICS
(see page 21)

Horizontal-Output & HV Troubles
(see page 14)

Essentials of Tape-Recorder Servicing
(see page 18)

Basic Properties of the Color Signal
(see page 25)

. . . PLUS SEPTEMBER SUPPLEMENT TO SAMS MASTER INDEX

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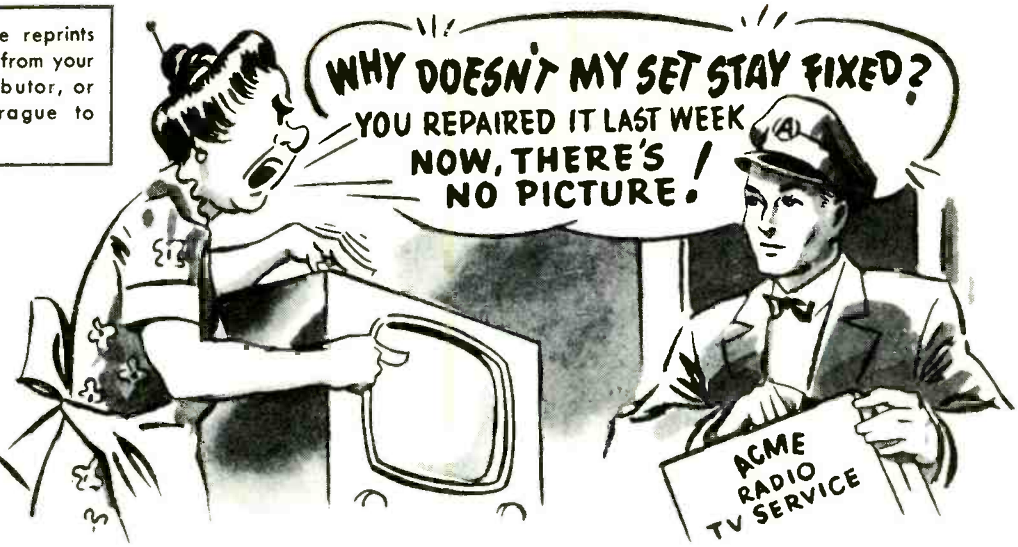

HERE'S YOUR ANSWER, MR. AND MRS. SETOWNER!

999 times out of a thousand, when this happens . . . *don't blame your service technician!*

The repair to your television receiver made several days ago or even several months ago probably had no relation to the new trouble that developed today.

Actually, there are more than 300 electrical parts in even a small table model television receiver. Trouble in any one of them might cause the picture or sound to disappear or to be received poorly.

Take your automobile for instance. Tuning up the motor today is no guarantee against a tire blowout tomorrow!

Such a thing is easier to understand because most of us are more familiar with automobiles than with today's highly complicated TV and radio sets. But such unconnected troubles occur in TV and radio nevertheless—and because they are so hard to explain in non-technical terms, it is always embarrassing to your service technician when they do.

His continued business existence is based on gaining the full confidence of you and other set owners like you. He isn't in business to "gyp" you or to overcharge you. His success is based on doing each and every job to the level best of his ability, at a fair price for his skilled labor. It's only when you patronize the shops that feature "bargains" at ridiculously low prices that you need worry. Good radio and TV service can't be bought on the bargain counter! Set owners who recognize this aren't likely to get "gypped."

Sincerely yours,

Harry Kalker

(HARRY KALKER, President)

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VOLUME 7, No. 9 SEPTEMBER, 1957

PF REPORTER

FOR THE ELECTRONIC SERVICE INDUSTRY

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USE HANDY CARD AT BACK TO ENTER YOUR SUBSCRIPTION

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next month

THEORY OF AUXILIARY SYNC CIRCUITS

This article will help you to understand and service most of the more complex TV sync stages.

THE FM SIGNAL

A review of its makeup, transmission, reception, and frequency conversion, including circuit discussions pertinent to the serviceman.

INTERPRETING COMPONENT COLOR CODES

A chart-type layout showing the various color codes used on electronic components to designate values, tolerances and ratings.

SERVICING INDUSTRIAL ELECTRONICS

Part 2 of this series deals with heat-sensing and temperature-controlling devices used in modern industry.

PROFESSIONAL RECOGNITION, GENERAL ELECTRIC ALL-AMERICAN


LIFE

Announcing

THE GENERAL ELECTRIC ALL-AMERICAN AWARDS FOR TV SERVICE TECHNICIANS WHO HAVE DISTINGUISHED THEMSELVES IN PUBLIC SERVICE

General Electric proudly establishes the All-American Awards to honor the TV Service Technicians of America for their good citizenship in many fields of public service.

Individually and as members of some three hundred trade groups, TV Service Technicians make many unheralded contributions to the welfare and happiness of their communities. You will find them repairing TV sets without charge in children's hospitals—teaching disabled veterans how to service TV sets—instructing Boy Scouts and other youth groups in elementary electronics—applying their specialized technical knowledge to many important fields of public service.

G-E All-American Award trophies will be presented to the eleven TV servicemen who, in the opinion of the judges, have achieved the most distinguished records of participation in community service during the two-year period ending September 30, 1957. In addition, General Electric will present $500 to each winner for use in community improvement activities.

Nominations may be made by any individual, club or association. Simply write a letter describing the community service performed, give the name and address of the serviceman you are nominating, and mail it before October 19th to the *All-American Awards Committee, General Electric Company, Owensboro, Ky.*

All-American Award winners will be selected by a panel of distinguished citizens renowned for their own public service activities.

WENDELL BARNES, Administrator, Small Business Administration
WENDELL FORD, 1956-1957, Pres., National Junior Chamber of Commerce
HERMAN HICKMAN, Sports Authority and Commentator
ED SULLIVAN, Columnist and TV Personality

Decision of the judges will be final.

Establishment of the All-American Awards is another step in General Electric's program to give recognition to independent businessmen everywhere for their important contributions to America's progress. *General Electric Co., Receiving Tube Department, Owensboro, Ky.*

WINNERS TO BE ANNOUNCED IN DECEMBER

GENERAL ELECTRIC

Full-page General Electric national advertising spotlights community service of independent TV-radio technicians such as yourself.

Your customers and prospects are being asked to help select an All-American award-winning team of 11 outstanding service dealers.

A complete package of promotion aids and display tie-ins is waiting for you. Your G-E tube distributor has this timely, colorful material. Ask him to help make your shop All-American service headquarters!

These advertising tie-ins can open your door wide to new fall business—

Easel-back display, "Football Time Is TV Tune-up Time"... Large football-theme window banner... Eye-catching window streamers... Special direct-mail folder and postcard...Newspaper mats... "Set-owners' TV Service Guide", a business-building booklet to give to service prospects.

INCREASED SERVICE VOLUME—CAMPAIGN OFFERS YOU BOTH!

FOOTBALL IS HERE. The star-studded entertainment programs are back. Millions of TV owners need to have their sets checked for top performance. Timed for this fall market, General Electric has kicked off its All-American campaign in support of the TV-service profession—the biggest ever—to 25,000,000 readers of LIFE. Full-page ads feature the all-around job service dealers like yourself are doing in and for the community...point to shops like yours as neighborhood TV-radio service headquarters.

To assist you further as an independent TV technician...to help identify your shop as first choice for tune-up work...General Electric has ready for you, through your G-E tube distributor, a new, timely kit of displays and advertising aids that will catch the eye of football fans and other set-owners who want tune-ups and repairs.

You also can make good use of the special football schedule shown below, carrying your name and address. It's a reminder item that prospects for TV-service work will value and keep with them for many months.

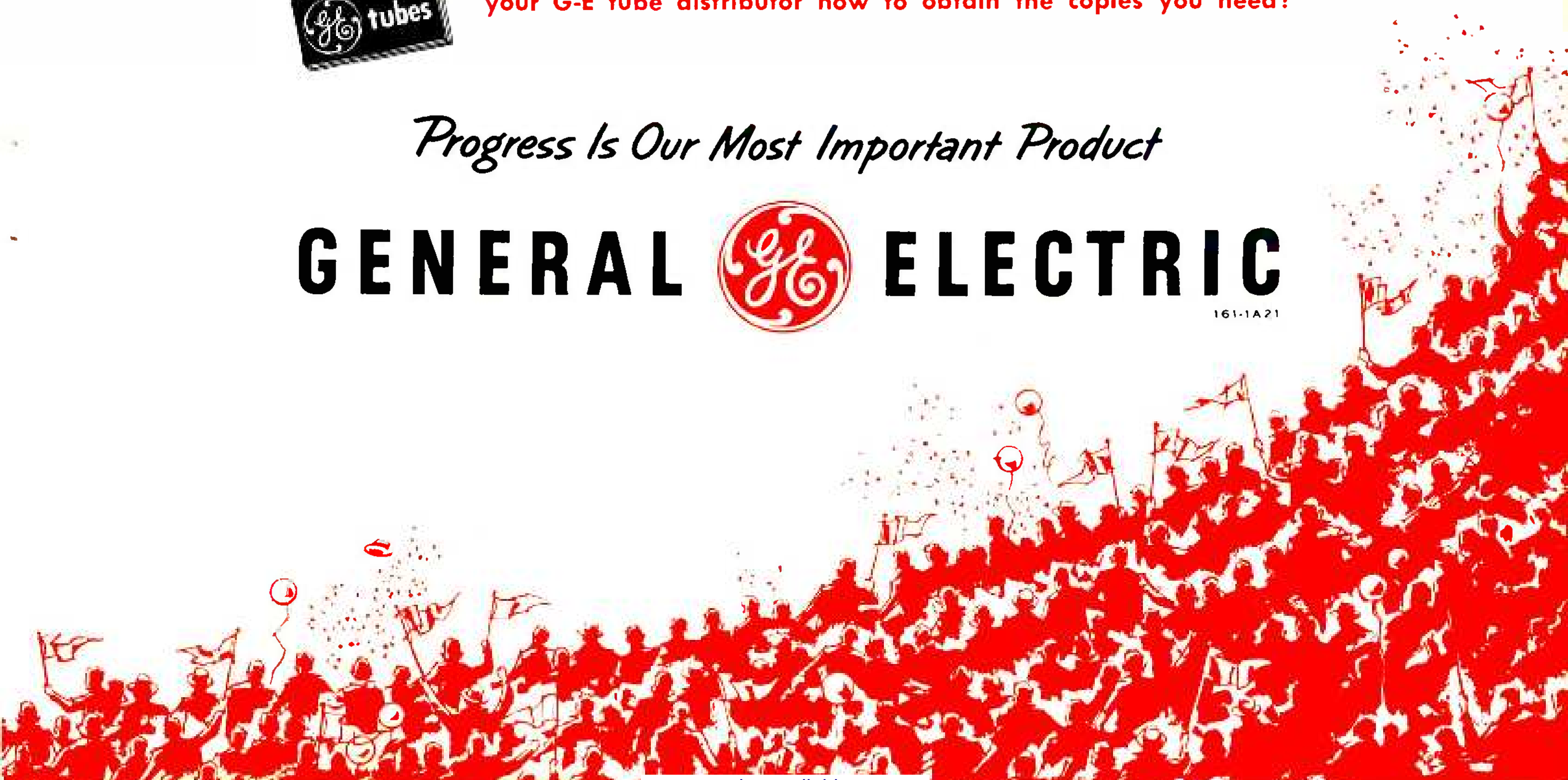
Phone your G-E tube distributor! Ask him how you can tie in *now* with this big General Electric fall campaign to strengthen your community standing, and underscore your reputation for service! *Distributor Sales, Electronic Components Division, General Electric Company, Owensboro, Ky.*

AVAILABLE IN QUANTITIES: 1957 college and professional football schedule, with space for your name and address. Everybody wants one. You can use this handy pocket guide to make friends for your shop and as All-American reminder advertising. Ask your G-E tube distributor how to obtain the copies you need!

Progress Is Our Most Important Product

GENERAL ELECTRIC

161-1A21



Letters to the EDITOR

Dear Editor:

As a novice radio-TV repairman, I certainly appreciated "Semiconductor Diodes" in your May issue. Too often, I feel that PF REPORTER "misses the boat" by not presenting enough basic articles regarding radio and TV theory. After all, a lot of your readers are in the same boat that I am.

Regarding Fig. 4B on page 71, I would appreciate your comments on the following:

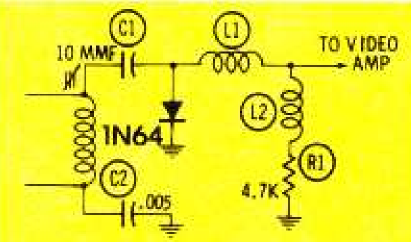
On the positive half cycle, does not the diode conduct through L1, L2, and R1, back to the cathode of the 1N64? Also, since this voltage is developed between L2 and R1, is that the reason for terming it negative voltage?

I am also assuming that, on the negative cycle, the 1N64 does not conduct at all.

What is the purpose of C1 and C2? Would not the impedance of C1 cause a loss of low video frequencies?

ROBERT MILLIGAN

Bartlesville, Okla.



(B) Shunt.

Fig. 4. Typical video detector circuits.

There is no circular conduction through L1, L2, R1, and the diode (see schematic) because there is no source of electromotive force within this circuit. The diode is in parallel with other components as part of a larger circuit for which EMF is furnished by the incoming IF signal. On the positive half cycle, the diode acts as a short circuit across the load and little or no voltage is developed. On the negative half cycle, the diode resistance becomes extremely high, and negative output voltage appears across the load. The polarity is negative because the direction of electron flow is from the top of the input transformer, through C1, L1, L2, R1 and ground to the bottom of the input transformer. C1 is a coupling capacitor, and C2 is a bypass in the B+ return of the last IF stage. Their reactances do not attenuate the video signal because it is still only a sideband of the high frequency IF carrier.—Editor

SHOCK HAZARD

Following the tragic incident resulting in the electrocution of a young boy in Skokie, Ill., we have had many inquiries regarding the shock hazards involved in the handling of transformerless TV sets.

For information on this subject, refer to "Hot-Chassis Safeguards," which appeared in the March, 1957 issue. This article deals with the insulating features incorporated in transformerless sets and the precautions the technician should take to make sure that these features have not been inadvertently defeated while the set was being transported or serviced.

In part, it mentions that voltage and resistance checks should be made following every repair to insure that the exposed metal parts are well insulated from the AC line. Even with a wooden cabinet, such parts as the antenna terminals, chassis bolts, speaker frames (particularly in consoles) and control shafts (knobs are sometimes broken or easily pulled off) can deliver a death-dealing blow if the insulating features have become ineffective.

Promote safety in your area by doing your part (and informing your customers of the dangers involved in tampering with sets) to prevent this shock hazard from taking another life.—Editor

Dear Editor:

I was most interested in "What's New In Batteries" published in your July issue, but regret that Mallory was not named as one of the companies making a solid electrolyte battery, since we were the first to publicly announce this product. Nevertheless, I enjoyed the story and, as always, delighted in looking through your fine publication.

GEORGE S. BOND

P. R. Mallory & Co.
Indianapolis, Ind.

Our sincere apologies for this oversight.—Editor

Dear Editor:

I have a new Emerson series-filament TV set in which the picture-tube and RF-amplifier tubes will not light up. All other tubes light. Would appreciate any immediate advice available.

STANLEY C. STRONG

Norwalk, Ohio

The RF-amplifier and CRT heaters are on the ground end of the filament string, in that order. Before reaching the RF amplifier, the filament current must pass through a feed-through capacitor in the tuner. Either this capacitor is shorted, or excess solder at the end connection of the capacitor is grounding the filament string, thus bypassing the two tubes in question.—Editor

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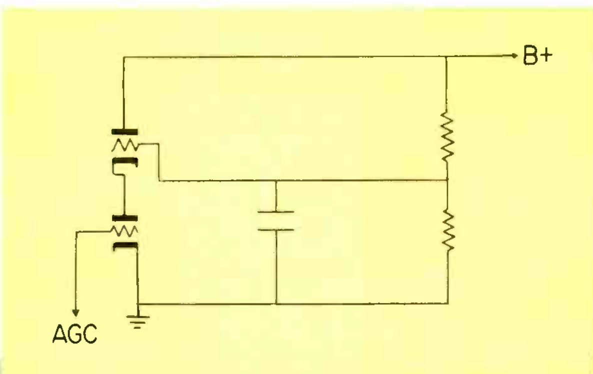
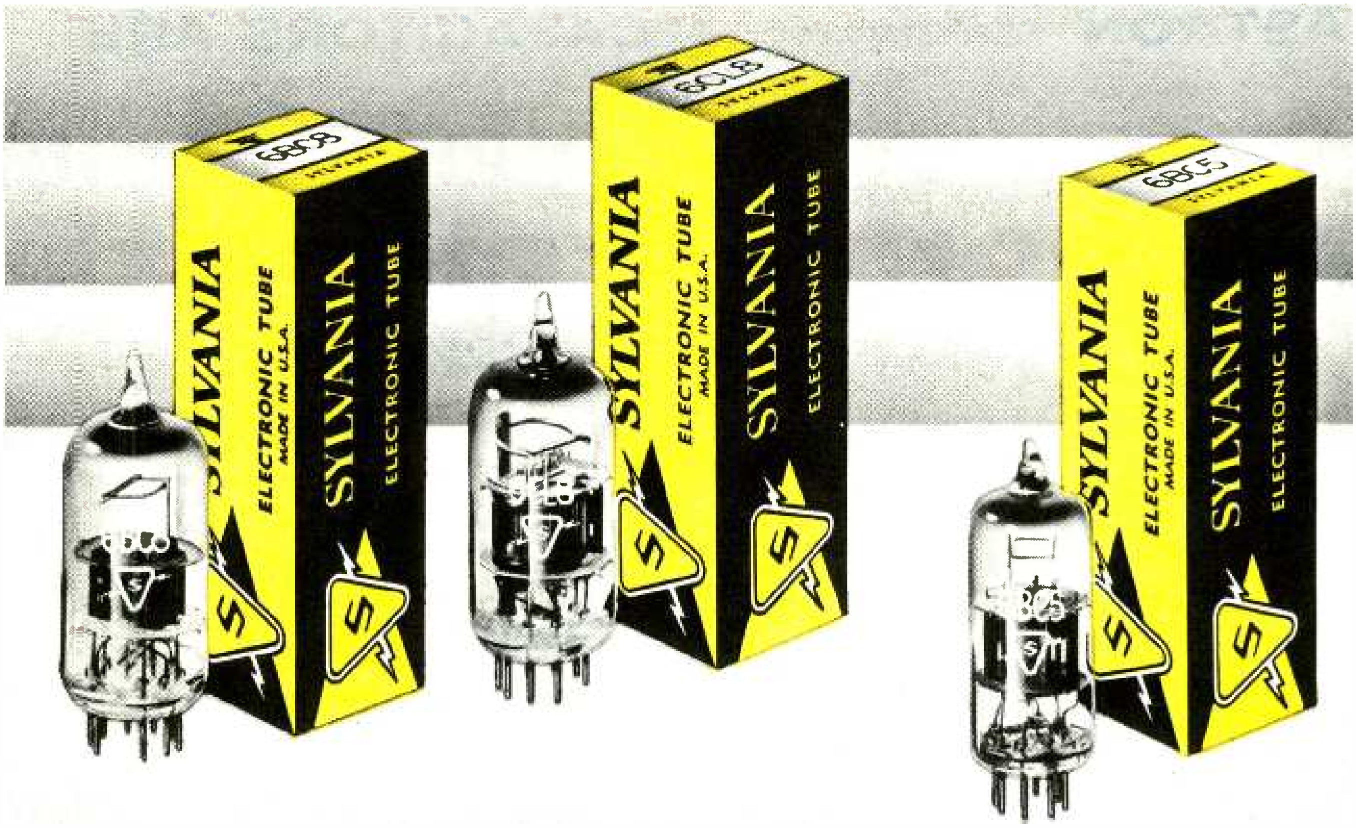
Sylvania TV Tuner Tubes

"R-X metered" at



Simplified schematic is a typical cascode circuit in which double-triode amplifiers are tested for transconductance and plate current under actual operating conditions. In this way, Sylvania offers you maximum assurance of proper circuit performance when you repair TV tuners. Regardless of make or model TV, Sylvania tuner tubes mean dependability backed by industry's most exhaustive dynamic testing program.

Type by type, Sylvania's own JEMC (Joint Engineering and Manufacturing Committee) establishes test conditions which represent the most realistic measure of a tube's ability to stand up in the sets you service. Their working knowledge of the needs of TV tuner manufacturers eventually means greater service profits through less callbacks for you.



200 mc for controlled, dependable performance

Measuring input resistance and capacitance of all TV tuner tubes at 200 mc, places important controls over gain and tuning characteristics. This and many other tuner tube tests have been developed by Sylvania to provide you with maximum assurance of dependable performance regardless of make, model, or age of the TV sets you service.

All tuner tubes are fixed-bias tested under conditions which simulate actual applications in TV sets. Cascode types are subjected to series Gm and series Ib tests in typical circuits. In addition, all types are checked both before and during life tests for serviceability at high and low line voltages.

Protect yourself against costly and unnecessary callbacks. Specify Sylvania TV Tuner Tubes in the new yellow and black carton.

SYLVANIA

SYLVANIA ELECTRIC PRODUCTS INC.
1740 Broadway, New York 19, N. Y.
In Canada: Sylvania Electric (Canada) Ltd.
University Tower Bldg., Montreal

LIGHTING · RADIO · ELECTRONICS · TELEVISION · ATOMIC ENERGY

Shop Talk

MILTON S. KIVER

Author of . . .
How to Understand and Use TV Test Instruments
and Analyzing and Tracing TV Circuits

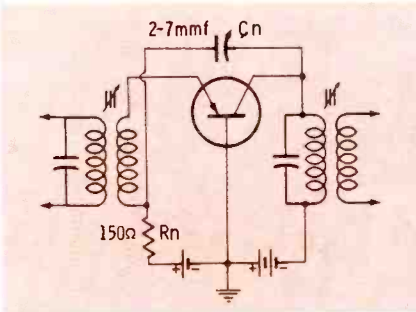


Fig. 1. A typical video IF amplifier using a surface-barrier transistor.

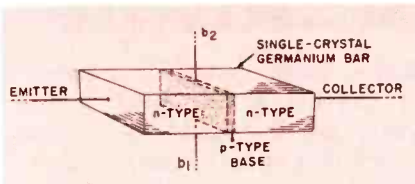


Fig. 2. Structure of tetrode transistor.

Transistor Applications in TV Circuits

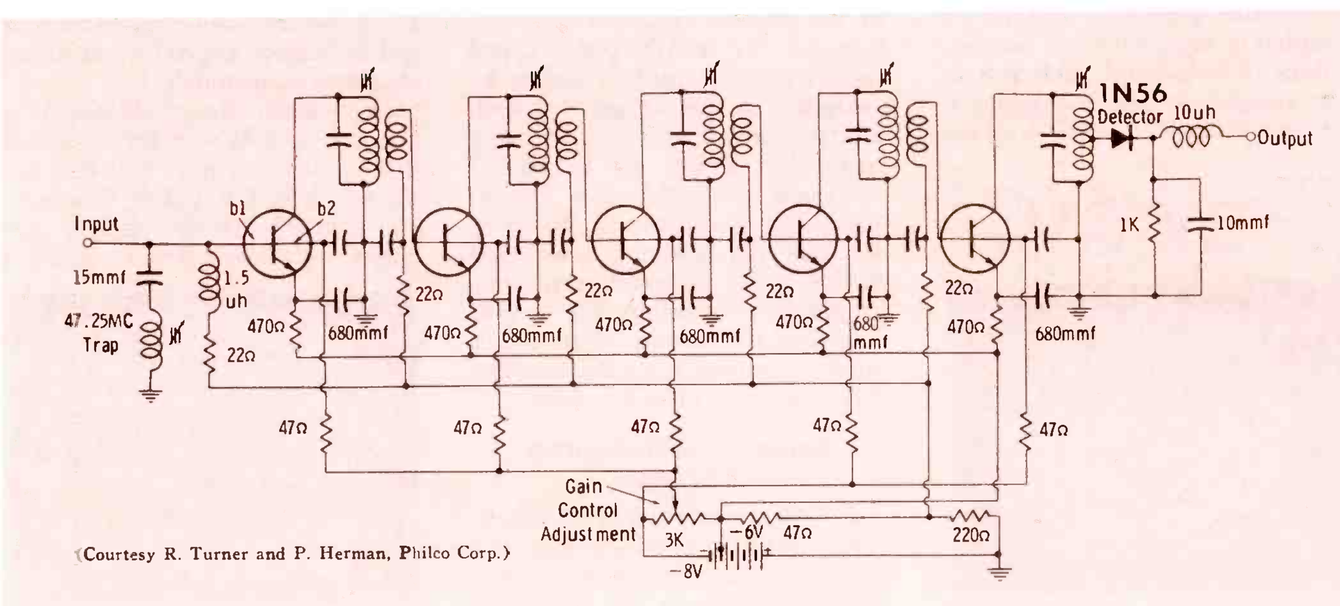
The use of transistors in radio receivers has already achieved a secure foothold. In television circuits, on the other hand, no commercial applications have been made to date, although there is considerable design work taking place in laboratories. With what we know today, about 90 per cent of a television receiver could be transistorized; however, the result would be a far more costly set. There is no doubt that transistorized television receivers will appear when the cost figures become more favorable or when space becomes a significant factor. Transistors could offer unequalled space advantages; for example, with a flat picture tube hung on the wall, the circuitry could be contained in a very small box.

In looking over the various sections of a typical television receiver, the first section where transistors currently could be employed, working forward from the antenna, is the video IF system. Since the present range of modern systems is between 41 and 46 mc, transistors with alpha cutoff frequencies of 50 mc or better would be required. (In case you have forgotten, the frequency characteristic of a transistor is given in terms of a cutoff frequency. This is defined as the frequency at which alpha drops to a value which is .707, or 3 db, below its low-frequency value. For amplifier applications, it is desirable to operate a transistor well below this cutoff frequency.)

There are several transistors commercially available at the present time suitable for this application. One is the Philco surface-barrier transistor which was described in the February, 1956 PF REPORTER.

A typical IF stage, using a surface-barrier unit, is shown in Fig. 1. The stage contains tuned input and output circuits and a neutralizing capacitor (C_n) and resistor (R_n) to prevent regeneration. With triode transistors, this is a very real danger and must be carefully avoided, usually by such means as shown in Fig. 1. Over-all stage gain on the order of 15 to 20 db is possible, although the band-pass of the stage would have a lot to do with this. The neutralizing components C_n and R_n form a bridge circuit with the internal base resistance and the collector capacitance. In vacuum-tube amplifiers the same basic approach is

· *Please turn to page 62*



(Courtesy R. Turner and P. Herman, Philco Corp.)

Fig. 3. A 5-stage, stagger-tuned transistor video IF system.

HORIZONTAL OUTPUT and high-voltage troubles

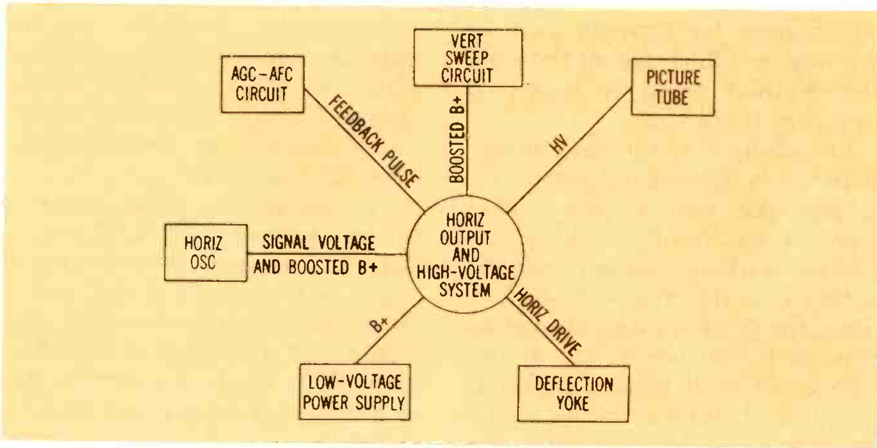


Fig. 1. Some of the circuits commonly associated with the flyback system.

Most modern television receivers employ a flyback type of horizontal sweep and high-voltage system which utilizes a horizontal oscillator and a horizontal output stage in conjunction with a matching transformer and damper circuit. There are three general types of flyback systems. One employs an isolated type of transformer in which the primary winding is completely separate from the secondary. The second includes an autotransformer which consists of one continuous, tapped winding with the primary and secondary composed of the turns between taps. The third type is the direct-drive system, employing a transformer which drives the high-voltage rectifier but not the yoke.

Other circuit variations may include such features as two damper tubes connected in parallel, AGC and AFC windings incorporated in the flyback transformer or as part of the width coil, tapped linearity coils, width controlled by variation of the air gap between the two halves of the transformer core, DC circuits for horizontal centering, resistors and chokes added for parasitic suppression, and specially-designed tubes used in the newer series-filament sets. In general, however, the circuit operation is the same. With this in mind, let's investigate the troubleshooting procedures involved.

EDITOR'S NOTE: The material in this article is based on a chapter from the book *TV Servicing Guide* ($2.00), by Leslie D. Deane and Calvin C. Young, Jr., a recent publication of Howard W. Sams & Co., Inc.

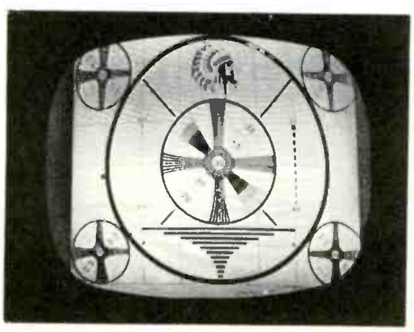


Fig. 2. Reduced width caused by a defect in the horizontal sweep system.

General Troubleshooting Procedure

A clear interpretation of the obvious symptoms involved is the first step toward locating and correcting troubles in any section of a television receiver. For example, when the horizontal output or high-voltage system is suspected of causing a particular trouble symptom, it should be remembered that other circuits in the receiver may be equally capable of producing the difficulty. The diagram of Fig. 1 indicates some of the circuits directly or indirectly associated with a typical flyback system. A process of elimination will be helpful when any of these circuits are suspected of causing the trouble.

Once it has been established that the trouble is isolated to the flyback system, there are still a few problems to solve. All too often, technicians are guilty of suspecting a defective transformer or yoke but not doing too much about it until all other possibilities have been exhausted. The problem of determining the condition of a flyback transformer is often a tough job unless a direct substitution is made. A resistance check will reveal an open or completely shorted winding, but it will not indicate a partial short or an impedance mismatch.

In general, the troubleshooting procedures followed for checking flyback transformers will also apply for deflection yokes. Commercial instruments for checking flybacks and yokes are now available

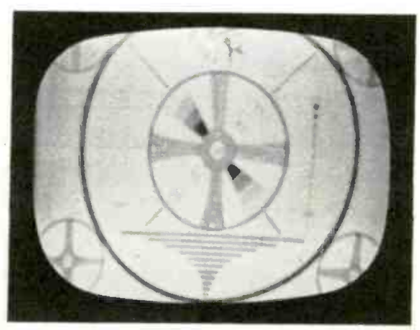


Fig. 3. Picture blooming caused by insufficient high voltage.

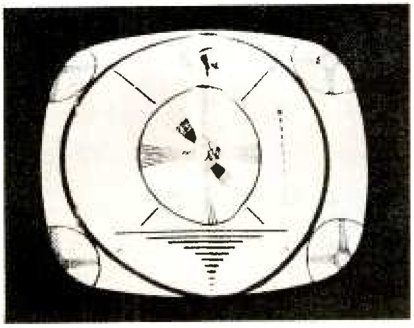


Fig. 4. Horizontal foldover affecting the center portion of the picture.

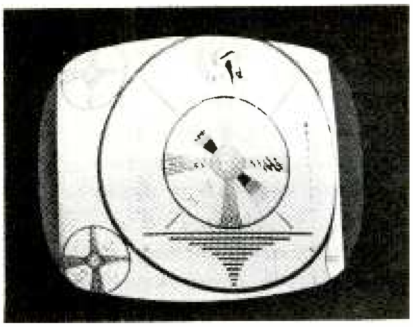


Fig. 5. Horizontal foldover on the right side of the screen.

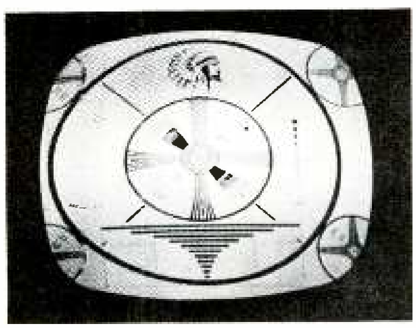


Fig. 6. A typical symptom of horizontal nonlinearity in picture.

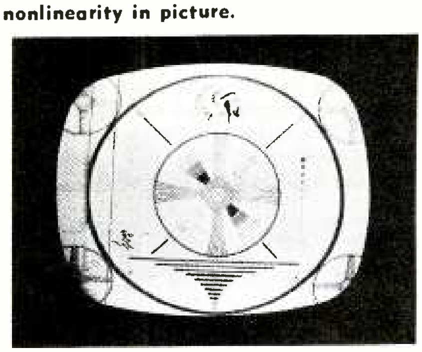


Fig. 7. Barkhausen oscillation as it may appear with a weak signal.

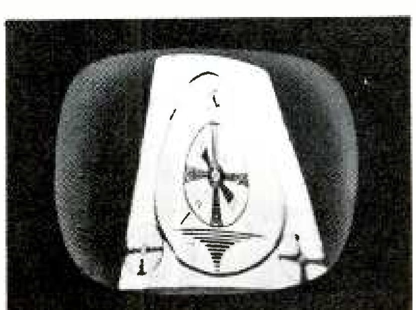


Fig. 8. Keystone effect caused by a shorted winding in the deflection yoke.

to the service technician. These units, which have proved very successful and are highly recommended, will test the suspected components without the necessity of removing them from their respective circuits. Regardless of the accuracy of any checker of this type, however, the only entirely foolproof method is still direct substitution.

Flyback transformers are somewhat sensitive to temperature, humidity and dust, and can develop short circuits or internal arcing. One way to determine whether a flyback is defective is by simple observation. A shorted flyback transformer will usually overheat, evidenced by melted wax around the transformer or an odor of smoke or burning. Flashes in the picture accompanied by popping or snapping sounds are typical symptoms of arcing in a flyback transformer. A close inspection of the transformer and high-voltage leads may reveal the point of arc-over.

Common Symptoms

Despite the circuit variations previously mentioned, there are a number of symptoms which can be attributed commonly to defective components in the flyback system. The following material shows photographs of these symptoms, describes them briefly, and lists the usual causes for each of them.

No Raster

Perhaps the most frequently encountered symptom of trouble stemming from the horizontal output and high-voltage system is loss of raster. This condition usually results from a lack of high voltage on the second anode of the picture tube. The presence of normal sound is an additional symptom pointing to difficulty in this section of the receiver.

When the technician is confronted with symptoms of no raster and normal sound, the operation of the brightness control should be checked first. Then a test for high voltage should be made. If sufficient voltage is found on the picture-tube anode, the trouble may be due to a defective picture tube, a faulty brightness-control circuit, or a misadjusted

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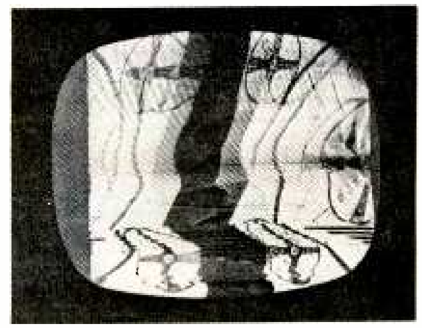


Fig. 9. Erratic horizontal synchronization with a reduction in picture width.

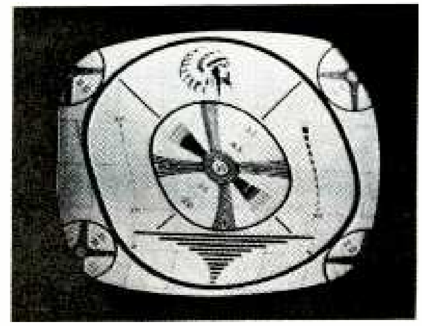


Fig. 10. Picture pulling caused by trouble in the horizontal output stage.

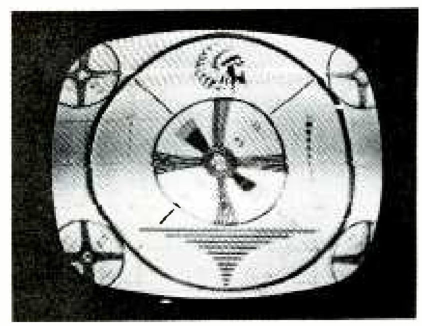


Fig. 11. Effects of high-voltage arcing as they may appear in the picture.

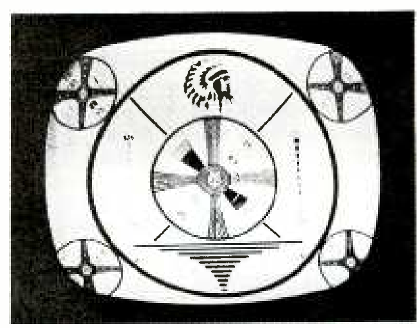


Fig. 12. A slight case of yoke ringing accompanied by reduced picture width.

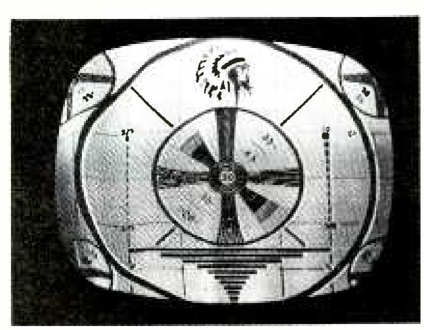
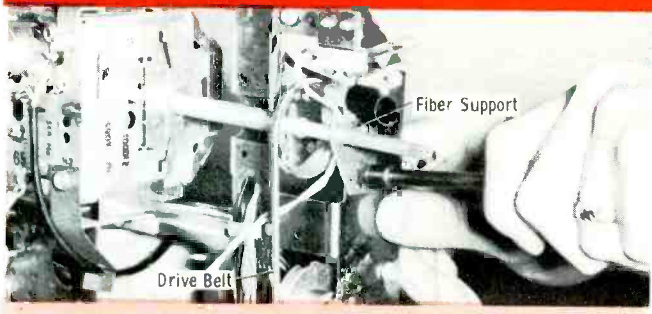


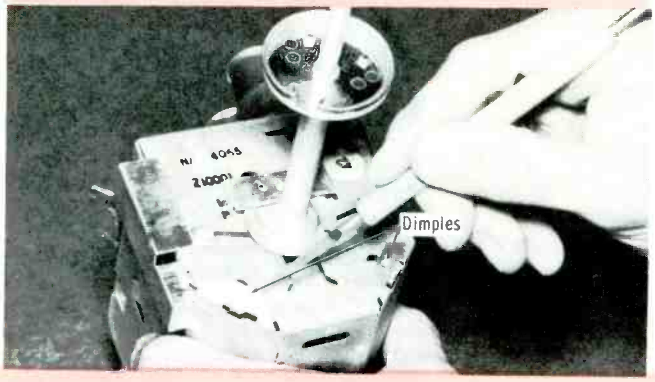
Fig. 13. Picture distortion resulting from a severe case of yoke ringing.

DISMANTLING A TURRET TUNER

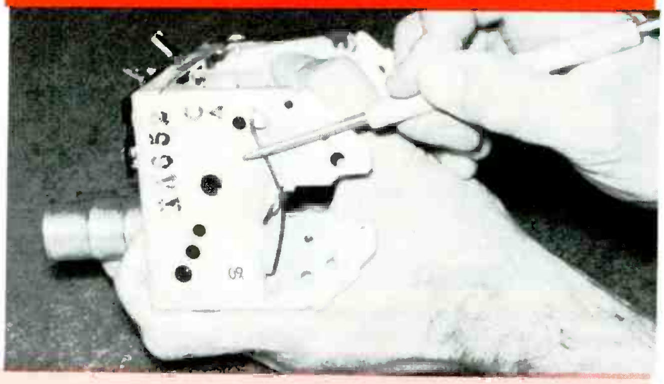
In most cases, the turret tuner in a TV set may be easily disassembled for servicing without removing it from the receiver chassis. We have shown the tuner unmounted for most of this coverage because of photographic considerations. Basically, there are two reasons for removing the turret drum from a tuner—first, to clean and relubricate the contacts and, second, to check or replace circuit components.



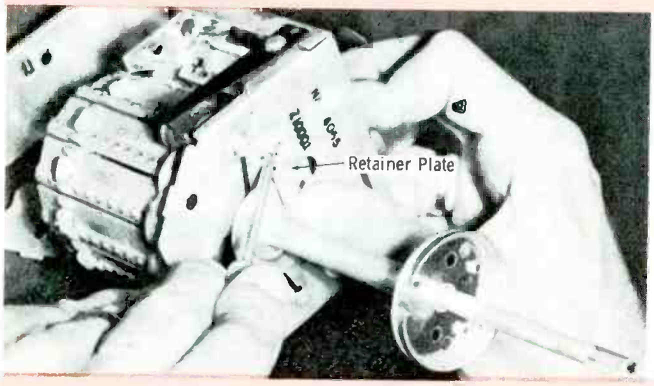
After the decision has been made to remove the drum assembly, a visual inspection should be made to determine which parts have to be removed before the drum itself can be removed. The small fiber support on the shaft should be the first thing taken off and the last thing reinstalled. The fine tuning drive belt (a long spring) must also be removed in this case.



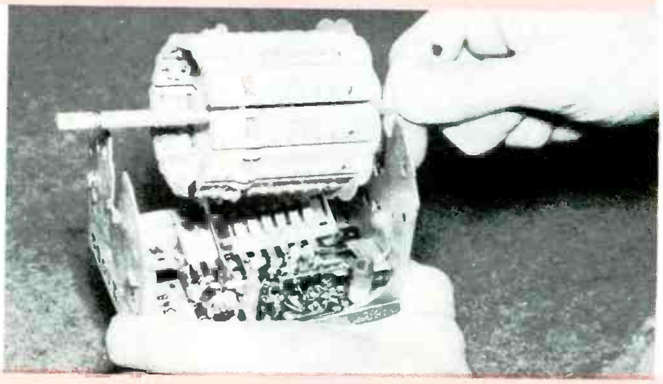
Next, the cover assembly should be removed. There are dimples at several points which must be released. This is done by gently prying with a screwdriver or soldering aid as shown. When all gripping surfaces have been freed, the cover will slip off.



The drum is held in place by springs at both front and rear. The forked end of a soldering tool makes the removal of these springs very simple and keeps spring action under control. NOTE—on the Neutrode tuner, the larger spring secures the rear portion of the drum.

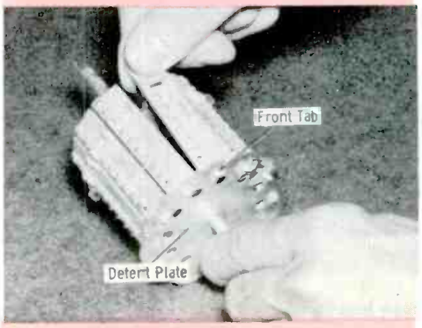


The retainer plate over the fine tuning assembly is removed by pressing it in the center and prying slightly outward on one end. The fine-tuning assembly may then be removed by slipping it off of the channel selector shaft. In some tuners, rotation of the fine-tuning shaft will permit its removal without the necessity for this action.

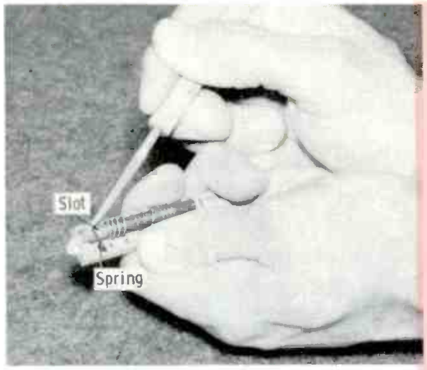


After removing the detent assembly, the drum may be lifted out of the tuner housing. This permits easy access to components and the contact assemblies.

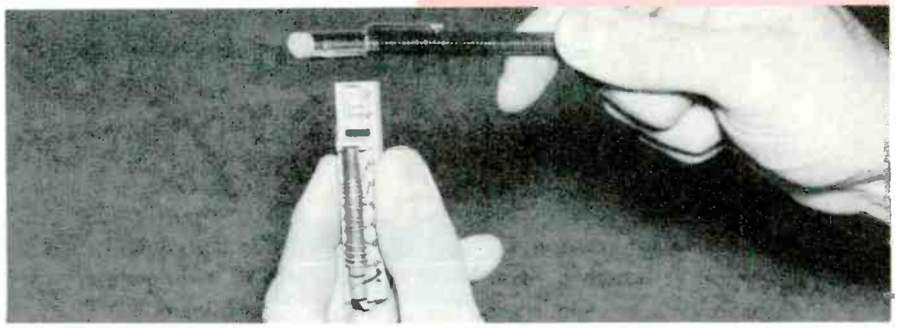
The turret strips, one for each channel, may be removed from the drum by pressing the spring clip toward the rear and gently lifting this end of the strip to clear the spring. Be careful not to force the strips—too much pressure will cause them to break.



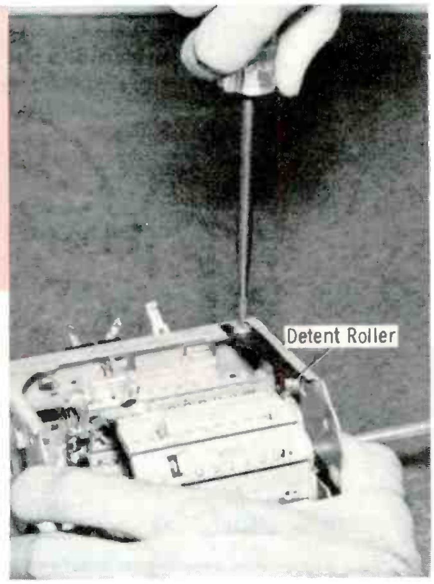
The strip is reinstalled in the drum by fitting the front tab into the hole in the detent plate and gently pressing until the spring catch slips through the hole in the strip and snaps into place.

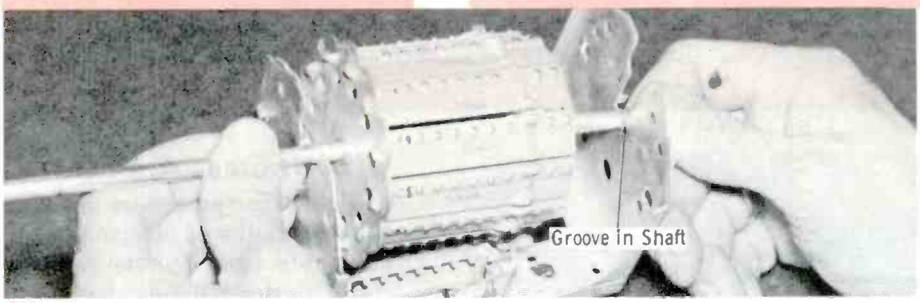


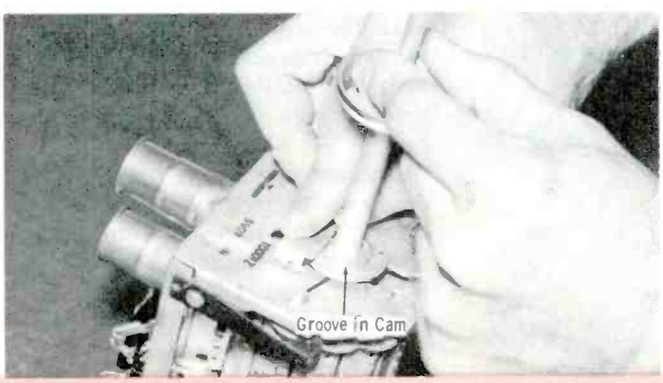
If the oscillator tuning slug should drop into the coil, it can be returned to position by slipping the spring out of the slot in the coil form *(left)* and tapping the other end of the strip with a pencil *(below)*. When the tuning slug has dropped back into position the spring may be slipped back into the slot so that it engages the threads of the tuning slug.



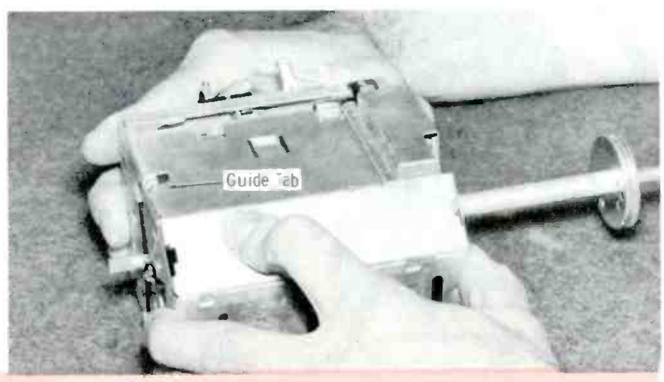
In replacing the drum, position the shaft so that the groove engages the rear housing plate *(below)* and then install the spring retainers. The detent roller can now be reinstalled and securely fastened in place *(right)*.







Slip the fine tuning shaft into place and engage the point on the lever in the groove of the fine tuning cam. While pushing the cam toward the tuner housing, install the retainer plate by engaging one side and then pressing on the other side until it snaps into place.



Reinstall the shield (bottom cover), making sure that the guide tabs pass under the top edges of the housing. The cover should snap firmly into place under normal pressure.

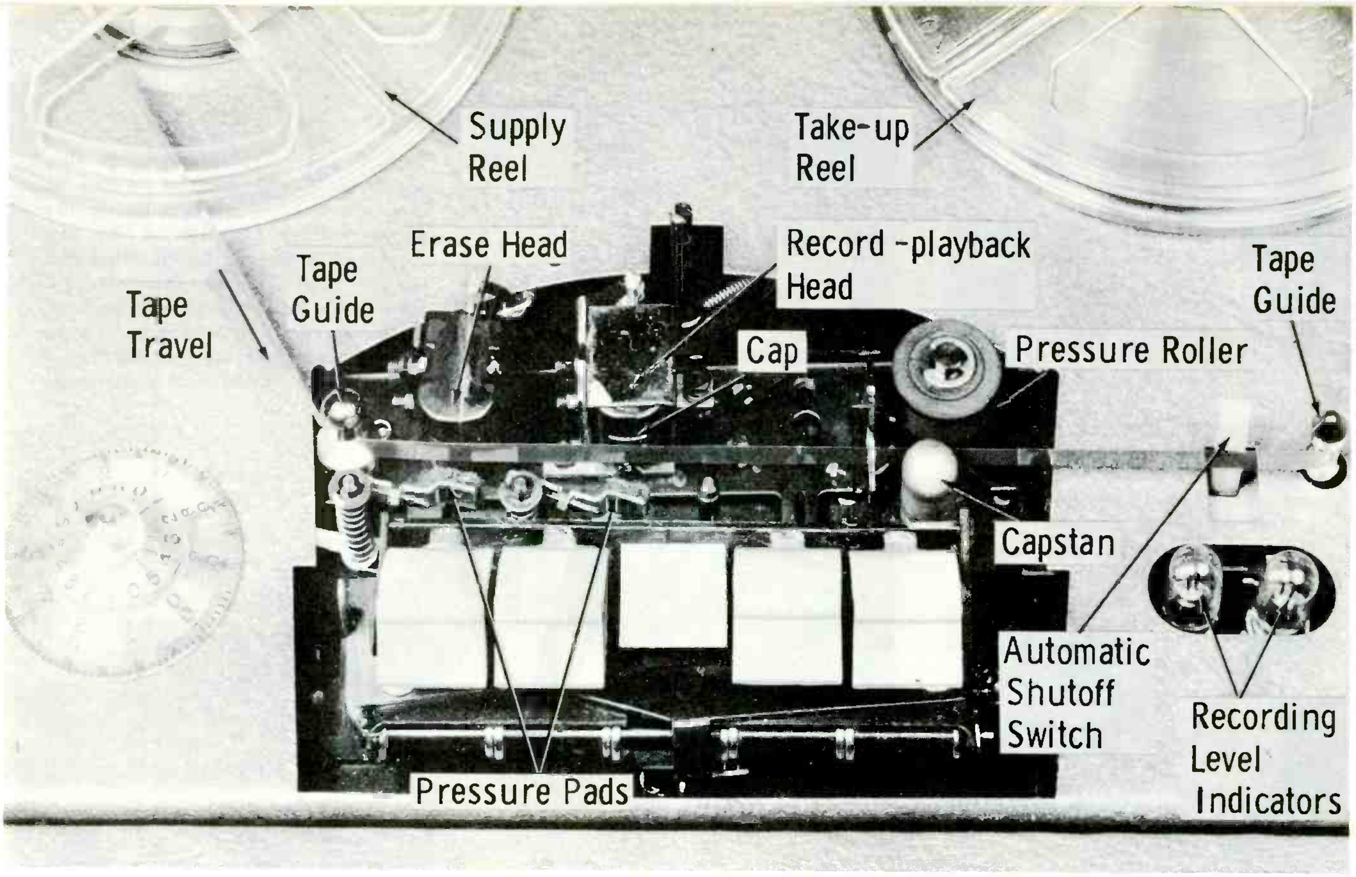


Fig. 1. Top panel of V-M Model 710 with cover removed to expose heads.

essentials of Tape-Recorder Servicing

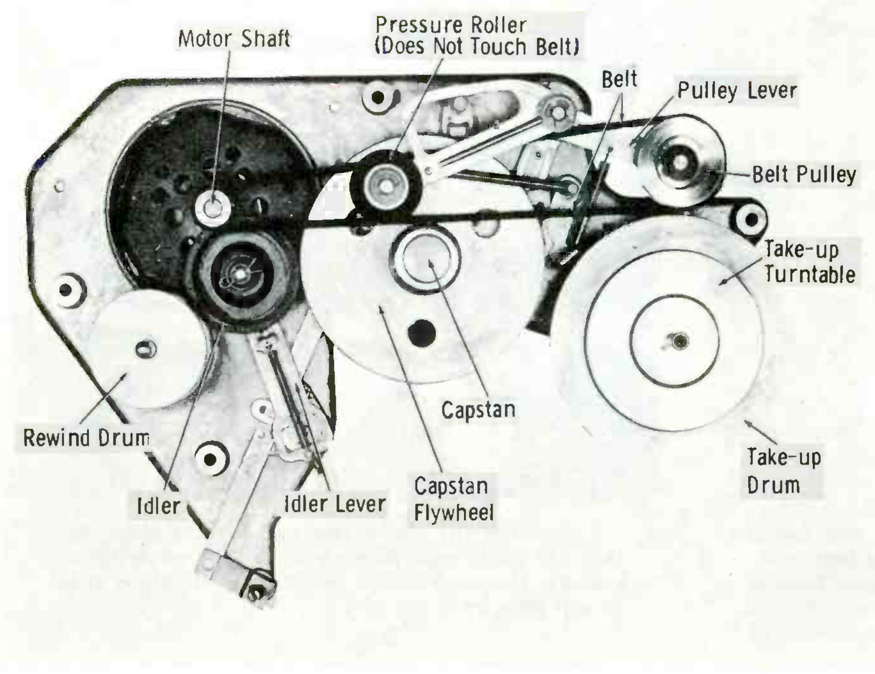


Fig. 2. Transport mechanism of Continental Model 220 tape recorder.

by Thomas A. Lesh

Magnetic tape recorders are fast joining the ranks of electronic devices widely used by the general public. This development has been speeded up during the past several years, as recorders with extended frequency response have become available in the same price range as table-model TV sets.

Present-day home tape recorders owe their good performance largely to precision in tape-handling mechanisms, and therefore these must be maintained in top-notch condition to give satisfactory service. Wear, slippage, or dirt in the mechanical drive system can cause loss of sensitivity, distorted sound, or the annoyance of spilling or breakage of the tape. And, of course, purely electronic defects also develop at times. A lot can be done by the radio-TV technician to renovate a defective or neglected tape recorder, if he knows which maintenance operations are likely to be needed—and, on the other hand, if he knows what jobs not to attempt while servicing a recorder.

Review of Magnetic Recording

Before any troubleshooting procedure is described, a summary of the normal operation of tape recorders will be presented.

The recording medium is a thin ribbon of "Mylar" plastic or cellulose-acetate tape, ¼" wide, on which a layer of iron oxide powder has been deposited. Also included in the tape coating are a binder to hold the oxide particles together, a plasticizer to keep the tape flexible, and a lubricant to help it pass smoothly over the tape guides. Tape is furnished on plastic reels in 3", 4", 5", and 7" sizes for home use.

Recording is a process of magnetizing the oxide so that it behaves like a series of tiny bar magnets lined up lengthwise along the tape. The magnetizing agent is an electromagnet called the "record head" which is fed an audio signal from an amplifier. The core of this magnet has a narrow gap, and when placed next to this gap, the tape serves as the path of least resistance for the magnetic flux and thus becomes magnetized. As the tape is moved past the gap at a steady speed, the length of each "magnet" induced on the tape is inversely proportional to the frequency of the audio signal, and its strength is directly proportional to signal amplitude. Gap widths are made extremely small—from .00025" to .0005" in commercial units—in order to reproduce high frequencies at relatively slow tape speeds.

To play back pre-recorded material, the magnetized tape is passed across the gap of an electromagnet similar to the one just described. Some of the lines of force surrounding the "magnets" in the tape are routed through the core of the electromagnet where they generate current in the coil, which is connected to the input of a high-gain amplifier.

Tape will stay in the recorded condition for many years, but it can easily be demagnetized or "erased" and then reused. The most popular method of erasure is to apply a supersonic AC signal of high amplitude to the tape. A separate "erase head," somewhat similar to the record head in construction, is ordinarily used to demagnetize the tape just before it reaches the record head. Erase-signal frequencies vary widely among different makes of recorders, but a typical value would be in the vicinity of 50 kc.

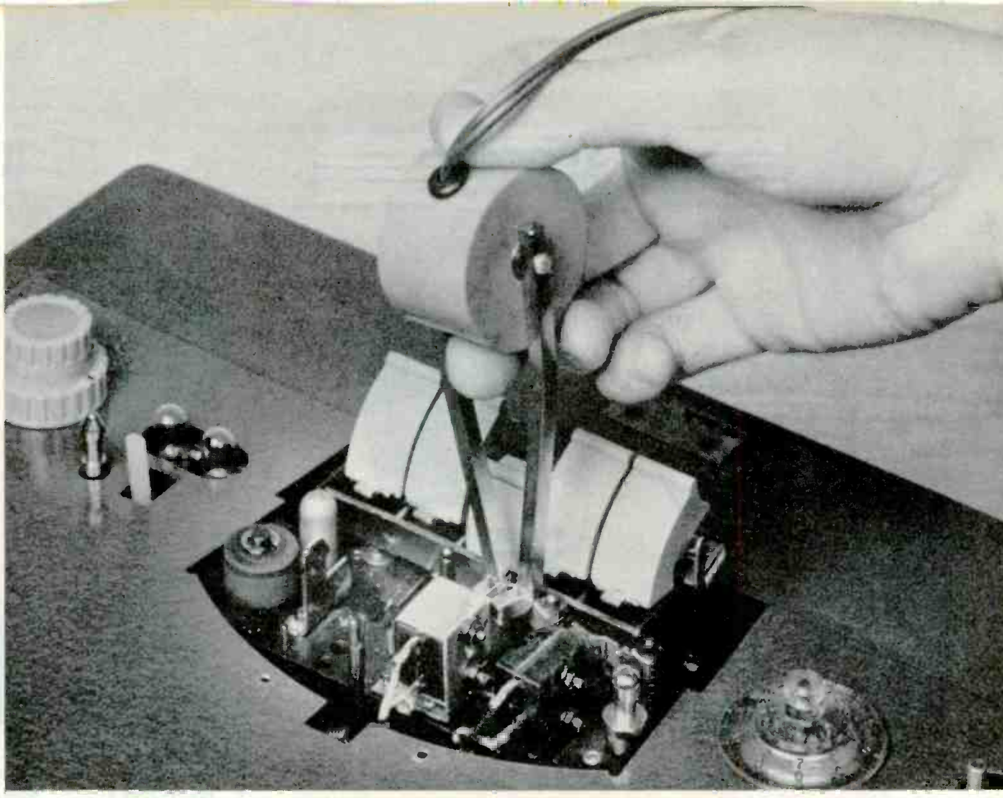


Fig. 3. Demagnetizer (Audio Devices Type 400) being used on a record head.

Some of this supersonic signal is also utilized during recording as "bias." Superimposing the audio signal on this bias signal, rather than applying pure audio directly to the record head, serves to minimize distortion caused by hysteresis (lag between the magnetic field and the energy which produces it) in the head.

Fig. 1 shows the magnetic heads and adjacent parts of a typical home tape recorder. In these machines, it is common practice for one head to serve for both recording and playback. A separate erase head at the left "wipes clean" the tape. Some recorders have both heads contained in a single housing, but these are still completely independent in operation.

Vertically the gap openings are less than half the width of the tape, and they are oriented so that they affect only the top half of the tape; therefore, two parallel tracks can be recorded on each reel. When the first track is finished the full reel can be lifted off

· *Please turn to page 71*

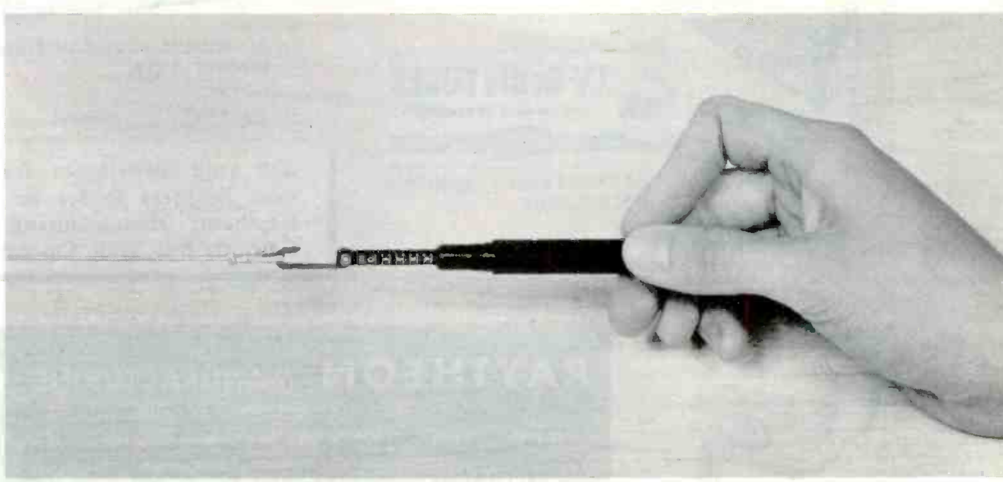


Fig. 4. Spring scale, which measures pulling forces up to 8 oz., for making torque and pressure measurements in tape transport mechanisms.

DOOR BAR

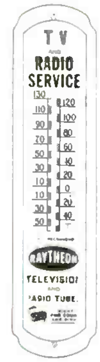
TRUCK DECAL

TV SCREEN POLISHING CLOTH

ILLUMINATED CLOCK

TUBE AND TOOL CARRYING CASES

OUTDOOR THERMOMETER



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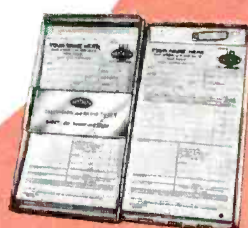
RAYTHEON

TUBE DISTRIBUTOR FOR THEM

DISPLAYS

OUTDOOR HANGING METAL SIGNS

Pictured are but a few of a most complete line of tested and proven shop, sales and business aids Raytheon has produced for you. All of them are specially designed to help make your work easier and more profitable. Many are free and the rest available to you through your Raytheon Tube Distributor at far below normal cost.



ALUMINUM Snap-Out-Form POCKET CASE

TRANSPARENT WINDOW STREAMERS

Ask your Distributor for the new Raytheon Business Builders folder or write to Department P Raytheon Manufacturing Company, Receiving and Cathode Ray Tube Operations, Newton 58, Mass.

RAYTHEON MANUFACTURING COMPANY

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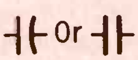
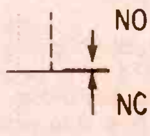
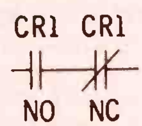
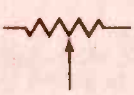
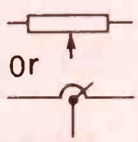
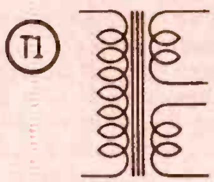
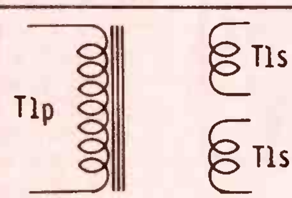
SERVICING INDUSTRIAL ELECTRONICS

part • 1

EXTRA DOLLARS from INDUSTRIAL SERVICE

by Melvin Whitmer

Table I—Schematic Symbols in the Radio and Industrial Fields

RADIO SYMBOL	COMPONENT	INDUSTRIAL SYMBOL
	Resistor	
	Capacitor	 Only
	Relay Coil	
	Relay Contacts	
	Potentiometer	
	Transformer	

EDITOR'S NOTE: This article marks the beginning of a new series which will appear monthly in PF REPORTER, and which comes about as the result of an almost overwhelming number of requests from our readers to present information on industrial electronic servicing.

As the series progresses, detailed data on specific phases of this type of work will be presented. Part II, for example, deals solely with heat-sensing and temperature-controlling devices, and future articles will cover such varied subjects as chemical-sensing, ultrasonics, control devices, etc.

A few years ago, when the use of electronic equipment in industrial processes involved no more than motor controls, simple timers and photoelectric cells, industry relied on the manufacturer for both installation and service. Factory service was highly practical because there wasn't very much equipment in use. Nowadays, however, because the applications of industrial electronics are so far advanced in both complexity and number, industrial service departments are not always able to answer a call immediately—to the point where the delay may extend to several days. Because a production line may be shut down when electronic equipment fails, this, in turn, means delays that are very costly to the producer. Thus, to reduce down time and production costs, a trend is developing among medium-sized manufacturing plants towards calling in a local firm when factory service is not available.

The general radio-TV service shop owner who is on the lookout for additional revenue might do well to cast an eye on the electronic servicing needs of industry. Industrial service by independents is comparatively new, and organizations who make a name for themselves now will remain the leaders in their area when competition in this field increases. An additional advantage accruing to the shop owner is that the slack periods tend to offset each other in a shop actively engaged in the servicing of TV, home and car radios, audio systems and industrial electronics.

Additional profits and a more stable business, however, are not acquired without effort—and industrial servicing is no exception. To do the job that's called for, the serviceman must arm himself with electronic and electro-mechanical knowledge which he may have learned at one time or another, but has not had occasion to apply and therefore forgotten. Electronically, he must refresh his memory on photocell characteristics, thyratron operation and AC power controls. The electro-mechanical aspects include re-

• Please turn to page 76

HICKOK

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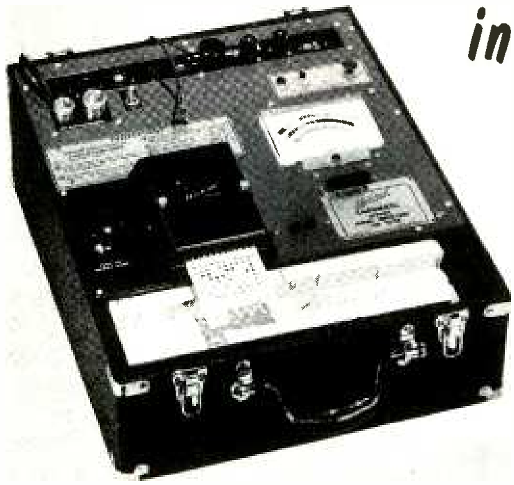
Basically NEW Development in Tube Tester Design in over 25 Years



MODEL 123A

Cardmatic®

1 Shorts-Leakage

2 Quality Value

3 Gas Content

8-Second HIGH-SPEED Test
(after tube warm-up)

Automatic and by far the Fastest, but . . . the real news is the Greatly Improved Circuit of this equipment which is the first important New Tube Tester Design in the past 25 years.

300% MORE ACCURATE: Tests Gm to an accuracy of 1%
(Most portable Gm testers attain 5% accuracy or less. Emission type testers cannot test for Gm and therefore have very poor performance in detecting weak tubes.)

SCREEN and PLATE VOLTAGES: 12 to 160 volts
This wide selection of voltages protects against obsolence. For instance, new car radios use 12 volt plate voltage.

FILAMENT VOLTAGES: 0.1 to 119.9 volts in 1/10 volt steps
More and more tubes are now in use with odd filament voltages. The 123A will accurately test all of them at their exact filament voltage.

200 MA LOAD ON RECTIFIER TUBES:
This gives an accurate test of the operation of a rectifier tube under load.

NEW KNEE TEST:
This new test evaluates the ability of a tube to perform in TV horizontal or vertical output circuits. As a tube gets older it loses its ability to deliver current which results in non-linearity of raster, (crowding of the raster where one side pulls away, etc.). The 123A tests this "Knee" point to determine whether the tube will cause trouble in a TV set.

TESTS SHORTS and LEAKAGE TO 20 MEGOHMS
(Users have detected as high as 50 megohms leakage.)

EXTRA SENSITIVE GAS TEST and Grid Emission Test
Here is what a CARDMATIC user said, "My 123A paid for itself in 2 months simply by weeding out weak tubes in four kinds of TV circuits—Horizontal Output, Damper, Rectifier, I.F. This is in addition to time saved me in hit-or-miss tube substitution or hunting for other troubles when the tube was actually at fault. Another said, "My wife tests all the radio-TV tubes in my shop. She says the 123A saves her so much time she absolutely will not give it up."

Ask your jobber for a free demonstration of the 123A CARDMATIC in your shop.

Free technical booklet is available.

This equipment includes the New Hickok Service-Instruction Warranty

Write to . . .

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10523 Dupont Avenue • Cleveland 8, Ohio

Stark Electronic Sales Co., P.O. Box 2407, Ajax, Ontario, Canada
Export Department, 431 Fifth Avenue, New York 16, N. Y.

BY JOHN MARKUS

Editor-in-Chief, McGraw-Hill Radio Servicing Library

Check List. People who have learned to eliminate obvious troubles themselves are generally more willing to pay fair charges for service work. After checking half a dozen simple things, they consider the trouble as something serious which definitely requires an expert.

A list of simple checks, with your name, address, and phone number at the bottom, makes ideal copy for a promotion tag which the customer can tie to the back of his set. It can also be used on post cards with the suggestion that the customer Scotch-tape the card to the back of his set.

One check list can be applied to both radio and television sets, or two separate lists can be used, thus giving you two promotional items. These cards are ideal for use as hand-out material at fairs and in your own shop, because the customer feels that he getting something worth saving. The list is also right in step with the current do-it-yourself trend, yet it does not lose any worthwhile service jobs for you. Here is an example of the wording you might use for such a promotion:

HOW TO SAVE MONEY ON TELEVISION AND RADIO SERVICE

If Your Set Goes Bad,
Make These Simple Checks First:

1. Is the set plugged in?
2. Is there power at the wall outlet? Try a lamp. If it doesn't work, check the power line fuse.
3. Check the AC cord for obvious breaks or damaged insulation.
4. Turn on the set and check the settings of all controls carefully.
5. Check the antenna connections at the back of the set. If one has fallen off, you can put it back on with a screwdriver with no danger of shock.
6. Are you sure the station is on the air?

If the trouble continues, call us for expert service.

Name, address, phone number.

To avoid losing this card, Scotch-tape it to the back of your set.

Tension. Tension is a part of everyday living. We actually enjoy certain tensions, such as those which occur when watching a ball game or a murder mystery on TV.

The tensions associated with making a living in our business world today are no different from those of our ancestors—only the causes are different. Where they worried about famine, epidemic diseases and attacks by savages, we worry about competition in the business world, incompetent bosses, unpleasant customers and a host of other things closely associated with modern living.

Sometimes these ordinary tensions get out of hand, making a normal work load seem unbearable. Little things which go wrong daily take on undue importance, and the resulting worry increases tension so that it may actually become a threat to mental health.

A new booklet available from National Association for Mental Health, 10 Columbus Circle, New York 19, N. Y., "How To Deal With Your Tensions," lists 11 things you can do to relieve the strain:

1. Talk it out.
2. Escape for a while—lose yourself in a movie, game or trip.
3. Work off your anger—clean out the garage, spade the garden, build something, take a long walk, or go bowling.
4. Give in occasionally, even when you're dead right. It's easier on your system.
5. Do something for others.
6. Take one thing at a time.
7. Shun the "superman" urge—stop trying for perfection.
8. Go easy with your criticism—look for the good points in others.
9. Give the other fellow a break.
10. Make yourself "available"—don't always wait to be asked.
11. Schedule your recreation—plan your evenings, weekends and vacation time so you forget about your work.

$ & ¢

Pilot Lamp. Failure of a simple pilot lamp on an 80-passenger airliner kept the plane circling for 90 minutes over an airport recently, with passengers worrying about whether they would get back to earth safely. This lamp was supposed to come on when the left landing gear was properly locked in position for a landing. The pilot had no way of knowing whether his indicator was working properly, hence had to play safe and circle until other pilots flew under him for a close inspection of the landing gear. After they reported it appeared normal, the airliner was brought down safely.

This story points up the importance of little things. The burned-out bulb was no bigger than a peanut and probably cost only a quarter, but it sure made a lot of trouble. The same holds true in television and radio; a simple hairline crack across a printed circuit wire, practically invisible, can run into many hours of service time if the connection makes and breaks in response to the slightest changes in temperature.

Most of the other troubles we run into in everyday servicing are equally simple and equally easy to fix once they are located. Your most valuable weapon here is clear thinking backed by knowledge of circuit behavior, so that you can reason from effect to cause and make a methodical planned attack on those exasperating troubles.

Basic Properties of the COLOR SIGNAL

by Robert G. Middleton

Discussion with TV technicians in various sections of the country reveals that some of the basic properties of the color-TV signal are misunderstood, in spite of the fact that efficient and intelligent servicing of color-TV receivers require that these fundamentals be clearly recognized.

For example, try asking yourself a few questions:

1. In color signal substitution work, do we use the same generator output for all receivers?
2. When the fine-tuning control is misadjusted to permit the appearance of sound bars in the picture, should the screen of the picture tube display a blue hue?
3. Should the blue bars be brighter than the red and green bars when the receiver is driven from a rainbow generator?
4. Is there a simple rule which we can follow to align *any* color-demodulation system?

Answers to these, and other questions you may have, will be found in the following discussion.

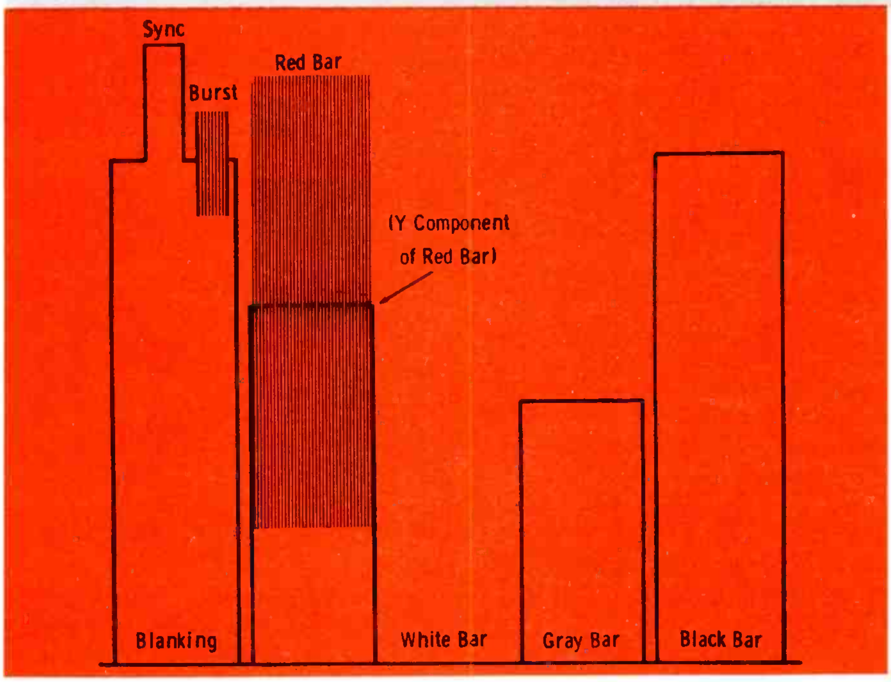

Fig. 1. Sample components of a composite color signal.

Signal Substitution Tests

Nearly all commercial color-bar generators provide a modulated RF output—sometimes on one of the low channels and sometimes tunable over the range from channels 2 to 6. This type of output is applied to the antenna-input terminals of the receiver. When the generator provides a tunable output over a number of channels, the instrument is more useful because it can be used to test tuners. You will occasionally encounter tuners which will pass the frequencies necessary for black-and-white reproduction, but not the 3.58-mc chrominance signal which is vital to the reproduction of color. This fault is caused by a bandpass response which falls off drastically at the color subcarrier frequency or which is peaked sharply at the picture carrier frequency. When a color-bar generator has tunable output over channels 2 through 6, you will find that the harmonics are useful for checking tuner response on the high band. The output is less, but a test can be made, which is far better than being in the dark.

No color-bar generators designed for the service field provide a modulated IF output. Hence, it is not possible to inject test signals of the proper frequency into the IF section. The next point of signal injection after the antenna-input terminals is the grid of the video amplifier (output of the video detector). Of course, some color receivers have a separate chroma detector, and a test of both circuits will be required in some cases.

First, let us consider the type of receiver in which the chroma signal and the Y signal pass through the same video detector. We can apply a video-frequency color-bar signal at the detector output and observe with a scope the circuit response between this point and the picture tube; however, the following requirements must be kept in mind:

1. The video output from the generator must have enough, but not too much, voltage. For proper operation, most receivers require from 1 to 2 volts peak-to-peak at this point.
2. The video output of the generator must be of the correct polarity. Some detectors provide a negative-going output, while others will have a positive-going output.
3. The output impedance of the generator must be rather low if the test is to be made without disconnecting the detector diode from the circuit.

Let's take a brief look at these requirements. First of all, it is quite understandable that if the output of the generator is limited to a nominal value of 0.1 volt, the video amplifier will not be driven hard enough to provide a normal output. On the other hand, if a 5-volt signal were used, the video amplifier could easily be driven into saturation and/or cutoff, resulting in severe distortion.

• *Please turn to page 78*

QUICKER SERVICING

by Calvin C. Young, Jr.

Mysterious Case of the Melted Balun Coil

The other day, while two TV receivers were being given an eight-hour operational check following a shop repair, a peculiar odor of burning plastic was noticed. Both receivers were hurriedly unplugged and a quick analysis was made. It was found that a plastic coil form for an antenna balun coil in one of the receivers was a melted, shapeless mass; however, a resistance check proved that the coil still had continuity. Needless to say, the technician was very concerned about what had caused the balun to overheat. It was a bright, sunny, cloud-free day, so he knew that neither lightning nor static discharge had caused the trouble. Besides, the antenna was very thoroughly grounded and the lead-in wire was equipped with a lightning arrestor.

To help in diagnosing the cause of this trouble, the technician made a block diagram of the hookup between the two receivers (Fig. 1). You will notice, as he did, that there were two electrical paths between the receivers: the common antenna system and the 117 VAC line. In addition, there was a path from each receiver to earth ground through the four-set coupler and the grounded antenna mast.

Using an ohmmeter, the technician measured the resistance between the two receiver chassis and found it to be only a few hundred ohms, even though they were both disconnected from the AC line during the check. After consulting the service literature, he concluded that this was normal; both antenna input circuits had a low resistance path to chassis ground as shown in Fig. 2. But this provided no reason as to the cause for the damaged balun unit.

To verify that the DC path between the two chassis was through the antenna system, the 300-ohm lead-in was disconnected from one of the receivers and the resistance measurement repeated. This time the resistance was infinite.

The technician again consulted the service literature and examined the power input circuits. Then, with the receivers still unplugged from the AC-line, he made an ohmmeter check of the line filter networks shown in Fig. 3. It turned out that one of the .01-mfd capacitors in the set not having the defective balun unit was shorted. Thus, when the AC line of this set was connected in one polarity, the chassis was at a potential of 117 volts AC with respect to earth ground.

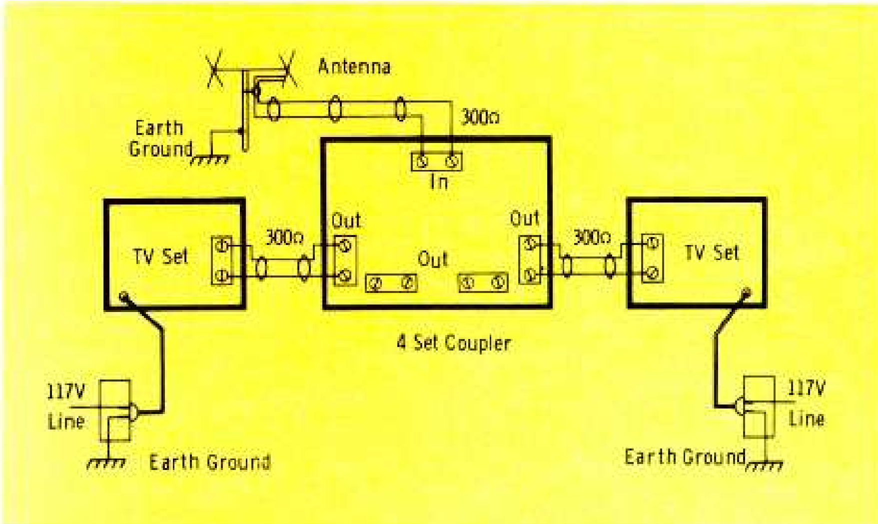

Fig. 1. Antenna and AC line hookup for two sets on test.

Expecting to find a similar condition in the other receiver (an RCA), the technician also checked its line filter. Boy—was he surprised! Both .01-mfd capacitors checked good, and the 100K-ohm resistor was right on value.

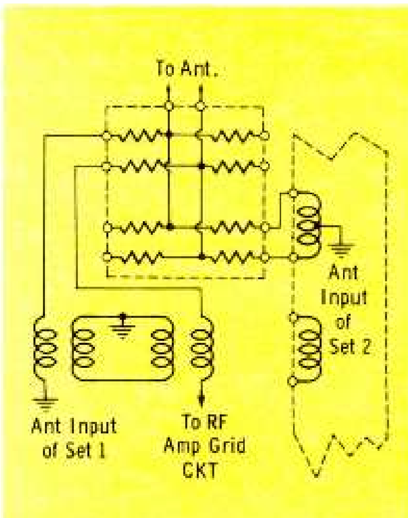

Fig. 2. Schematic of antenna distribution system to the two TV receivers.

Removing the antenna leads from each receiver and using a voltmeter, he determined that a 117-volt AC potential existed between the chassis of the second TV receiver and the switch side of the AC line on the first receiver. At this point the technician very rapidly calculated that the damaged balun had been subjected to an AC current from the power line and had melted as a result of the heat generated.

Replacement of the damaged balun in the RCA set and the shorted .01-mfd capacitor in the other receiver cured this trouble, but this isn't the end. The foregoing trouble could have been avoided by following these recommendations: 1. Always checking line filters on every chassis before beginning any shop repair. 2. By installing a resistor-capacitor network (Fig. 4) in series with each receiver outlet connected to a

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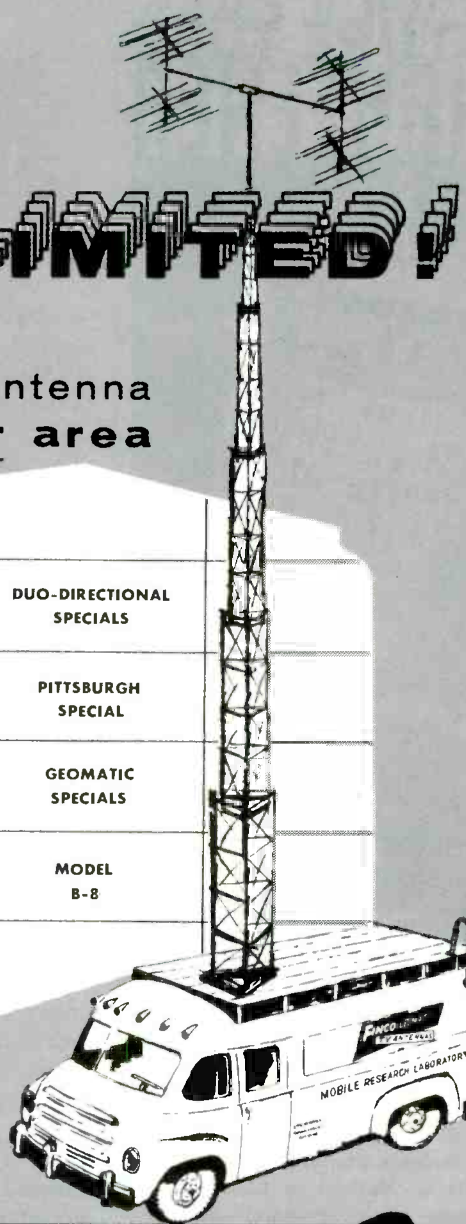

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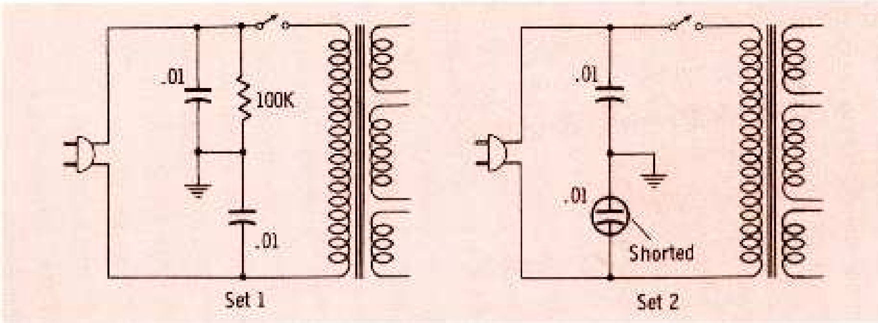


Fig. 3. Power input circuits.

multi-set coupler. There is no loss across such a unit, and the protection it provides against receiver damage makes the small additional effort well worth while. The idea for the resistor-capacitor isolation network came from the realization that almost every TV receiver employing a series-filament string or an AC-DC power supply uses such a network. One other thing—you could get "fried" between a grounded antenna lead and a "hot" chassis. Use of the network in Fig. 4 greatly reduces this hazard.

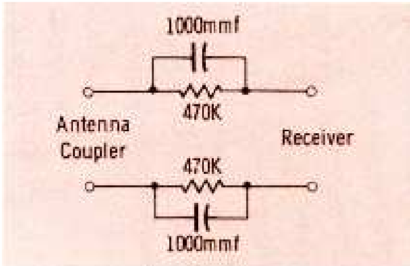


Fig. 4. Antenna isolation network to be used when two or more receivers are connected to multiple antenna system.

Almost a Dog

The customer's complaint was "No picture" and, after the usual check of the operating controls and substitution of tubes had failed to restore the set to normal operation, the chassis was removed. The cathode resistor in the horizontal output stage (100 ohms, 2 watts—see Fig. 5) was burnt and broken in half.

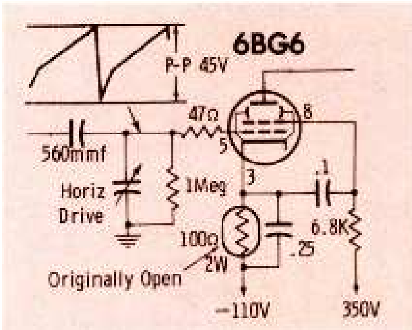


Fig. 5. Horizontal output tube circuit in which the cathode resistor burned.

The resistor and the 6BG6 tube were replaced and an ohmmeter check made for shorts which could have caused excessive current to flow through the resistor. Since no defect was found, power was applied and the picture came on; however, the 100-ohm resistor began to smoke. Using a VTVM, it was determined that the drop across the resistor was 25 volts, indicating a current of 250 ma. A rapid check of the screen-grid potential and the control-grid driving signal proved that they were normal and provided no clues to the trouble. The 45 volts peak-to-peak observed at the grid is normal for this circuit in a 10" TV receiver (which this one happened to be). The technician, deciding to risk the tube and the 100-ohm resistor, applied power while very carefully watching the 6BG6 for signs of excess current flow. Even after the 100-ohm resistor had smoked for several seconds, there was no telltale red glow on the plates of the 6BG6; so the technician felt that the entire 250 ma was not being passed by the tube. This left but one possible cause of the trouble—the new 6BG6 must have heater-to-cathode leakage. A simple ohmmeter

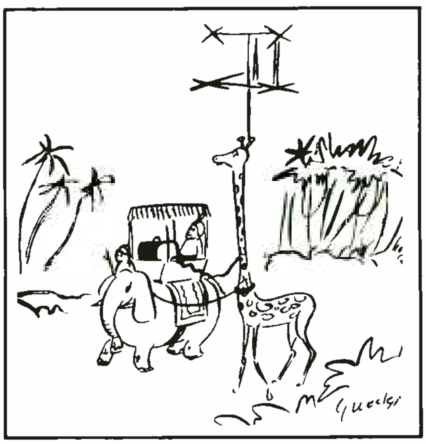


Fig. 6. Pomona vibrator test adapter.

check of this tube proved this to be the case, and the installation of a second tube (tested for leakage before being installed) turned out to be a lasting cure.

Vibrator Testing

How many times have you received an old auto radio in for repair and wondered about the quality of the vibrator, even though it seemed to operate satisfactorily? Or have you ever wondered, when the customer complains of fuse blowing, if the vibrator is really the cause of this trouble?

It is common knowledge that an ohmmeter test of a vibrator tells only one thing—whether the coil has continuity or not. Yet, most technicians will make this test on a vibrator they suspect of being defective. This is an indication that technicians feel that they should in some way check the vibrator.

A vibrator test adapter which converts any tube tester into a vibrator tester at a very low cost is now being manufactured by Pomona Electronics Co., Inc. Model 4A of this test adapter (Fig. 6) is designed for testing all 4-pin, 6- or 12-volt, shunt-driven coil vibrators. Model 3D (not shown) is for testing 3-pin, 12-volt, shunt-driven coil vibrators.

To use a Model 4A test adapter, you simply set your tube tester up for a 6AX4 or 12AX4, depending on whether you wish to test a 6- or 12-volt vibrator; then, you plug the suspected vibrator into the test adapter as shown in Fig. 7. An even brilliance of the two test lamps indicates a properly operating vibrator. Uneven brilliance, flickering of one or both

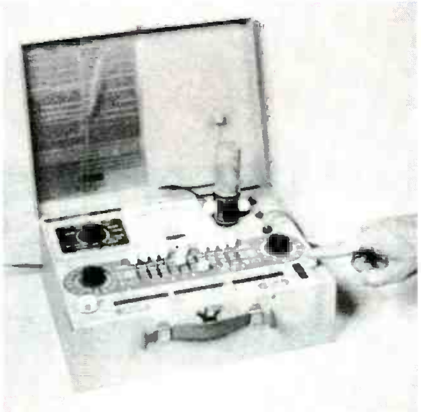


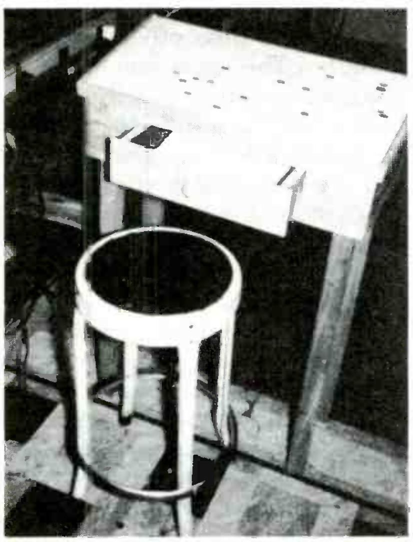
Fig. 7. Using Model 4A test adapter to test a suspected vibrator.

lamps, either lamp out, or both lamps out, indicates a defective vibrator.

Diagram Bench

One of our readers has come up with what we think is an excellent idea for solving the problem of keeping service data where it can be readily referred to while working on a set, and yet not scattered all over the bench.

Mr. Bernard Parrott of Southtown Electronics, Kansas City, Mo., has made up what he calls a



"Diagram Bench" (pictured) which will accommodate a complete schematic diagram under a glass top. This prevents them from becoming soiled, torn, or burned by a soldering iron, thus preserving schematics in their original condition.

The remaining pages of the folder are kept in the drawer for ready reference, and the entire folder is returned to the file when repairs on the receiver have been completed. ▲

GERMANIUM ENTERS the B+ RECTIFIER FIELD

by Thomas A. Lesh

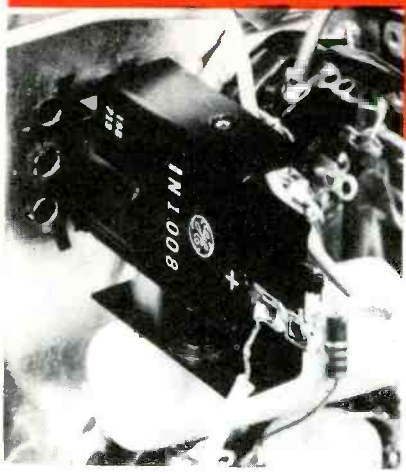


Table I—General Electric Germanium Rectifiers

Rating	Original Equipment	Replacement
250 ma half wave	1N573	1N1005
350 ma half wave	1N575	1N1007
400 ma half wave	1N576	1N1008
2-250 ma (wired as doubler)	1N581	1N1013

The electronics industry has come up with a new skill—the ability to produce low-cost germanium semiconductors capable of handling much more current than was formerly possible. This recent development has not only given us power transistors for auto radio and hi-fi use, but also junction diodes suitable for operation as B+ rectifiers in television sets. Among the newest items in the power-diode field is a series of germanium rectifiers now being mass-produced by General Electric Co.

Actually, two lines of germanium rectifiers are being made, the 1N573 series for use in new equipment and the 1N1005 series for the replacement market. Each line contains four rectifiers with different electrical specifications; thus, there are a total of eight different type numbers. All are listed in Table I.

For a comparison of the two 250-ma units (a 1N1005 and a 1N573, respectively), see Fig. 1. Notice that the rectifiers are physically identical except for differences in the mounting facilities; the actual diode is only a small part of the assembly. The cathode is fastened to a large cooling fin or heat sink, which is designed to keep the diode at lower operating temperatures than other types of rectifiers. The maximum rating for fin temperature is only 65° C. The cooling fin also helps to protect the diode while the connections are being soldered.

The mounting clip of the replacement-type rectifier (at left in Fig. 1) incorporates a pin with spring tabs designed to snap into a round hole in the chassis. The mounting hole for the original selenium rectifier is usually of the correct size and location to accommodate the germanium replacement. Extra support for the rectifier is furnished by braces which rest against the chassis. A locating tab is also provided, but this should be broken off if the chassis has no slot to receive it; otherwise, it interferes with the installation.

The original-equipment rectifier (at right) is mounted by means of a pair of spring clips which fit into special slots punched in the chassis. As more of these rectifiers are installed as original equipment in new TV sets, the 1N573 series will occasionally be needed as replacements.

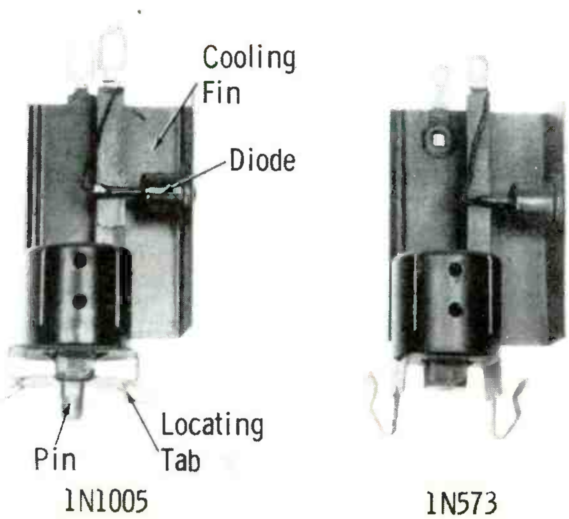
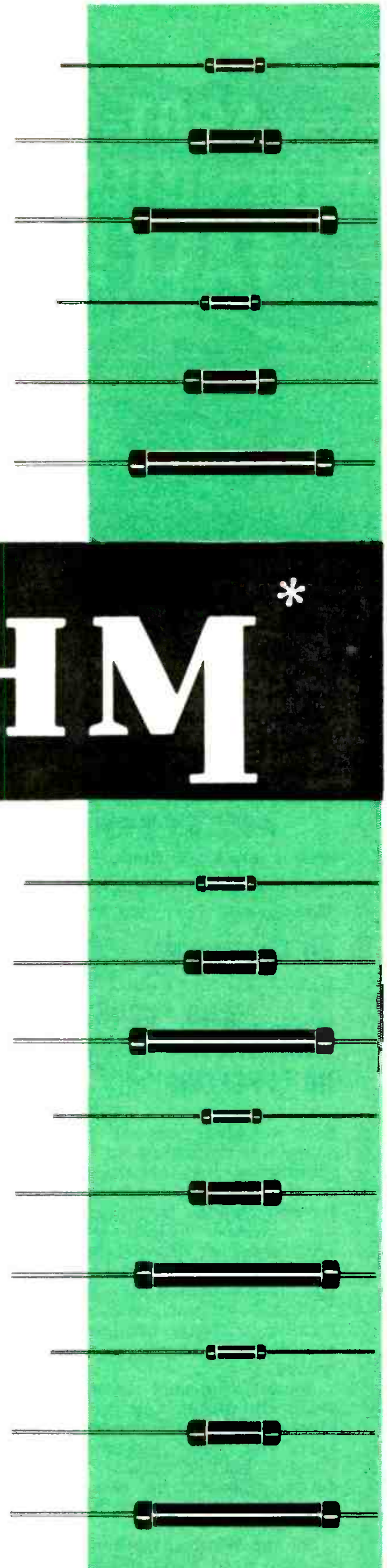


Fig. 1. Both replacement- and original-equipment rectifiers snap into place on chassis.



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Physically, the 350- and 400-ma rectifiers consist of two diode-fin assemblies wired in series. Overall maximum voltage ratings of these units are the same as for the single 250-ma units: 130 volts rms and 380 peak inverse volts.

The 1N581 and 1N1013 units each consist of two 250-ma diode units mounted on a single housing and wired in a compact doubler arrangement. Three terminals are provided, and they should be wired as labeled in Fig. 2, which is a top view of a 1N1013. The input terminal is color-coded with a yellow dot.

The doubler unit is electrically identical to two of the single 250-ma units. Which should you use? That depends almost entirely upon convenience in installation or ease of wiring. The cost is almost identical either way.

Choosing the Right Rating

A generous margin is usually provided between the output current rating of a selenium rectifier and the actual current drain requirement, in order to allow for the increase in forward resistance which occurs during the first several months of use. According to the manufacturer of germanium rectifiers, these units are not expected to undergo this aging effect; therefore, their current rating can correspond more closely to the actual B+ drain of the receiver. As a result, the germanium rectifier will not necessarily have the same rating as another type of rectifier which it replaces.

The proper rectifier rating can be determined by referring to a replacement guide or by actual measurement of B+ current drain —as is done to determine the recommendations given in Photofact folders. Pick a rectifier which you think will have an adequate rating, and operate it at an rms input voltage of 125 volts. If the rectifier does not pass more than its rated current when operated at this elevated voltage, it is safe to install it permanently in the receiver.

A property of solid-state rectifiers in general is that their output voltage falls off to some extent as current drain increases. Differently rated selenium rectifiers have different voltage vs. current

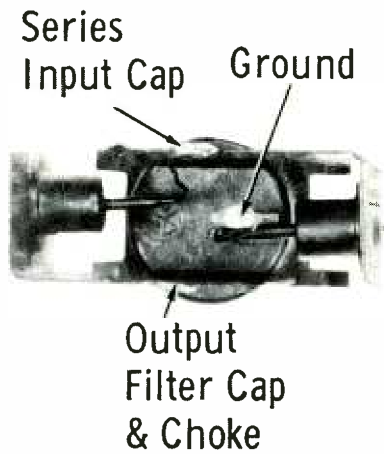

Fig. 2. Types 1N581 and 1N1013 contain two diodes wired as a doubler.

curves, and the output of a selenium-type power supply can usually be boosted several volts simply by installation of oversize rectifier stacks. It is interesting to note that this practice yields no advantage in the case of germanium rectifiers, since the voltage vs. current curves of the various types are all very similar.

The results of our own lab tests agreed with the information given in these curves. For example, we tried a 250-ma 1N1013 in a Zenith Model Z1512J receiver, and found that the current drain (285 ma) exceeded the rating of the unit. So, we substituted a pair of 1N1007 rectifiers, each rated at 350 ma. The current drain remained the same, as did the B+ voltage (268 volts). This test was made at a nominal line voltage of 117 volts. We also checked germanium rectifiers of different ratings in the same sets under various reduced and elevated line-voltage conditions, and found little difference in performance.

In all our tests, the B+ voltage and current were both increased by substitution of germanium for selenium rectifiers. The high efficiency of the new units is mainly a result of their extremely low forward resistance. The internal voltage drop in the forward direction is no more than 0.3 volt in the 350- and 400-ma rectifiers, and 0.15 volt for the 250-ma type. Results of sample installations are given in Tables II and III for voltage-doubler and half-wave rectifier circuits, respectively. Actual voltage and current increases

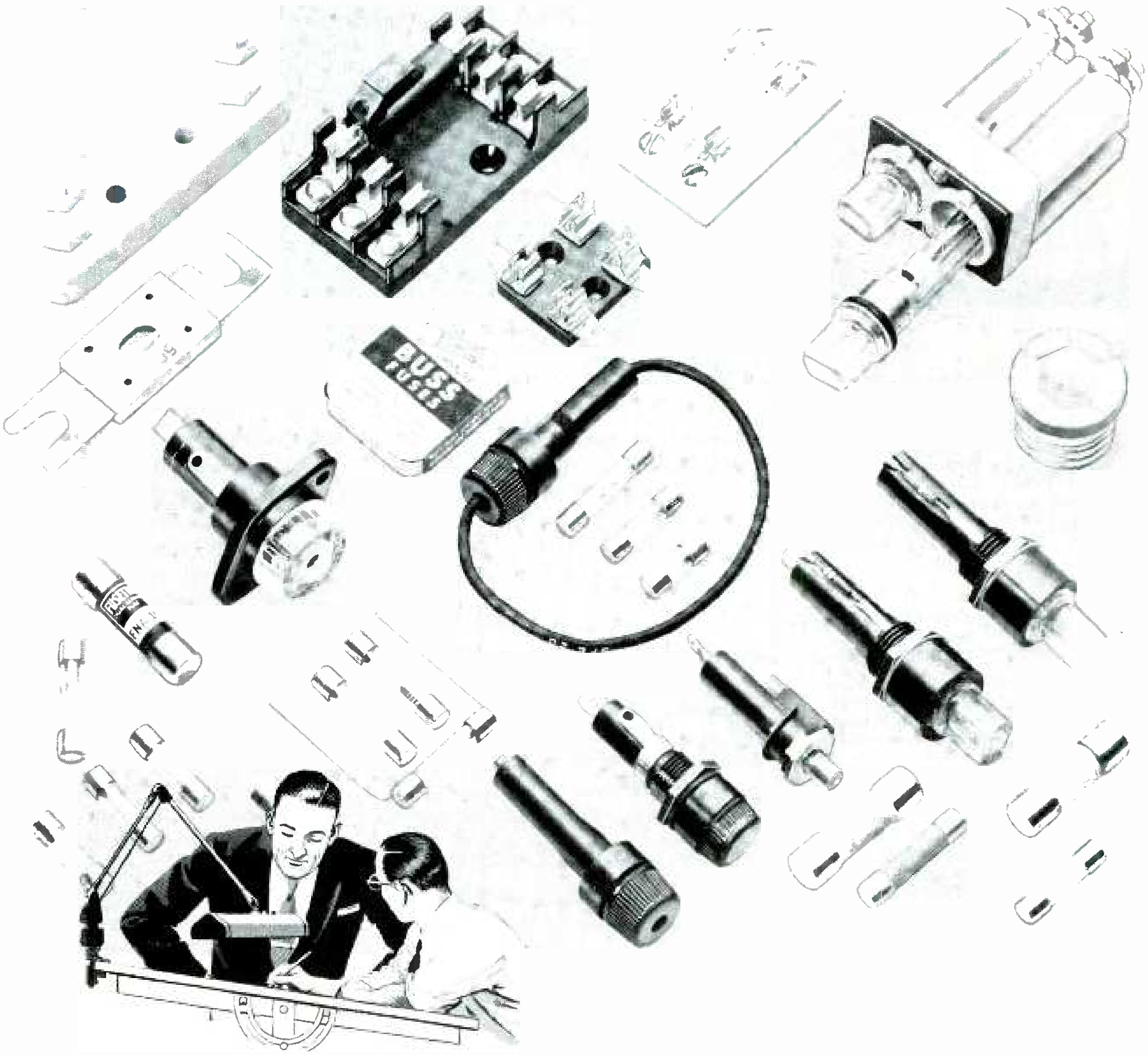

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Table II—Results of Germanium Rectifier Installation in a Voltage Doubler Circuit (Truetone Model 2D1730C).

AC INPUT 117 VOLTS	ORIG. 300 ma. SEL. RECT.	1N1007, 350 ma. GERMANIUM RECT.
B+ Volts	262	280
B+ Ma	285	310
Boost Volts	535	575
AC INPUT 110 VOLTS		
B+ Volts	248	265
B+ Ma	270	295
Boost Volts	500	540

obtained in any given receiver will depend upon a number of factors such as the spread between the selenium rectifier rating and actual current drain, and also the value of the series surge-limiting resistor.

Note that the performance of germanium rectifiers at 110 volts is practically equal to that of selenium stacks at 117 volts. This is a clue that the new components would be helpful in compensating for the chronically low line voltage which is found in some areas.

Precautions for Use

Since B+ voltage is increased when germanium rectifiers are installed, you are probably wondering if it goes to excessively high levels when line voltage rises higher than normal—as it does in many localities at some hours of the day. To simulate such high-voltage conditions, we operated each set for an extended period with a 125-volt AC input, turning it on and off several times. We induced no parts failures, but we observed that the B+ voltage often rose until it practically equaled the maximum ratings of the filter capacitors. For instance, the value of B+ became 297 volts in the receiver of Table II and 148 volts in that of Table III. Capacitor ratings in these sets were 300 and 150 volts, respectively. The ratings were not actually exceeded in any receiver we tested—just pushed near the limit. Nevertheless, the extra strain on the filters should be taken into account and their condition checked before germanium rectifiers are placed in service.

The extremely low forward resistance of a germanium diode, and its small junction area, leave it vulnerable to damage from excess current unless properly protected. A fusible surge-limiting resistor, which is already included in most selenium rectifier circuits, will provide this protection. This component tends to limit the charging current of the filter capacitors when the set is first turned on and also protects the rectifier against overloads in the B+ system. The resistor should have a minimum value of 4 ohms, but higher values are permissible.

In summary, our tests indicate that properly installed germanium rectifiers can be expected to operate efficiently and with a minimum of trouble in television low-voltage power supplies. ▲

Table III—Results of Germanium Rectifier Installation in a Half-Wave Rectifier Circuit (Hoffman Model GT1144U).

AC INPUT 117 VOLTS	ORIG. 350 ma. SEL. RECT.	1N1007, 350 ma. GERMANIUM RECT.
B+ Volts	135	140
B+ Ma	260	275
Boost Volts	335	350
AC INPUT 110 VOLTS		
B+ Volts	127	133
B+ Ma	240	258
Boost Volts	315	335

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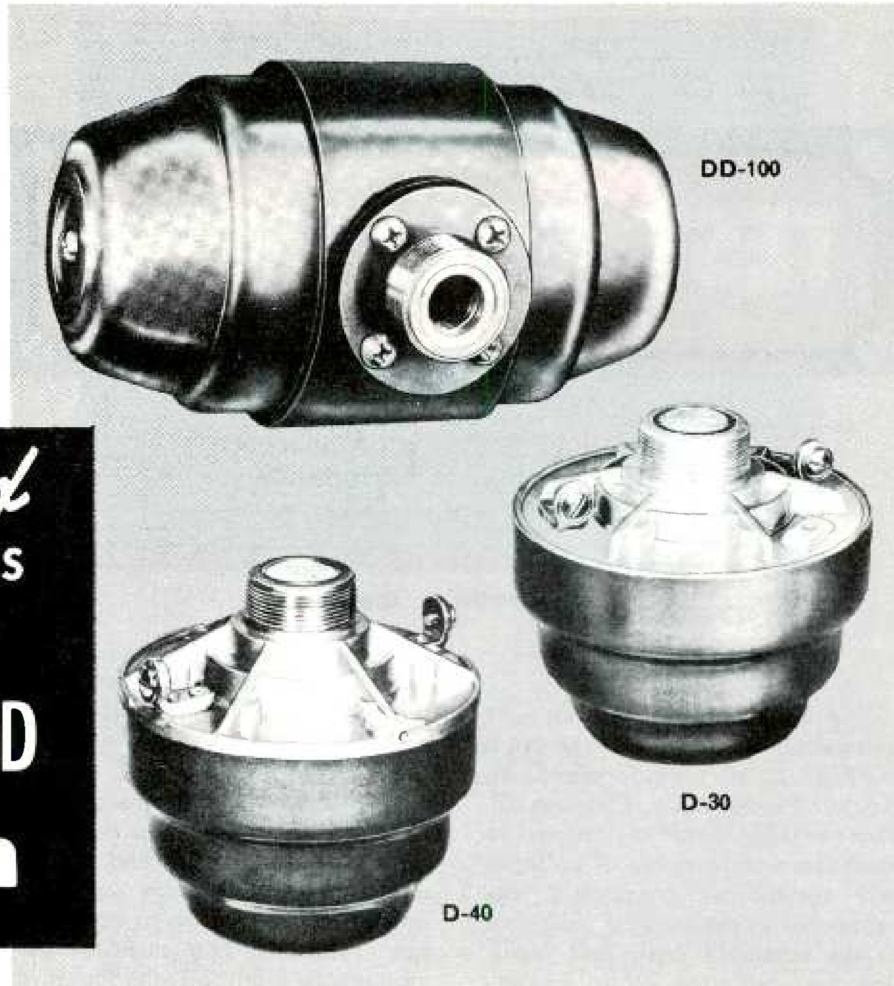

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DD-100	100 w.	8/32	75-10,000	5 5/16"	8 1/2"	$96.50

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Notes On TEST EQUIPMENT

Latest Information on Application, Maintenance and Adaptability of Service Instruments

by Leslie D. Deane

New Batteryless VTVM

The Model V500 vacuum tube voltmeter, pictured in operation in Fig. 1, is manufactured by Anchor Products Co., Chicago, Ill. This portable meter is designed to measure a wide range of voltages and resistances frequently encountered in the service field, and comes complete with test leads, line cord, isolation probe, and instruction manual.

Specification features are:

1. *Power Requirements—115/120 volts AC, 60 cps.*
2. *DC Voltmeter—ranges 0 to 3, 30, 300, and 1200 volts; input resistance 11 megohms; accuracy ±3% of full scale deflection.*
3. *AC Voltmeter—rms and peak-to-peak voltage ranges 0 to 3, 30, 300, and 1200 volts; input resistance 11 megohms; accuracy ±5% of full scale deflection from 30 cps to 100 mc.*
4. *Ohmmeter—ranges R × 1, 100, 10K, and 1 meg; zero- and ohms-adjust controls provided on front panel.*
5. *DB Meter—direct decibel scale for 3 and 30 volts AC; 300 and 1200 volt positions require additions of 40 and 52 db respectively; zero db corresponds to 6 milliwatts of AC power across a 500-ohm impedance.*

When working with the Model V500, one feature in particular caught my attention. This was the fact that the instrument operates on all resistance ranges without the use of internal batteries. Examining the construction more closely, I found that a rectified portion of the AC line voltage furnishes the meter's resistive measuring circuits with power.

A full-wave bridge arrangement of selenium rectifiers in conjunction with the zero- and ohms-adjust controls assure accurate indications regardless of line voltage variations. This could be advantageous from the standpoint of meter maintenance, because, with this design feature, corrosion problems and frequent battery replacement are eliminated.

I tested the ohmmeter function of the instrument by following conventional zero and ohm adjustments outlined in the instruction manual. Checking the values of a number of resistors, I found the accuracy on all scales to be very satisfactory. For precise measurements, I nevertheless zeroed the meter for each different range as recommended by the manufacturer.

Other visible features of the instrument include a polarity reversing switch and a neon on-off indicator lamp, both located on the front panel. In addition to the voltage, DB, and resistance ranges, the meter scale is also marked for a zero-center indication which comes in handy for bias measurements or for TV sound alignment. The isolation probe or cartridge pictured in Fig. 2 slips directly over the regular meter test prod and may be used for isolation purposes when measuring voltages from points other than ground or in any high impedance circuit. This accessory unit minimizes loading and lead pickup since it conveniently places a 100K-ohm resistance in series with the test lead.

Designed for field as well as bench use, the Model V500 VTVM has a detachable front cover and a separate compartment for test leads and line cord.

Portable Transistor-Diode Checker

As semiconductors become more and more prevalent in modern electronic equipment, test instruments such as transistor checkers are likewise becoming of more and more interest to the service technician. Featured in the photo of Fig. 3 is the new Sencore Model TDC22 transistor and crystal diode checker. This relatively small battery-operated instrument is produced by Service Instruments Corp. of Addison, Ill.

Specification and test features are:

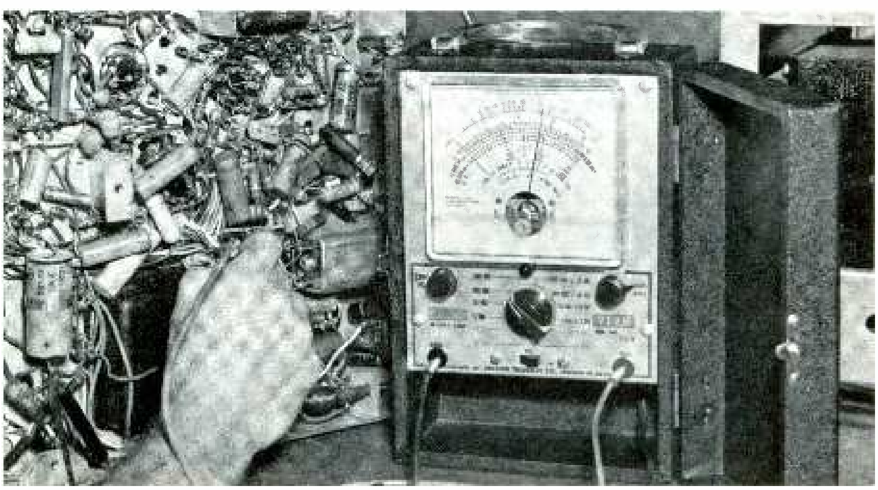
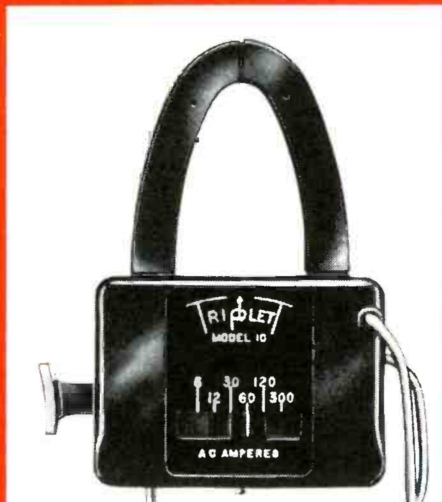


Fig. 1. Anchor Model V500 VTVM.



Model 10

Here is a real value—much more value than in any other clamp-on ammeter. Remember, in Triplett Model 100 you get not only a clamp-on ammeter but a genuine Triplett complete Volt-Ohm-Milliammeter with which you can measure AC volts, DC volts, AC and DC current, and Ohms.

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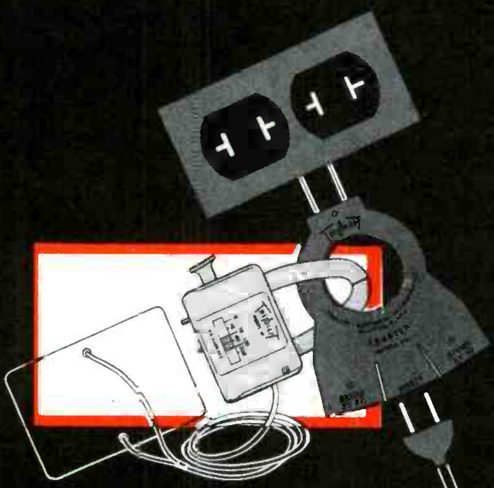

1st news: Triplett Model 10 Clamp-On Adapter

Just plug into any Triplett Model 310 Miniature VOM it becomes an AC clamp-on ammeter to measure AC amperes without cutting or opening current carrying wires. The split transformer yoke opens at the touch of a lever to fit around a single conductor or bus-bar for direct readings of AC amperes from 6 to 300 in 6 steps. Model 10 $14.50 net.

The Model 10 can be separated from the Model 310 as shown in the drawing at left by No. 311 lead attachment. This permits readings in difficult locations. No. 311 leads $1.90 net.

2nd news: Triplett Model 101 Line Separator

Serves to plug in at outlet to divide 2 conductor cords for clamp-on measuring. Makes accurate, rapid-testing of radio and TV sets, phonographs, appliances, motors, etc. possible without opening or splitting double conductors. Also serves to increase ammeter sensitivity 10X and 20X, if desirable, for easier reading. Model 101 $5.50 net.

3rd news: All four parts are available conveniently packaged in one handy, durable, high-quality carrying case. This complete package is known as Triplett Model 100 and is priced at $31.90 net.

Model 100 consists of Model 310 VOM, Model 10 Clamp-On Adapter, Model 101 Line Separator, No. 311 leads and carrying case with provision for all parts.

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In addition, to use with the Model 310, the Model 10 Adapter also can be used as a Clamp-On Ammeter with any Volt-Ohm-Milliammeter having a 3 AC volt scale at 5000 Ohms per volt such as Triplett Models 630, 630-A, 630-NA, 631, etc., by employing Triplett No. 611 leads, $1.90 net.

Triplett Model 100 gives you the world's most flexible test equipment for all electrical and electronic applications.

631 | 630-NA | 630 | 630-A | 310 | 630-T | 666-HH | 625-NA | 666-R

Fig. 2. Converting test prod to isolation probe for Anchor VTVM.

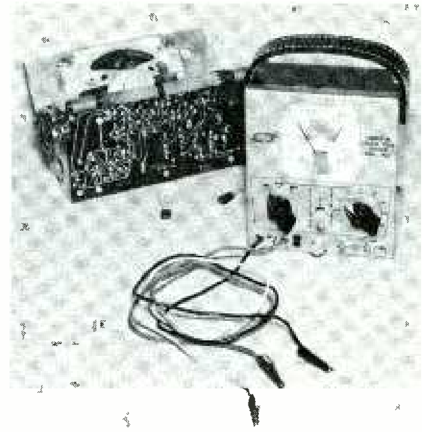


Fig. 3. Sencore Model TDC22 transistor-diode checker, ready for use.

1. *Power Source—one self-contained 6-volt battery.*
2. *Contact Provisions—one standard-base transistor socket plus separate emitter, base, and collector test leads.*
3. *PNP-NPN Transistor Test—base-emitter and base-collector leakage current with open base element. Base current amplification factor (β) with preset collector current of 1.5 ma. Special noise level test also outlined in manual.*
4. *Crystal Diode Test—forward and reverse resistance measured in terms of current flow; reverse voltage limited to 2 volts for protection of UHF diodes.*

I recently had the chance to use one of these units while performing experimental work on a few portable transistor radios and I thought our readers might be interested in the operating procedures for checking a transistor using this particular instrument.

Testing a transistor usually involves two separate operations comparable to the shorts and emission test of a tube checker. For the Model TDC22, the first operation is termed the leakage test. Here a transistor is checked for an open, short, or excessive leakage.

When checking an RCA 2N109 transistor, I first consulted the set-up chart provided with the instrument. This chart has a complete listing of transistor types and their test set-up data. I noted from the chart that the 2N109 is a p-n-p transistor so I placed the selector switch in the PNP position. I next noticed that a letter "D" followed the transistor number on the set-up chart. This letter corresponds to a certain leakage scale to be used when reading the meter. There are four individual leakage scales—A, B, C, and D. Each is intended for use with a certain characteristic group of transistors. Following the letter designation for the 2N109 was the number "12." This number indicates the proper setting of the instrument's gain control. The control is calibrated in divisions of 2 from 0 to 100, so I proceeded to set the pointer on the first mark beyond the indicated 10 position. Since the transistor I was testing was a plug-in type, I inserted its small leads into the test socket provided on the front panel. At this point I was able to read leakage current directly from the D scale of the meter. In this particular case, the meter needle remained in the green area indicating that the transistor possessed normal leakage characteristics. If the needle swings all the way to the right in this test, the transistor is shorted. If an absence of needle deflection is noted, the transistor is open.

The next step was to check the gain or amplification characteristic of the unit. I accomplished this by depressing the gain button conveniently located on the front of the instrument. This time the needle came to rest in the center green area of the top scale marked "Gain." This was par for the course—so the transistor checked good.

Three-in-One Portable Tube Tester

The piece of equipment shown

in Fig. 4 represents one of the latest ideas in portable tube testing instruments. Developed and produced by Seco Mfg. Co. of Minneapolis, Minn., the Model 107 tube tester is capable of performing three basic tests on popular radio and TV vacuum tubes. Weighing only 11½ pounds and housing a number of pre-wired tube sockets in its lid, the unit is very handy to carry on service calls.

Test features are:

1. Leakage and Shorts Test—tubes are automatically checked for leaks, shorts or grid emission. Pre-wired sockets may be used for all popular tube types.
2. Conductance Test—all popular amplifier tubes are tested for dynamic mutual conductance in pre-wired sockets, "good-bad" and "relative %" scales provided.
3. Emission Test—all tubes may be tested for cathode emission, 6 different type sockets provided on main chassis, complete set-up data supplied with instrument.

When checking out this unit in our test equipment lab, the first feature I noticed was its compact design. When the tester is closed into a small carrying case, it measures only 12½" × 9" × 6". With the case open, however, the size of the instrument is comparable to many counter type testers. Another interesting feature is the 6AF6G tuning-eye tube employed as an indicator for the grid emission and shorts test.

In order to familiarize the reader with the operation of this apparatus, let's see exactly how tubes are tested in the Model 107. To understand more fully the test procedures, I have pointed out several significant features in Fig. 4.

The pre-wired tube sockets in the lid or cover of the instrument are used when checking common amplifier type tubes for shorts, leakage, and mutual conductance. Tubes are checked in a matter of seconds due to the individual sockets being wired and ready for test. In addition, the simple set-up data is clearly printed on the socket panel. The only adjustments required for test in the pre-wired section are filament voltage

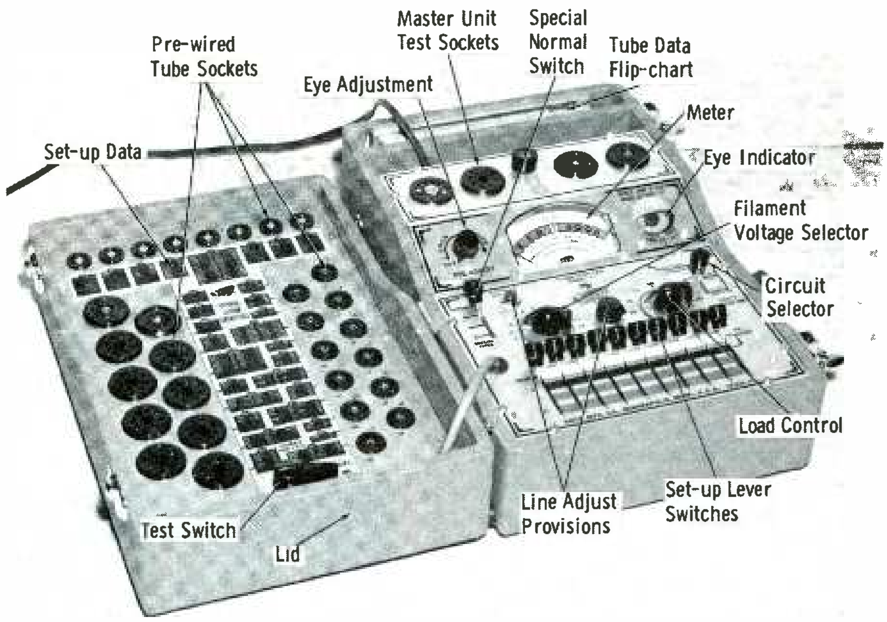


Fig. 4. Seco Model 107 tube tester.

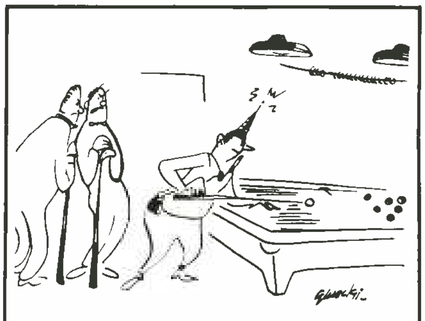
and load.

With the test switch in the "grid circuit test" position, the eye indicator will detect any leakage, shorts, or grid emission immediately upon insertion of the tube in the proper socket.

To check a tube's dynamic mutual conductance, the test switch is moved to its upper position marked "D.M.C." The merit of the tube can then be read directly on the "good-bad" or % scale of the meter. Twin type and dual purpose tubes are tested by first placing the test switch in the upper position and then in its lower position labeled "D.M.C. 2nd section." Dual purpose tubes may require different load settings for each section tested, while the twin type only requires one load value for both tests.

After reading over the instructions completely, I became aware of the fact that tubes can also be tested for shorts, leakage, grid emission, and for cathode emission on the "master unit" or main chassis. Six tube sockets are provided directly above the meter panel. These sockets are not pre-wired but are set up for test by adjusting the controls and lever type switches pointed out in Fig. 4. To test a tube in this section of the tester, I first looked up the test data in the tube index flip-chart. The flip-chart supplied with the instrument resembles a telephone index pad having a small sliding indexing device and a spring-loaded opener.

After setting up the filament voltage, load, and lever switches according to instructions, I inserted the tube in the proper socket and waited for a short warm-up period. With the "circuit selector" switch in the "grid circuit test" position, the tube is first tested for shorts, leakage, and grid emission by observing the eye indicator. As in the other test using the pre-wired sockets, if the eye opens into the red or "bad" area the tube is defective. To perform the emission test, I next moved the "circuit selector" switch to the "cathode emission" position. I was then able to read the merit of the tube on the "good-bad" meter scale. The Model 107 also provides an element analysis test which checks for shorts between individual tube elements. In addition,



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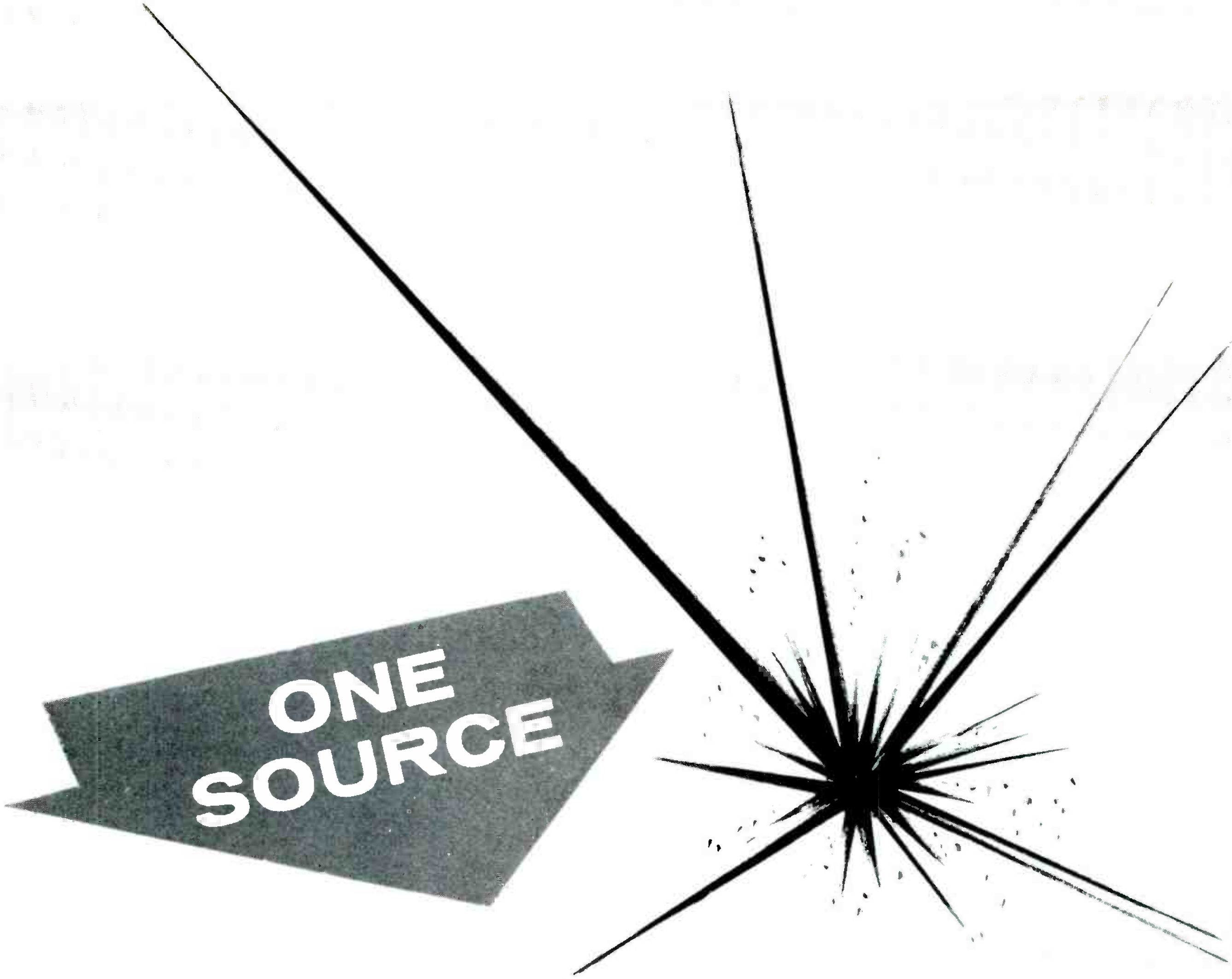

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the manufacturer recommends a quick and easy continuity test set-up for servicing series-filament receivers.

In-Circuit Selenium Rectifier Tester

Today's trend toward low-priced portable TV has brought about an increasing number of transformerless receivers to the modern market. With this trend, the service technician naturally becomes more concerned with instruments which can help him determine the quality of the selenium, germanium, or silicon power rectifiers used in these receivers. Such an instrument is pictured in Fig. 5—the Model SRT-1 in-circuit selenium rectifier tester, manufactured by Century Electronics Co., Inc., Mineola, New York.

Specifications and test features are:

1. *Power Requirements—117 volts AC, 60 cps within a tolerance of ±10%.*
2. *In and Out of Circuit Test—checks rectifiers for quality, fading, shorts, opens, arcing, and life expectancy; separate "Replace — ? — Good" meter scales provided for both in and out of circuit tests.*
3. *Components Tested—checks all power rectifiers rated from 10 to 500 ma regardless of type of construction.*
4. *Test Ranges—10 to 40, 65 to 100, 150 to 200, 250 to 300, 350 to 400, and 450 to 500 ma.*
5. *Safety Features—will not blow fuses or damage units under test, well insulated test leads with voltage applied only when "test" switch is depressed, instrument case isolated from power line.*

Fig. 5. Century Model SRT-1 in-circuit selenium rectifier tester.

In my lab examination of this particular instrument, I found its in-circuit test to be of considerable interest and value. The set-up procedure for in-circuit testing of single or double rectifier power supplies is relatively simple; however, I found that interpreting the results of such a test requires a little thought.

Following instructions, I decided to check the selenium rectifiers employed in a typical voltage-doubler circuit of a TV receiver. My first step was to disconnect the set from the power line and from all ground connections—including any grounded antenna systems. I next determined the approximate current rating of the units to be tested. In this instance, the type numbers printed on the rectifiers indicated both were 350 ma. If the current value of a unit is not apparent, the manufacturer of the Model SRT-1 provides a handy chart telling how to identify this rating.

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- Combination Wien and Wheatstone bridge.
- Accurate vacuum-tube meter circuit.
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Knowing the rectifiers I was about to test were rated at 350, I placed the rating switch on the 350 to 400 ma position and turned on the instrument. I then plugged the test leads into the jacks on the front panel and connected the clip ends to the first rectifier. I observed the polarity of the leads and attached the red test lead to the positive cathode terminal and the black to the negative anode terminal. The instruction manual contains a section entitled "How to Tell Rectifier Polarity." This information comes in handy when rectifiers are uncoded or when their markings are not distinguishable.

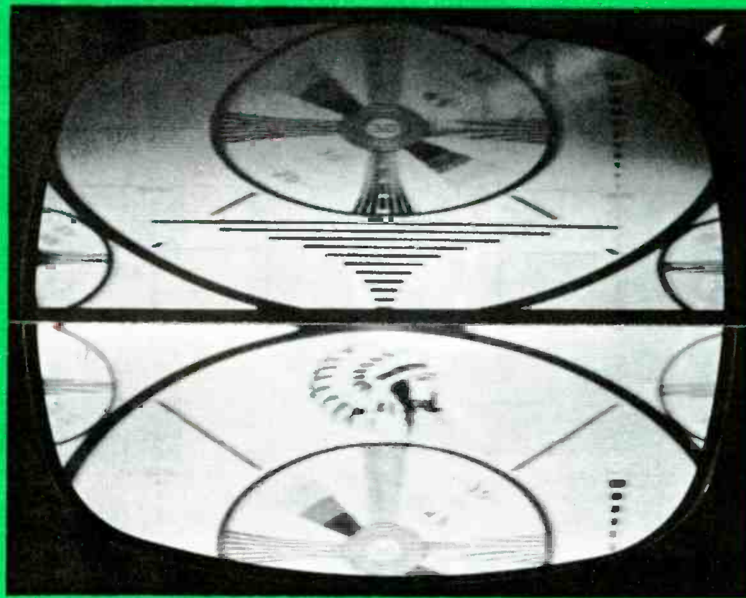
With the apparatus all set up to check the first rectifier, I pressed down on the test switch and observed the top meter scale. The meter needle came to rest in the green area marked "good," indicating that the unit passed the test. My next step was to make the "life-expectance" test. This I accomplished by holding the test switch down for about 20 seconds. The reading fell only slightly, indicating the rectifier had a fair life expectance. Had the needle dropped or faded to the "?" or "bad" area of the scale, the unit would not have been long for this world.

One might keep in mind that when making an in-circuit test, unfavorable indications can either mean a short in the rectifier, wrong connection of test leads, or a short in the receiver circuitry. A short in the receiver will often damage the power supply; therefore, after the circuit short is removed always recheck the rectifiers.

I tested the other rectifier of the doubler network in the same manner as the first and found it also serviceable. When testing either rectifier, if the other had smoked or sparked, I then would have immediately known that the other unit was bad. Also, if one had checked weak, I would have tested the other before deciding. Then I would have replaced the weakest and rechecked the remaining unit. The manual recommends that, once a short is detected, it's a good idea to unsolder the rectifier and make an out-of-circuit test. ▲

TROUBLE SHOOTING

with GEORGE



THE CASE OF THE DOUBLE-DECKER PICTURE

by Leslie D. Deane

This visit we pick up George as he enters the home of an anxious customer who is suffering with an ailing TV. Eager to gather all the facts of the case, George questions the client as he removes the back and plugs in a cheater cord. He listens with one ear to the owner's explanation while awaiting picture and sound from the late-model portable receiver.

A few seconds later, just as the key witness had stated, the sound came on normal but the picture or raster appeared as a narrow horizontal line across the center of the screen. Opening up his tube caddy, our modern Sherlock Holmes went right to work. He had been faced with these same clues on other cases and knew exactly where to start his investigation.

Poking his flashlight in the back of the cabinet, George located a small tube layout diagram. From this he learned the set employed a single 6CM7 for both vertical oscillator and output stages. Thinking that perhaps a new 6CM7 would solve the case, he immediately replaced this tube with one from his caddy. Much to his disappointment, however, the vertical sweep did not return. Even after a considerable warm-up time, the bright line still appeared across the center of the screen.

George next varied the vertical hold, height and linearity controls but found that they had no visible effect on the symptom. Before giving up, he substituted another 6CM7 and carefully moved the tube in its socket to make sure it was making proper contact. With the handle of his screwdriver, he also tapped on the vertical output transformer and yoke, hoping to see the sweep intermittently fill the screen. This bit of detective work uncovered no new clues, so George was forced to pull the set and return to the shop with the case yet unsolved.

Later, we find George at his bench removing the vertical type chassis from its portable cabinet. George had recently repaired a set having a similar vertical sweep system so he decided to go ahead and examine the circuit without looking up any service literature. Besides, he wasn't sure if he had the information on this particular set. The circuit, as George recalled, was a multivibrator-output arrangement using two triode stages. (See Fig. 1.)

Giving the circuit components a look, George failed to see any discolored resistors, but he did notice that one of the feedback capacitors (C6 in Fig. 1) appeared a little oily. Our detective was in luck—for after a few quick resistance measurements he thought he had found the trouble. Disconnecting one end of C6, he measured approximately 200K ohms across the capacitor.

The unit was a black molded job with color code stripes. As is true of so many of us, George had not completely mastered the art of reading capacitor color codes; however, from the markings and size of the unit he was sure it was an .01 at 1600 volts. At first he was a little puzzled over the high voltage rating but he knew there was a fairly husky pulse present on the plate of the output tube and that his interpretation of the markings were probably right.

Even though George maintains a fairly adequate stock of components in his shop, he still felt relieved to find a suitable replacement in his parts cabinet. Feeling that he now had the case wrapped up, he quickly soldered the new component in the circuit, connected an antenna, and applied power to the chassis. He waited a moment, then adjusted the controls and tuner for a picture. The vertical was running all over the

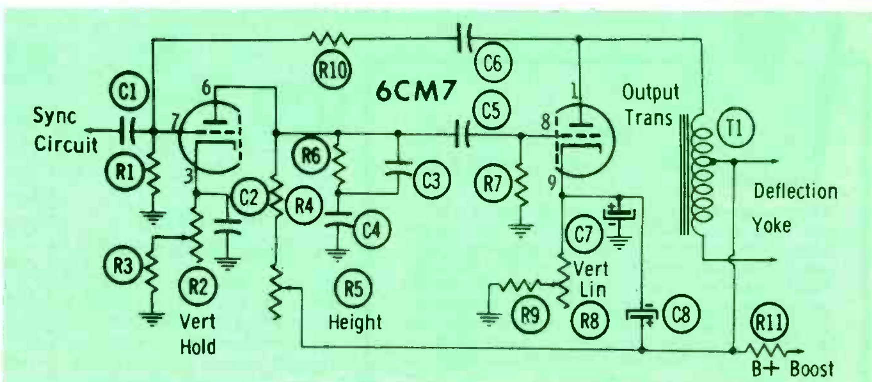


Fig. 1. Diagram of George's vertical sweep circuit.

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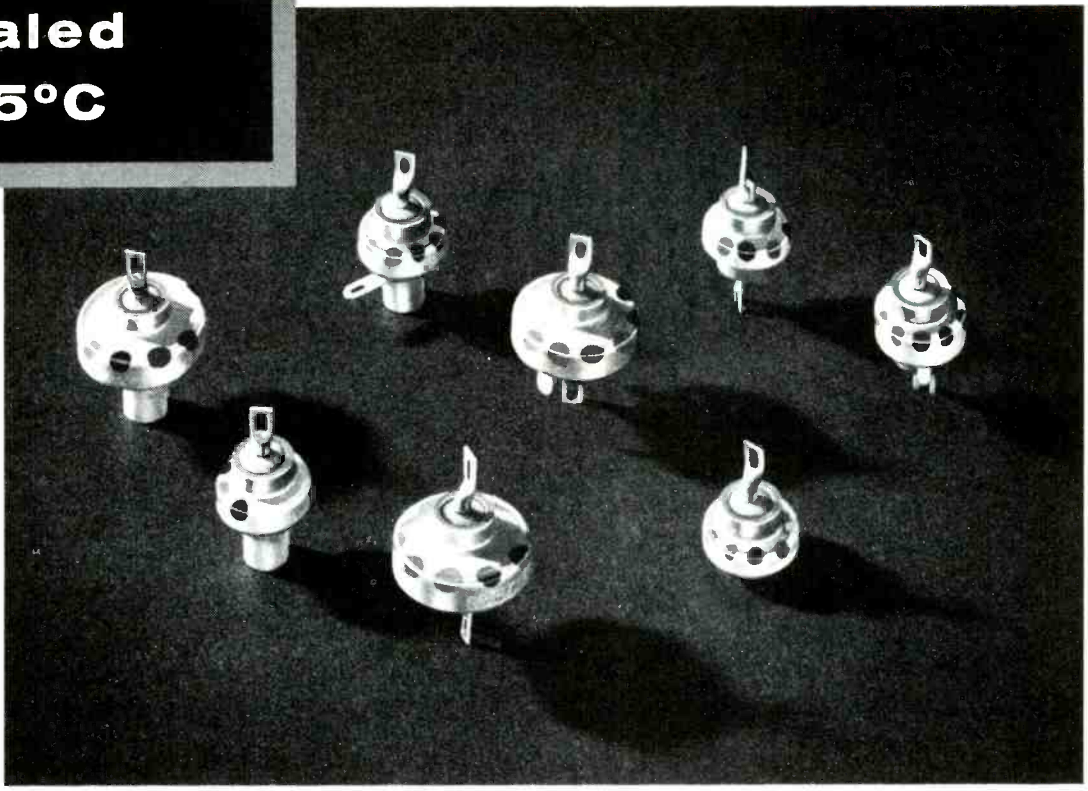

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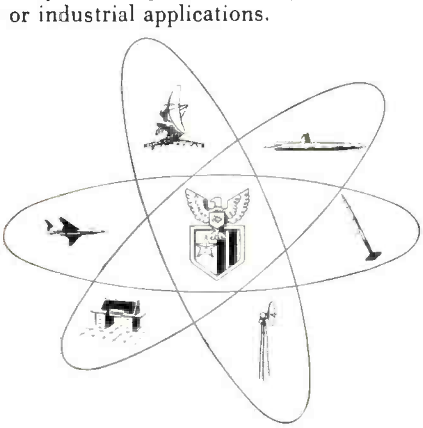

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place, so he located the hold control and adjusted it. But, lo and behold, two almost complete pictures locked in on the face of the screen. (See head illustration. The dark area at top of screen was caused by photographic limitations.)

Stepping back away from the bench to get a better look at the puzzling pattern, George thought to himself, "Do you suppose I've got another trouble in that blankety-blank circuit?" Before getting panicky, however, he switched to another operating channel—here again, though, the two separate pictures boomed in. He then tried adjusting the vertical linearity and height controls but, naturally, they had little or no effect upon sweep frequency. Thinking that perhaps the component he had used as a replacement might have been defective, George proceeded to substitute another in its place. This effort, however, proved fruitless, for the trouble still remained, with the picture locking in at 30 cycles.

Before going any further, our mastermind came to the conclusion that he'd better use some service literature. "Ah ha!" he exclaimed, as he found the folder covering the set in his files. Spreading the schematic out in front of him, George decided first to take a few voltage readings around the circuit. Measuring plate, grid and cathode voltages on each section of the 6CM7, he found all values to be within tolerance except the grid voltage on the first stage—the service literature called for a −3 volts while George measured about −6.

With no more clues to go on than this, he proceeded to check and even replace C1, R1, and R10. (See Fig. 1.) He also measured the value of all other resistors in the circuit and substituted electrolytics for C7 and C8—but to no avail.

George thought to himself, "This is it—I've had it! But, still, there must be something I'm overlooking." Examining the schematic more closely, George finally discovered his error. The trouble, incidentally, was very obvious. An explanation to the solution of this baffling case can be found on page 65. ▲

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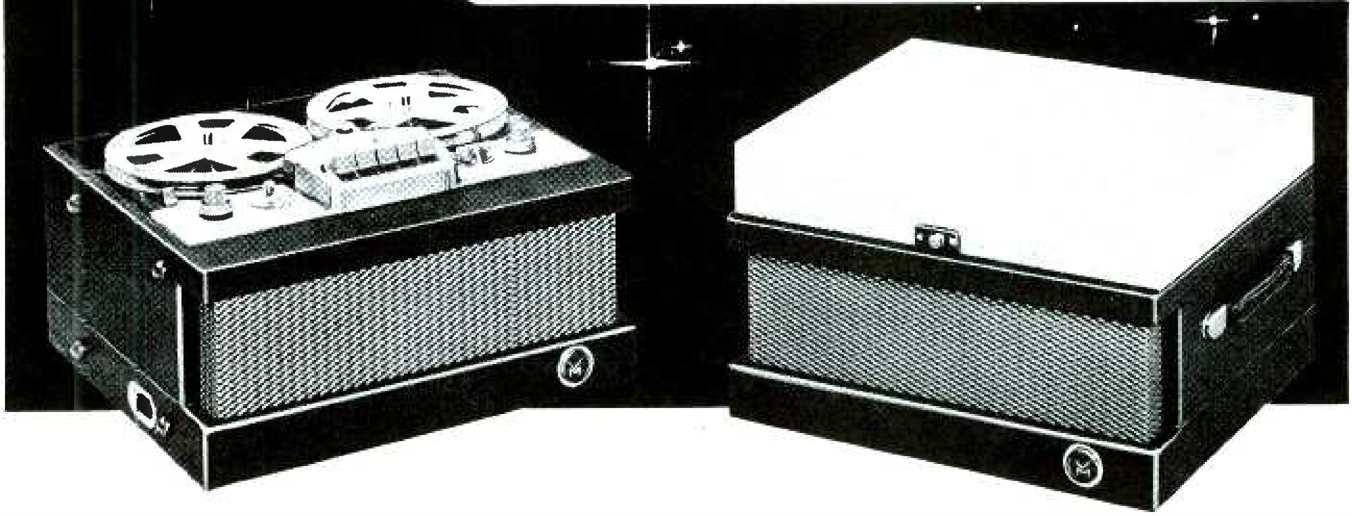

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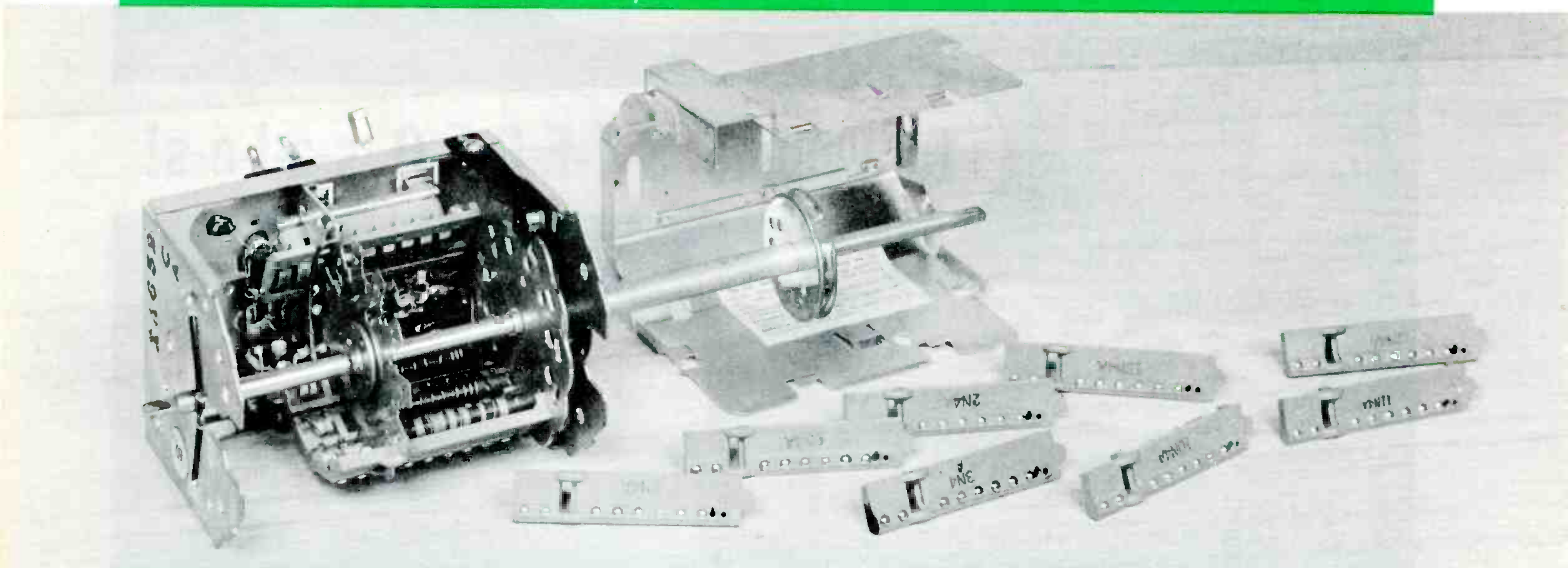


part · 2 Modern RF Stages and Their Output Circuits

by Calvin C. Young, Jr.

The various RF amplifier circuits in common use can be classified into four basic types; pentode, cascode, neutrode and tetrode. It is to the technician's advantage to know the features of each type so that he will be able to recognize variations in each class and understand how the performance of each may be affected by tube replacement and other normal servicing requirements. The following data is presented with this in mind.

Pentode Circuit

This RF circuit (Fig. 1) was one of the first to be utilized and gets its name from the type of tube employed, a sharp cutoff pentode operated class A. Its chief advantage is that it will perform satisfactorily, without any complex neutralizing, from a low voltage (100-volt) power supply. The fact that this circuit generates more noise than a triode circuit and is therefore not as suitable for fringe-area operation does not lessen its usefulness in strong signal areas. For the most part, the circuit is very stable, and tube replacement or minor component aging has only a small effect on its frequency response characteristics.

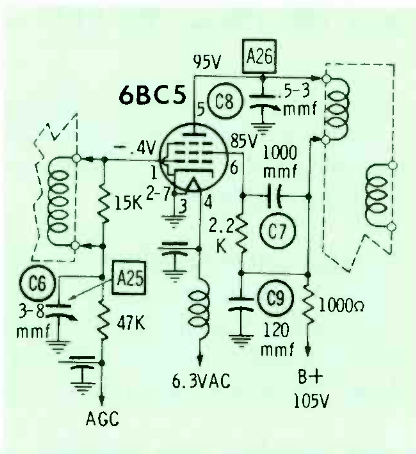


Fig. 1. Pentode RF amplifier circuit.

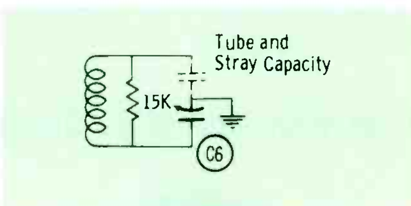
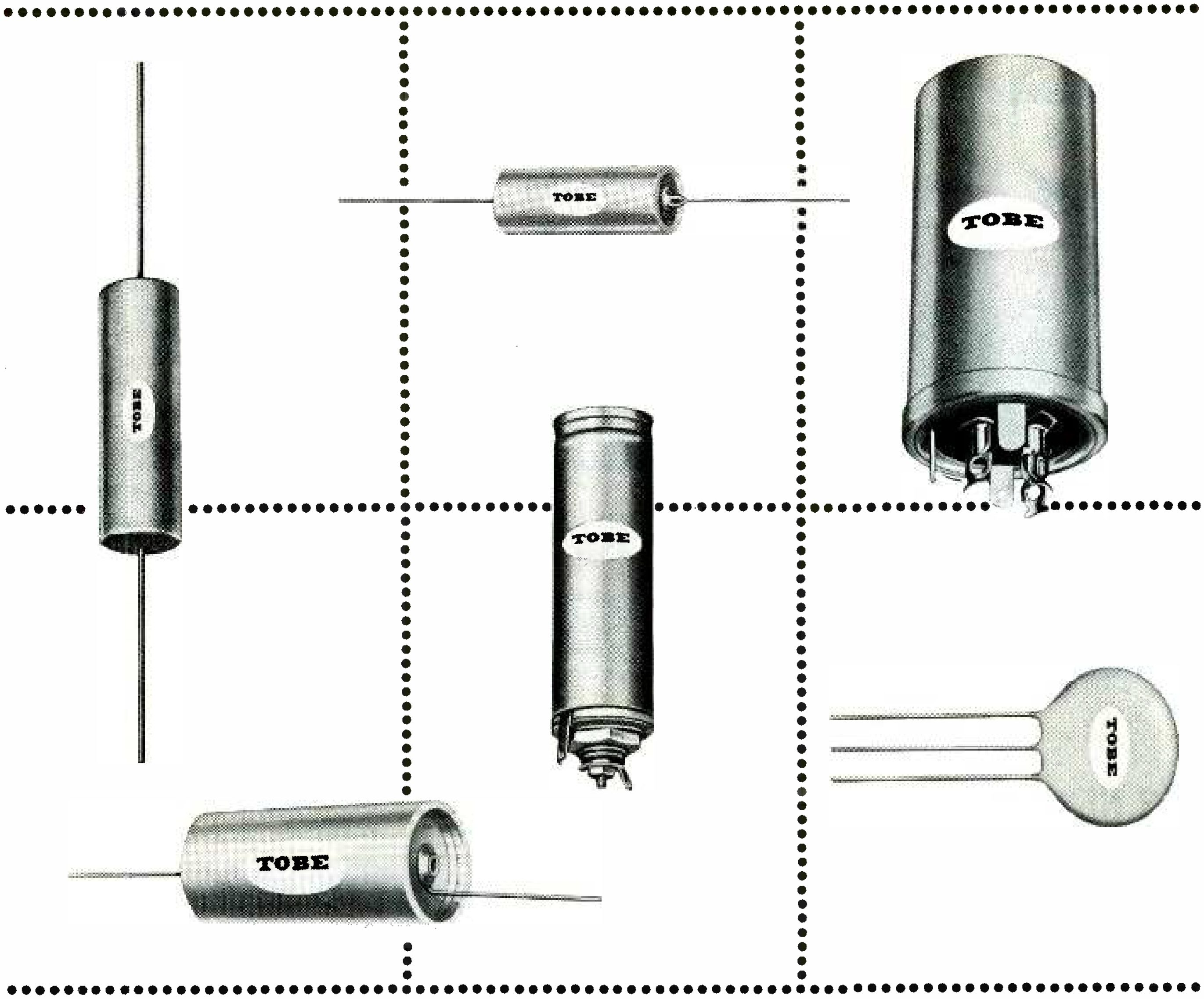


Fig. 2. Simplified RF input circuit.

Now that we've seen where this type of circuit is employed, let's get into an analysis of its salient points. In Fig. 1, you will notice a 3-8 mmf trimmer capacitor (C6) from the lower side of the grid coil to chassis. At first glance, this trimmer does not seem to be a part of the tuned input circuit; however, when the circuit is redrawn (Fig. 2), it can be seen that the trimmer is actually in series with the input capacity of the RF amplifier tube.

The equivalent value of two capacitors in series is less than that of the smaller unit; therefore, the effect of the trimmer is to reduce the capacity of the tuned circuit. It also minimizes variations in circuit capacity due to replacement of the RF amplifier tube.

As an example, let's examine the effect of tube changes in hypothetical circuits, one with a series padder and one without. In a circuit without a padder (Fig. 3A), it is easy to see that replacement of the tube with one having 1 mmf less input capacity would cause a 1-mmf change in the tuned circuit capacity. On the other hand, the



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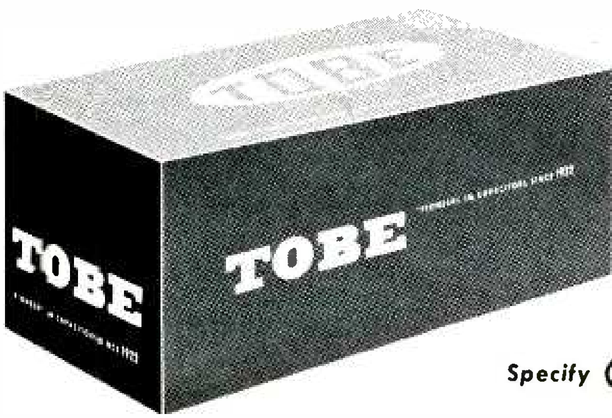

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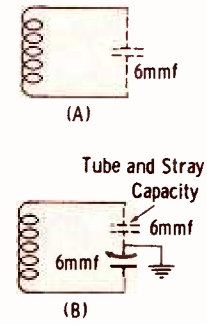

Fig. 3. Circuit tuned with stray capacity compared with one using series trimmer.

same tube change in the circuit of Fig. 3B will affect circuit capacity in accordance with the formula,

$$C_t = \frac{C1 \times C2}{C1 + C2}.$$

The circuit capacity is now 3 mmf. A reduction of 1 mmf in tube capacity would reduce the total capacitance to 2.72 mmf, a change of only .28 mmf. Thus, the frequency response of pentode circuits incorporating a trimmer unit is relatively unaffected by replacement of the tube. In the plate circuit of Fig. 1, we find a trimmer (C8) from the plate to ground. The plate coil connects to signal ground by virtue of the very low impedance to RF of the 120-mmf capacitor C9. This means that the trimmer plus the stray and output capacities of the stage comprise the tuned circuit capacity. Since the output capacity (plate to cathode) of pentode RF amplifiers is normally quite small (usually less than 2 mmf), tube replacement does not materially alter the bandpass response of the output circuit.

The RF amplifier stage must govern most of the selectivity and sensitivity of the tuner, and since the grid circuit is very broadly tuned, the plate circuit is designed to present the desired RF signal with an impedance as high as possible in order to maximize the gain and selectivity. The necessary bandwidth is further governed by the degree of coupling between the RF-plate and mixer-grid coils.

Cascode Circuit

The term "cascode amplifier" is generally used to define an RF circuit like that in Fig. 4, where two triodes (usually in the same envelope) are connected in series. The 4-mmf capacitor from the signal grid of the first triode

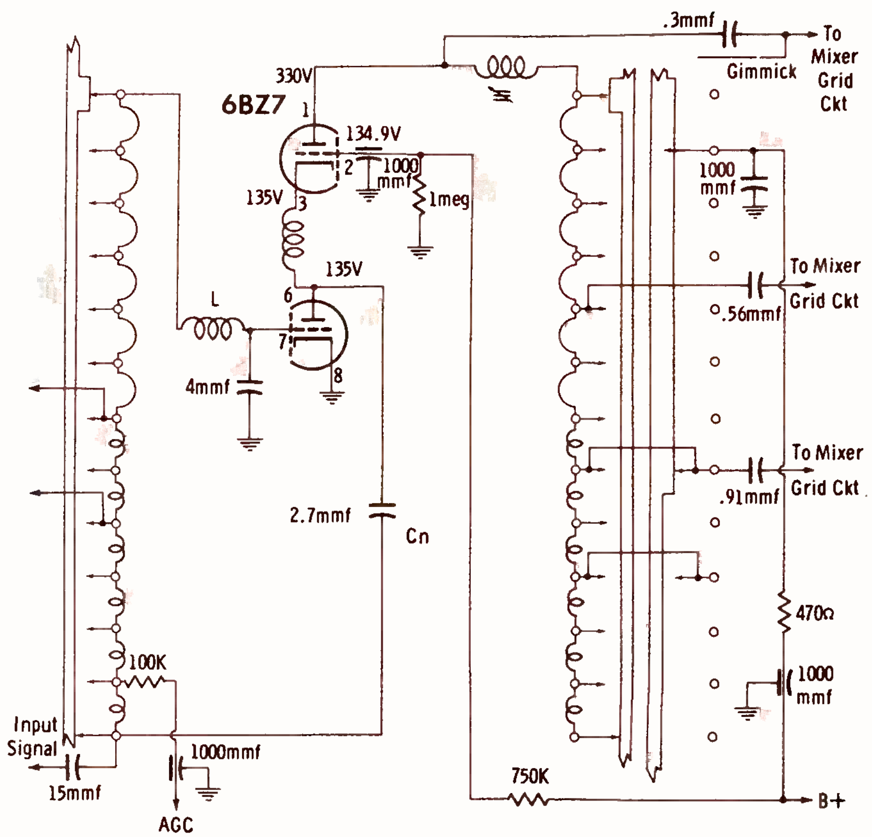

Fig. 4. Cascode RF amplifier circuit used in a switch-type tuner.

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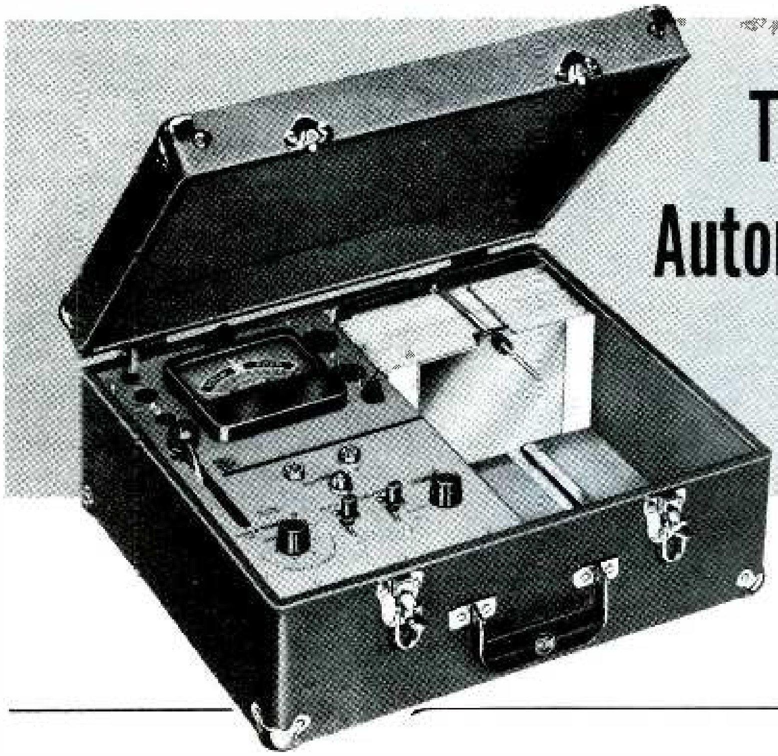

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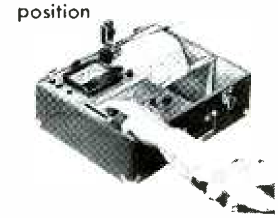
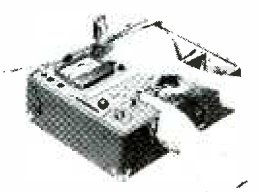


c. press calibrate lever and adjust calibration control



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stands out like a prune in a bowl of milk because we have previously given good reasons why this wasn't necessary. In this particular switch type tuner, however, the stray wiring and distributed capacities are very low. In addition, the input capacity of a 6BZ7 is only 2.5 mmf; consequently, the manufacturer found it necessary to add this small amount of capacity in order to achieve the desired bandwidth and selectivity on each channel.

One consideration that must be given when using a triode is the feedback path through the relatively high capacity from plate to grid. If the tube is connected in a grounded cathode configuration, the feedback signal causes regeneration and results in undesirable noise. The feedback signal can be neutralized by providing a second feedback path which reverses the phase of the second signal and provides cancellation.

In the circuit of Fig. 4, neutralization of the first section has been accomplished by feeding a certain amount of energy from the plate to the grid through the 2.7-mmf C_n. Notice that the feedback is to the low end of the grid inductance, thus providing the necessary 180° phase reversal to neutralize the stage. The grid of the second section is at AC ground because of the 1000-mmf capacitor, and the signal is applied to the cathode. This hookup eliminates the feedback path and requires no neutralization.

The grid of the first stage is controlled by AGC bias so that the output from the tuner will not overload the IF section under strong signal conditions. The control grid of the second section is held at a constant DC level by the voltage present at the junction of the 750K and 1-megohm resistors; thus, when the first section conducts less due to AGC action, the cathode voltage on the second section rises, increasing the bias on that stage.

The ratio of the resistor values in the grid circuit of the second stage is very critical. If the 1-megohm resistor should increase in value, or the 750K resistor decrease in value, the voltage on the grid could rise above that on the cathode. This would result in ex-

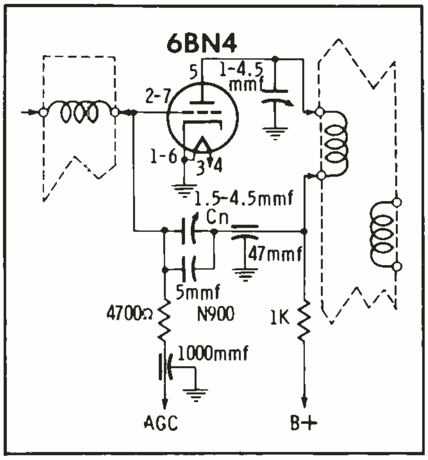


Fig. 5. Neutrode RF amplifier circuit.

cessive conduction and shorter tube life. If you have a set that is bothered with repeated RF amplifier tube failure, it would be a good idea to check the values of these voltage-dividing resistors.

The cascode RF amplifier is accepted as about the ultimate for fringe area performance, not only because it has the high gain normally associated with a pentode amplifier, but because it also has the low noise factor long associated with triode amplifiers. The six or so various dual-triode tubes in common use have similar electrical characteristics but different internal connections to facilitate component placement and layout in the various tuner designs.

Neutrode Circuit

As the name implies, this is a neutralized triode RF amplifier. The tube, a 6BN4 or 2BN4, has been especially developed for this application and features a plate dissipation of about half that of the dual-triode tubes used in cascode RF amplifiers. Reduced plate dissipation means less heat generation and consequently longer predictable tube life. The neutrode circuit of Fig. 5 is used in a newly designed turret tuner that also features a printed board for all wiring of the RF and oscillator-mixer circuits.

The printed board makes possible a very rigid structure which minimizes drift and radiation problems. The use of a single triode as the RF amplifier reduces the number of components required and, due to the special design of the 6BN4 tube type, the circuit will operate on low B+ voltages (125 volts).

Neutralization of the triode is provided through the 5-mmf capacitor paralleled with a trimmer from the low side of the plate coil to the control grid. The required 180° phase inversion is obtained through the plate coil and the amount of feedback is controlled by adjustment of C_n so that the exact amount of signal required for most effective neutralization can be obtained.

The cathode of the 6BN4 tube has two leads (pins 1 and 6) which are both connected to ground for minimum cathode-to-ground inductance and improved high-channel reception.

The performance specifications of the neutrode tuner compare favorably with those of cascode tuners. Field tests have shown that about 32 db of gain with less than 8 db of noise can be obtained on low channels. The cascode tuner features about 35 db of gain with about 6 db of noise. These figures indicate that the neutrode tuner will operate satisfactorily in both metropolitan and fringe areas.

Servicing the neutrode RF amplifier entails only one problem not generally associated with a pentode RF amplifier, and that is adjustment for most effective neutralization. While this is not extremely critical and won't be required every time the tube is replaced, there will be occasions when it will be necessary. For proper adjustment, a sweep generator, bias pack, oscilloscope, two 120-ohm carbon resistors and a detector probe are required.

A suitable probe is shown schematically in Fig. 6. The detector probe input is connected to the plate of the first IF tube and chassis ground and the output is connected to the scope. The signal generator is set to produce a 10-mc sweep over channel-10 frequencies (192-198 mc) and connected to the antenna input terminals through the two 120-ohm resistors. The bias box is used to clamp the RF and IF AGC lines to normal levels. The tuner is set on channel 10 and the output of the signal generator is adjusted to produce a suitable response curve on the scope. The neutralization capacitor is then adjusted to reduce the amplitude of the response curve to minimum.

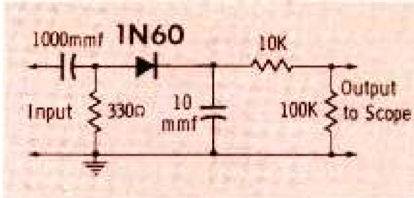


Fig. 6. Detector circuit used during adjustment of RF amplifier neutralization.

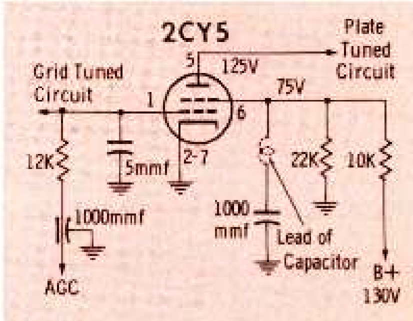
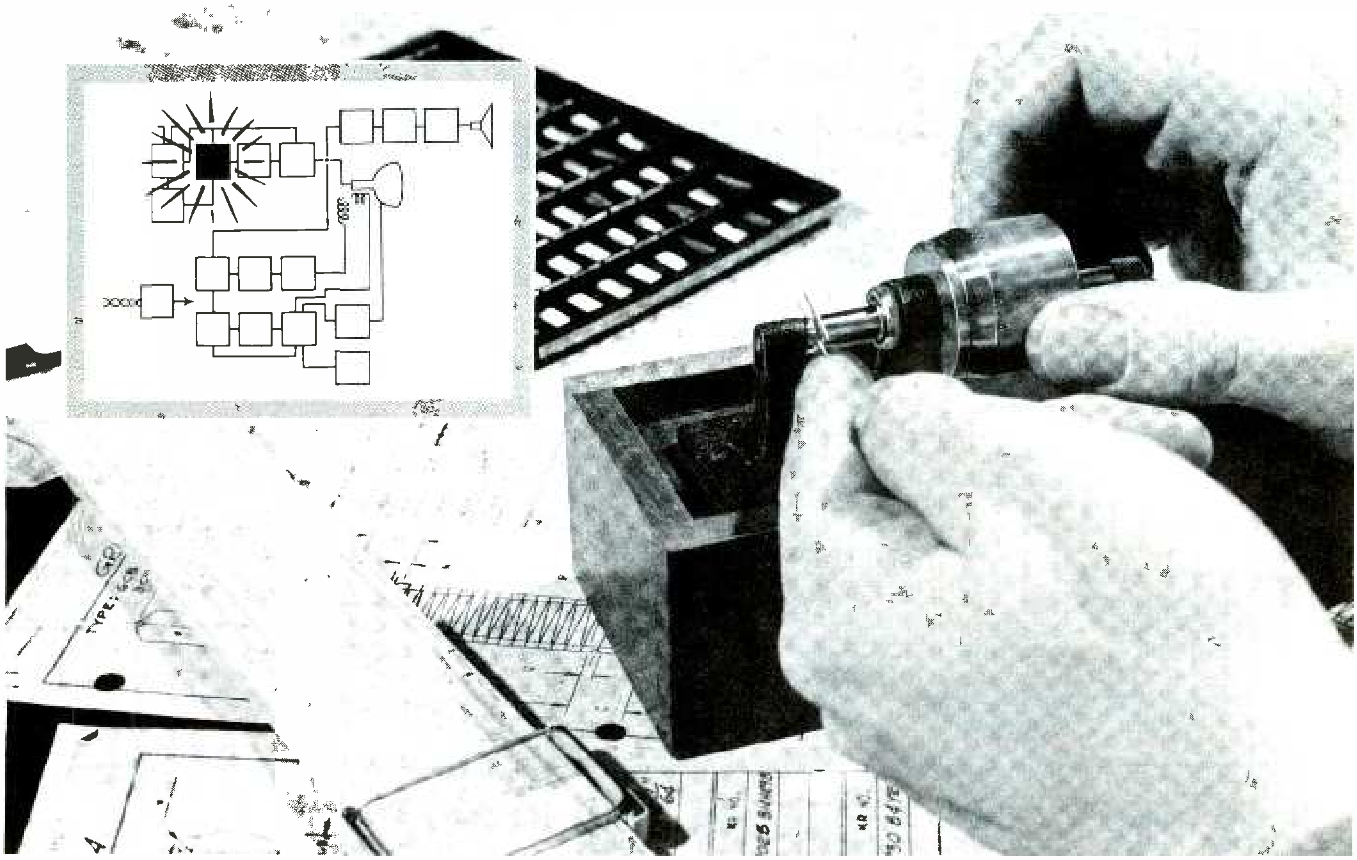


Fig. 7. Tetrode RF amplifier circuit.

Tetrode Circuit

The tetrode RF amplifier circuit is designed around a new tube series (2CY5, 6CY5, etc.). This tube features a very high transconductance (g_m) of 8,000 micromhos with a noise figure approaching that of some of the RF triodes and was developed by combining a plate and screen grid similar to that of a 6AK5 tube with a cathode and control grid like that of a 6BS8. The low noise figure of the new tetrode is partially a function of the high plate-to-screen current ratio (7-to-1 or higher), while the extremely high g_m is due to very fine (8 mil) control grid wire.

Circuitwise, the tetrode RF amplifier is almost identical to the pentode RF type. Of course, there is no suppressor grid in the tetrode and there is a small inductance in series with the screen-grid bypass capacitor (Fig. 7). This inductance is the lead of the capacitor itself and serves to cancel the effect of the cathode lead inductance. Replacement of this capacitor must be with one of a similar type, and its lead length must be the same as that of the original unit. The lead to the screen grid pin should be dressed as near to the original configuration as possible to insure optimum performance. The tetrode tuner provides about 35 db of signal gain at a 6 to 8 db noise level, which is comparable to the performance of cascode units. ▲



A STOCK GUIDE FOR TV TUBES

The chart on this page is presented as a guide for the maintenance of an up-to-date stock of television receiving tubes. The figures shown are expressed as proportions based on a total of 1,000 tubes. For example, if the figure 6 is given for a particular type of tube, this means that six out of every 1,000 tubes in television receivers now in service are of that type. The minimum entry in the "No. of Units" column is 0.5 per 1,000, rounded off to 1. Tubes which are used more rarely than this are also listed but the usage figure is not given.

The listing of a large figure for a particular type of tube is not necessarily a recommendation for stocking that number of tubes, but it does indicate that the tube is used in many circuits and should always be on hand in sufficient quantity to fill requirements between regular tube orders. Some consideration should be given to the frequency of failure of a particular tube type when stock requirements for that type are being considered.

This guide is based on all brands of TV receivers, and the frequency-of-use data for tubes represent nationwide averages; therefore, these figures should be adjusted to take into account regional and local conditions. In addition, shops which specialize in servicing particular brands of sets will need to modify their tube stocks to suit the requirements of those sets.

In most cases, combined listings are given for redesigned "A" and "B" tube types and their prototypes. It is often practical to stock the latest version exclusively.

The figures in the Stock Guide are obtained statistically by keeping a cumulative record of the tubes used in new models of receivers. The results are adjusted to take into account the quantities of production of different models and the retirement of old sets at an estimated average age of 5 years.

TUBE TYPES	NO. OF UNITS	TUBE TYPES	NO. OF UNITS	TUBE TYPES	NO. OF UNITS	TUBE TYPES	NO. OF UNITS	TUBE TYPES	NO. OF UNITS
1AX2	—	5CG8	—	6BA8A	1	6CH8	—	12AV7	2
1B3GT	43	5CL8	—	6BC5	6	6CL6	3	12AX4GT/-A	7
1V2	1	5CM8	—	6BC7	—	6CL8	—	12AX7	5
1X2A/-B	9	5J6	1	6BC8	1	6CM6	—	12AZ7	1
2BN4	1	5T8	1	6BD4/-A	—	6CM7	1	12B4A	2
2CY5	—	5U4GA/-B	45	6BE6	6	6CN7	1	12BH7/-A	13
3A2	—	5U8	4	6BF5	1	6CS6	3	12BK5	1
3A3	1	5V3	—	6BF6	—	6CS7	1	12BQ6GA	—
3AL5	2	5V6GT	—	6BG6G	4	6CU5	—	12BQ6	
3AU6	2	5X8	1	6BH8	1	6CU6	3	GTA/-B	1
3AV6	—	5Y3GT	2	6BJ7	—	6DC6	1	12BR7	—
3B2	—	6AB4	1	6BJ8	—	6DE6	2	12BV7	—
3BC5	1	6AC7	5	6BK4	—	6DG6GT	1	12BY7/-A	11
3BN6	3	6AG5	6	6BK5	2	6DN6	—	12BZ7	—
3BU8	—	6AG7	2	6BK7A	6	6DQ6/-A	2	12C5	1
3BY6	—	6AH4GT	3	6BL4	—	6DT6	1	12CA5	1
3BZ6	2	6AH6	6	6BL7GT	6	6J5	3	12CT8	—
3CB6	8	6AK5	2	6BN4	—	6J6	23	12CU5	—
3CF6	1	6AK6	—	6BN6	6	6K6GT	7	12CU6	1
3CS6	1	6AL5	63	6BQ6G/-A	2	6M3	—	12D4	—
3DT6	1	6AM8	3	GTA/-B	20	6S4/-A	2	12DQ6/-A	2
4BC8	—	6AN8	7	6BQ7A	17	6SL7GT	2	12L6GT	2
4BQ7A	1	6AQ5	15	6BR8	—	6SN7GT/-B	68	12R5	—
4BS8	—	6AR5	1	6BS8	—	6SQ7	3	12SN7GT/-A	4
4BZ7	—	6AS5	3	6BU8	—	6T8	13	12W6GT	1
4CY5	—	6AS6	1	6BV8	—	6U4GT	—	17H3	—
5AM8	1	6AS8	1	6BX7GT	1	6U8	18	18A5	—
5AN8	1	6AT6	2	6BY6	2	6V3A	3	19AU4/-A	1
5AQ5	1	6AT8	1	6BY8	—	6V6GT	14	25AV5GA	—
5AS4	—	6AU4GT/-A	3	6BZ6	4	6W4GT	19	25AX4GT	1
5AS8	—	6AU6/-A	95	6BZ7	4	6W6GT	10	25BK5	1
5AT8	2	6AU8	2	6BZ8/X155	—	6X8	7	25BQ6GA	—
5AV8	1	6AV5GA	3	6C4	7	6Y6G	1	25BQ6	
5AU4	—	6AV6	16	6CB5A	1	7AU7	2	GTA/-B	4
5AW4	—	6AW8A	5	6CB6/-A	125	9U8	—	25C5	—
5B8	1	6AX4GT/-A	14	6CD6G/-A	2	9CL8	—	25CD6G/-A	1
5BE8	—	6AX5GT	1	6CE5	—	10C8	—	25CU6	—
5BK7A	1	6AX8	—	6CF6	2	12AT7	10	25DN6	1
5BR8	—	6AZ8	—	6CG7	4	12AU7/-A	32	25L6GT	4
5BT8	—	6BA6	7	6CG8	—	12AV5GA	—	25W4GT	1

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Shop Talk

(Continued from page 13)

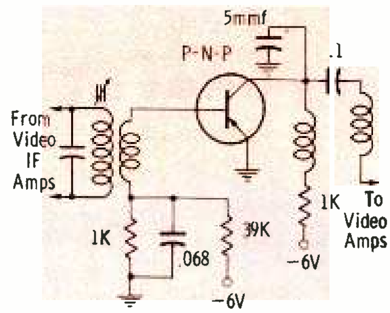


Fig. 4. A class-B video detector.

taken, with C_n being connected from the plate of the tube to some point in the grid circuit.

High-frequency IF stages have also been designed using tetrode transistors. Since these units are new in the sense that, to date, none has been used in radio receivers, let us briefly review their mode of operation to see why they are suitable. A tetrode transistor is, as its name implies, a four-electrode device. Structurally, it resembles a triode transistor except that there are two oppositely placed leads connecting to the base. See Fig. 2. One lead, b1, is the normal base connection and serves as the common element between the emitter and the collector. The other lead, b2, is connected to a point on the side opposite b1. Electrically, a voltage is applied to b2 which is higher than the normal emitter-to-base potential. The latter differential voltage, it will be recalled, is generally on the order of 0.1 volt. On the other hand, b2 is given a potential of several volts. For an n-p-n unit, the potential applied to b2 is negative; for a p-n-p transistor, it is positive. Note that this polarity is counter to the normal emitter-to-base voltage.

To appreciate the effect of this additional base lead and the voltage applied to it, it is necessary to realize that the voltage is not equally effective throughout the base area. Rather, the base section appears as a resistive element to the voltage, resulting in a gradual drop between the two connecting points. Thus, if we apply a minus 5 volts to b2 (in an n-p-n transistor), this voltage is fully effective only at the b2 point. As we move along the base section away from this point, the actual negative voltage present decreases until it reaches zero at the point where b1 connects to the base.

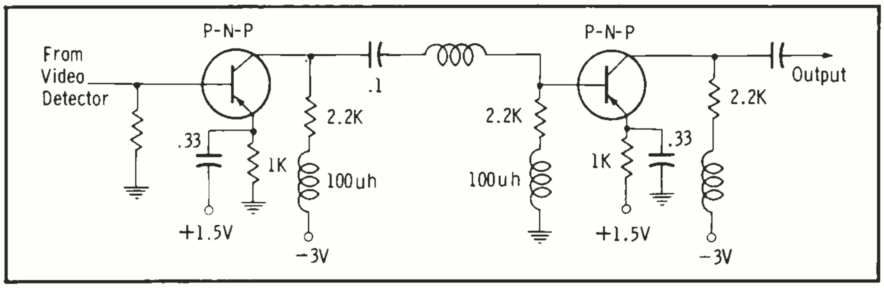


Fig. 5. A 2-stage video amplifier using peaking coils to obtain a 4-mc bandwidth.

In an n-p-n transistor, electrons will travel from the emitter to the base when the emitter is negative with respect to the base. In a tetrode transistor (n-p-n type), with a negative bias on b2, this situation will only occur near the very bottom of the base section in the vicinity of b1. At all other points, the base will be more negative

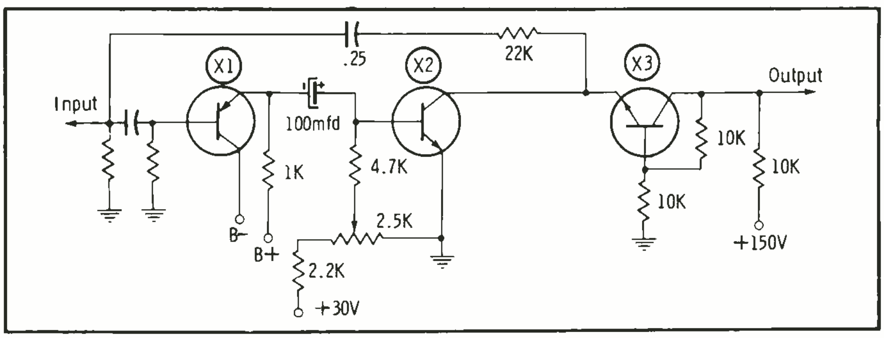


Fig. 6. A video amplifier capable of providing an output signal of 80 volts peak-to-peak when X2 and X3 are silicon transistors.

than the emitter. Thus, the additional base element and its opposing voltage force the normal current from emitter to base to collector into a very narrow channel near b1.

This restrictive action helps to improve the high-frequency response of the transistor in several ways. First, it reduces the collector capacitance by reducing the active area of the collector junction. This capacitance acts to shunt the signal around the output of the transistor in somewhat the same manner as the output capacitance of a vacuum tube. By decreasing the value of this capacitance, the frequency at which it becomes a significant shunting factor is increased.

Another benefit accruing from the action of b2 is that the active base area is reduced. This means that the over-all base resistance is also reduced and helps to raise the frequency response. Thus, on these two major accounts, tetrode operation of a transistor results in improved high-frequency operation.

An IF circuit which has been designed using General Electric tetrode units is shown in Fig. 3. There are five stages, stagger-tuned, of which two are resonated at frequencies in the low end of the IF band, two near the video carrier frequency and one which tunes rather broadly over the middle frequencies. The latter circuit is positioned just ahead of the second detector. (Note that the detector is tapped down on the coil in order to achieve a better impedance match between the two stages.)

Tracing from each of the transistor elements back to the voltage supply, it can be seen that the second base connection, b2, receives a higher negative voltage than either b1 or the emitter. As it is, the latter elements receive negative voltages which are generally higher than normal because the collectors are grounded. This is done so that the elements of these n-p-n transistors will have voltages of the proper polarity for class-A operation. (In vacuum tubes, an equivalent arrangement would necessitate a large negative voltage on the cathode and the plate grounded.)

Each of the emitters possess a 470-ohm resistor for protective purposes. Since each resistor is bypassed by a 680-mmf capacitor, no signal degeneration is involved. However, presence of the 470-ohm resistance does tend to stabilize stage operation during changes in temperature and also when transistor replacements are required. It could, if desired, be looked upon as a DC degenerative element. (Comparison to vacuum-tube circuitry may again be helpful. In a tube, a fully bypassed cathode resistor offers no AC or signal degeneration, but it does offer DC degeneration. That is, if we pass DC current through the stage, the gain will be lowered because the DC voltage developed across the cathode will partially offset the DC applied to the grid. Ordinarily, however, we are not concerned with amplifying DC signals, so while present, this decrease is unimportant.)

Circuitwise, bifilar tuned circuits are employed, with the higher impedances placed on the collector side of the preceding stage and the lower matching impedance assigned to the input of the succeeding stage. AGC could be employed, but the circuit shown utilizes a manual gain control which can be used to vary the negative bias on b2. If AGC were used, it would control the same three stages. Trap circuits (one shown here) would be placed outside the AGC loop to prevent altering the transient response of the system. Over-all gain of this system is on the order of 60 db. This is power gain, which is the quantity usually quoted in transistor circuits. On the other hand, in vacuum-tube systems, where most stages are voltage amplifiers, db figures usually represent voltage gains.

Second detectors in television receivers fall into the same two categories they do in radio receivers. That is, they could either employ germanium diodes as shown in Fig. 3 or transistors biased for class-B operation as in Fig. 4. The latter would not only provide additional gain, but would also supply needed power for any AGC voltages that might originate in this stage.

Note the use of series and parallel peaking circuits in order to maintain the frequency response of the circuit out to 3.5 or 4.0 mc, as desired. Actually, because of the lower resistances, it is easier to obtain an extended response with transistor circuits than with vacuum-tube circuits. (With a lower resistance, capacitive shunting is delayed to a higher frequency because a much lower value of X_c can be tolerated.)

The Solution

In his haste to pin down the criminal without the aid of reliable service information, George had himself committed a crime by introducing the second trouble in his clumsy endeavor to cure the first. After examining both the schematic and parts list of the receiver, he eventually recognized his mistake. The feedback capacitor, C6, was actually listed as a .001 mfd rather than the value of .01 mfd assumed by George.

Increasing the coupling capacitance in this feedback network raised the grid bias of the first multivibrator stage, and the tube was thus held in cutoff for too long an interval. After adjustment of the vertical hold control therefore, the oscillator would lock in at one-half its designed frequency, or 30 cps. Replacement of the capacitor with a .001 mfd restored the set to normal operation.

Had George been able to properly interpret the color stripes on the faulty capacitor or had he referred to the service literature for the value of this component, he would have perhaps never experienced the case of the double-decker picture.

Following the detector, video amplifiers are required in order to raise the signal to a level high enough for a suitable picture to be produced on the screen. The video stages must also possess a bandwidth extending from about 30 cycles to about 4.0 mc, although 3.5 mc is suitable for most black-and-white receivers. A two-stage amplifier which possesses the required bandwidth is shown in Fig. 5. Two high-frequency transistors, together with a number of peaking coils, are used to maintain the desired response. Because of the low-valued resistors, close to 3.0-mc bandpass can be obtained even with the peaking coils removed. Adding the coils serves to extend the bandwidth, or they can be used to advantage in raising the resistor values (primarily the load resistors) thereby obtaining somewhat greater gain for the same bandwidth. Additional gain can also be achieved by raising the collector voltages. A two-stage gain of 25 is readily obtainable with this arrangement.

A video amplifier that can provide an output voltage of 55 volts is shown in Fig. 6. The amplifier consists of a common-collector stage X1 driving a common-emitter stage X2 with shunt resistive feedback from the collector of X2 to the base of X1. The collector circuit of X2 drives the common-base output transistor X3. This latter stage gives an approximate voltage gain of 2 from DC up through the band of video frequencies.

When the transistors are constructed of germanium, the circuit is suitable for driving black-and-white picture tubes. However, by reverting to high-frequency n-p-n type silicon transistors, particularly for X2 and X3, peak-to-peak voltage swings up to 80 volts can be obtained, thereby enabling the circuit to be utilized for color television picture tubes. (X1 can remain a high-frequency germanium unit.)

X2 is connected as a grounded emitter in order to obtain the maximum power gain and also to obtain DC restoration which is so vital to color reproduction. X1 is connected as a grounded collector (essentially a cathode follower) to assist the over-all frequency response and to better enable X2 to perform its DC restoring action. The maximum power drain of the circuit is 2 watts. In comparison, a pentode video output amplifier that does approximately the same job has a maximum power drain of about 20 watts. This 10-to-1 saving shows some of the benefits to be derived from converting to transistor operation. ▲

Horiz. Output Troubles

(Continued from page 15)

ion trap. When a lack of high voltage is encountered, the horizontal output and high-voltage circuits should be checked for an open fuse or a defective tube. If only a weak arc can be drawn from the plate cap of the high-voltage rectifier tube, disconnect the plate lead and recheck for an arc on the lead itself. If the arc is normal at this point, the rectifier tube may be defective. If this tube must be replaced periodically, the filament resistor in the circuit may need to be changed.

There are times when the technician may assume that the high voltage on the picture tube is sufficient to produce a raster when the voltage is actually RF or alternating in nature. If this should be the case, a reddish-blue, snake-like arc will be observed when the anode lead is placed near chassis ground. This condition is often a direct result of a shorted high-voltage rectifier tube.

A thorough visual inspection of the high-voltage section plays a definite part in the troubleshooting procedure. Broken connections, burned components, and faulty insulation can often be detected in this manner. One might check to determine if the plate of the horizontal output tube appears red or overheated. If it glows cherry red or the tube appears gassy, the oscillator may be inoperative or there may be a short in the output stage.

Possible causes of no raster are:

1. Defective tube in the horizontal-sweep or high-voltage circuits.
2. Open fuse in the flyback system (usually indicative of another trouble).
3. Shorted or leaky screen-bypass capacitor in the output stage.
4. Open screen resistor in the output stage.
5. Shorted or open coupling capacitor to the output-tube grid.
6. Defective yoke or yoke socket.
7. Shorted or leaky boost B+ filter capacitor.
8. Breakdown of high-voltage insulation. (Check high-voltage leads, standoff insulators, and connectors.)
9. Defective flyback transformer.
10. Open cathode resistor in the output stage.
11. Open or shorted capacitor in the yoke return lead.

Insufficient Width

The symptom pictured in Fig. 2 represents a trouble caused by insufficient horizontal sweep. Symptoms of this nature usually indicate to the technician that the trouble exists in either the horizontal sweep circuit or in the low-voltage power supply. Although the present discussion deals only with those faults originating in the horizontal sweep circuit, it should be pointed out that a weak low-voltage rectifier tube or selenium rectifier is also a very common cause for this condition; however, a deficiency of low voltage will also often reduce the height of the picture.

The most frequent cause for insufficient width is a weak horizontal output tube. This weakness may be due to the relatively large amount of power handled by this tube. The efficiency of the horizontal output stage is rather critical and the slightest change in drive or bias voltages may result in width reduction. The technician should always check the amplitude of the drive voltage before delving too far into the circuit.

Possible causes for insufficient width are:

1. Defective horizontal output or damper tube.
2. Misadjusted or defective drive control, width coil, or linearity coil.
3. Open or leaky boost B+ filter capacitor.
4. Open or leaky screen bypass capacitor in the output stage.
5. Horizontal output grid resistor low in value.
6. Horizontal output screen resistor increased in value.
7. Open or leaky coupling capacitor to output-tube grid.
8. Defective flyback transformer.
9. Leaky capacitor in the yoke return lead.
10. Horizontal-output cathode resistor increased in value.

Blooming

Picture blooming is a common term used to describe the condition of raster expansion as the brightness control is advanced. This trouble symptom is shown in the photograph of Fig. 3 in which the picture detail appears out of focus. For proper focus, the brightness level must be reduced to below normal and in such a case the raster may not fill the screen. If this condition becomes extreme, the raster may disappear completely as the brightness control is advanced to its maximum setting. When these symptoms occur, the receiver is usually operating with insufficient high voltage.

Possible causes for blooming are:

1. Defective HV-rectifier tube.
2. Filter resistor in anode lead open or increased in value.
3. High-voltage arcing or corona discharge. (Check lead dress and solder connections.)
4. Filament resistor of high-voltage rectifier changed in value.
5. Misadjusted horizontal drive control.
6. Defective flyback transformer.

Horizontal Foldover

Horizontal foldover can produce various symptoms on the picture-tube screen. These may appear as light drive lines near the left center of the picture, or large portions of the raster may sometimes be folded back at either the left or right side of the screen.

The trouble symptom pictured in Fig. 4 represents horizontal foldover near the center of the screen. This condition and those in which the left side of the raster folds over are most often caused by defective components in the damper circuit. When the foldover (or cramping) occurs at the right side of the screen (as shown in Fig. 5), the trouble usually originates in the horizontal discharge or output circuits. This method of isolation will not always hold true, but should prove helpful in most cases. A waveform analysis of the horizontal sweep section is perhaps the quickest way to localize a fault of this nature.

Possible causes for horizontal foldover are:

1. Defective horizontal discharge or output tube.
2. Leaky coupling capacitor to output-tube grid.
3. Misadjusted or defective drive control.

4. Open or leaky cathode capacitor in the output stage.
5. Output-stage grid resistor of incorrect value.
6. Open or leaky screen bypass capacitor in the output stage.
7. Defective width or linearity coil.
8. Open or leaky boost B+ filter capacitor.
9. Output stage cathode resistor of incorrect value.
10. Open capacitor in deflection-yoke anti-ringing circuit.
11. Defective yoke or flyback transformer.

Horizontal foldover may be a result of improperly matched components in the flyback circuit. When it becomes necessary to replace such components as the yoke, flyback transformer, width coil, or linearity coil, it is imperative that these items duplicate the original part or that certain circuit modifications be performed to compensate for any mismatch.

Horizontal Nonlinearity

The trouble symptom represented in the photograph of Fig. 6 reveals a case of horizontal nonlinearity. Symptoms of this type are closely related to those of foldover. Defective components may cause foldover in some instances; and in others, the same components may produce some form of nonlinearity.

Possible causes for horizontal nonlinearity are:

1. Defective discharge, output, or damper tube.
2. Defective or misadjusted linearity coil.
3. Open or leaky boost B+ filter capacitor.
4. Open screen bypass capacitor in the output stage.
5. Output-tube grid or cathode resistor changed in value.
6. Improper value of output-tube screen resistor.
7. Defective yoke or width coil.
8. Partially open or leaky coupling capacitor.
9. Shorted or leaky capacitor in the yoke return lead.

In many receivers, the setting of the horizontal linearity coil is somewhat critical. If this coil is misadjusted, it can cause the flyback transformer to overheat or it can place an undue strain on the output tube. In order to check the setting of the linearity coil, a milliammeter should be connected in series with the cathode circuit of the output tube. The linearity coil may then be adjusted and a peak current reading obtained at both ends of the adjustment range. A dip or reduction in current should be noticed at about mid-range, and the proper setting should be as close to this mid-range point as possible. If minimum current cannot be obtained near the midrange position, the coil or some other component is probably defective.

Barkhausen Oscillation

An interference known as Barkhausen oscillation is another common trouble symptom often encountered. This type of interference is illustrated in the symptom of Fig. 7. In this example, a weak signal is being received and the interference appears as two dark vertical lines near the left side of the screen. The interference is actually the result of oscillations originating within the envelope of the horizontal output tube. When the signal voltage on the plate of the output tube drops to zero or becomes slightly negative (following retrace time), the electrons which have already passed the screen grid are attracted back by its more positive potential. When the plate voltage becomes positive, the electrons again change direction and are attracted toward the plate. Thus, an oscillation is set up within the tube and will radiate and be picked up by the antenna lead-in, the tuner, or the IF strip.

Barkhausen oscillation is most evident when no signal is being received. A strong local signal will usually override it or cause the dark lines to appear much lighter.

Possible causes for Barkhausen oscillation are:

1. Defective output tube.
2. Misadjusted drive, width, or linearity controls.
3. Improper shielding.
4. Incorrect lead dress.
5. Excessive lead length in the flyback circuit.
6. A slight physical or electrical change in component values.

Snivets—another type of interference resembling Barkhausen oscillation—may develop in the flyback circuit. They usually originate in the damper tube or its associated circuitry. The symptom resulting from this radiation is similar to that produced by Barkhausen oscillation and will appear as a narrow vertical line or band at the right edge of the screen. If a weak signal is being received, the interference will usually show up as a dark, ragged line. Under normal signal conditions, the line will appear lighter and will be made up of small, moving diagonal lines.

Keystone Effect

The trapezoidal raster pictured in Fig. 8 is commonly referred to as a "keystone." The distortion shown was produced by a short circuit across one of the horizontal windings of the yoke. Usually, the effect will not be this severe, since it will probably result from a short of only a few turns. Resistive measurements of the yoke may not reveal this fact; however, this symptom is almost never caused by anything but a defective yoke.

Unstable Horizontal Synchronization

Difficulties originating in the horizontal output section of the receiver can produce a wide variety of unusual synchronization troubles. A symptom of one of these is illustrated in Fig. 9. The horizontal blanking bar appears in the center of the screen, and the picture tends to tear horizontally. In this particular instance, the erratic distortion disappeared as the brightness control was turned down; but at the same time, the entire raster shrunk and the brightness was below a normal viewing level. Some cases of arcing can cause a similar erratic tearing condition. The interference generated by high-voltage arcing will often affect the stability of the horizontal oscillator.

A symptom of horizontal pulling is shown in the photograph of Fig. 10. This trouble was the result of heater-to-cathode leakage in the horizontal output tube.

The operation of the horizontal AFC system can be upset by an improper feedback pulse from the horizontal output circuit. A trouble of this nature will often cause the picture to shift back and forth or the horizontal blanking pulse to appear near the center of the screen. Other trouble symptoms such as horizontal jitter, picture tearing, or multiple images may result from various defects in the horizontal output circuit.

Possible troubles in the sweep circuit which could cause unstable horizontal synchronization are:

1. Defective horizontal output or damper tube.
2. Defective component in the AFC feedback network.
3. Internal arcing of a defective component. (Check the screen and cathode bypass capacitors, the high-voltage filter capacitor and the feedback components.)
4. Open or leaky coupling capacitor to output-tube grid.
5. Improper lead dress.

Corona Discharge and High-Voltage Arc-Over

Corona manifests itself as a blue or violet discharge radiating from a source of high voltage, usually producing an audible hissing sound. The bluish haze results from the ionization of the air surrounding the point of high potential. Corona discharge will often precede an actual high-voltage arc-over which is a complete breakdown of the insulation separating two points of different potentials. The streaks in the picture (Fig. 11) are usually accompanied by a periodic or an erratic snapping sound. A close examination of the high-voltage section may reveal a flashing at the point of breakdown and the odor of ozone can sometimes be detected.

Corona troubles occur more frequently in those receivers which are operated in damp basements or in areas where the humidity is relatively high. The accumulation of dust particles around components in the high-voltage system also contributes to the possibility of high-voltage breakdown.

Distortion Caused by Ringing in Yoke

The interaction between vertical and horizontal windings of a deflection yoke can often result in unwanted picture distortion. The result of one trouble originating in the yoke circuit is shown in Fig. 12. The raster width is reduced slightly, and a certain amount of yoke ringing can be seen in the left side of the picture. A more severe case of yoke ringing is represented in Fig. 13. In this particular example, the over-all brightness has been reduced and the ringing tends to distort the entire left half of the test pattern.

Components that have incorrect values, or damping and neutralizing elements that are defective will usually produce symptoms similar to those illustrated.

Possible causes for distortion caused by yoke ringing are:

1. Open capacitor across one half of the horizontal yoke winding.
2. Improper lead dress (yoke leads).
3. Open shunt resistor across one half of the horizontal yoke winding.
4. Incorrect yoke replacement.

High-Frequency Whistle (Flyback Singing)

Another trouble symptom that warrants mention is the whistle caused by flyback singing. Many people are capable of hearing beyond the normal audible range and may find the high-pitched squeal emanating from the flyback circuit very annoying. The cause of this trouble is usually mechanical vibration in the flyback transformer. ▲

Tape Recorder Servicing

(Continued from page 19)

the take-up turntable, turned over and placed on the supply drum, ready to begin recording of the second track. On some of the newest machines, an extra head is furnished so that both tracks of special pre-recorded tapes can be played simultaneously to obtain a stereophonic effect.

The machine in Fig. 1 is shown in the "Stop" or "Off" position, with the tape disengaged from the heads. In this particular recorder, the heads are mounted on a pivoting bar and are swung into contact with the tape when the "Record" or "Playback" control button is pushed. At the same time, pressure pads are brought against the tape under spring tension in order to maintain firm tape-to-head contact.

Tape-Transport Mechanism

The mechanical section of a tape recorder, or transport mechanism, has a big job to do. It must move tape past the heads at a perfectly steady speed and also provide for fast tape movement in the reverse direction (and usually in the forward direction, too) so that any desired spot on the tape can be reached in a hurry. In addition, the transport mechanism has to supply smooth, extremely rapid braking—from a high speed to a full stop in a fraction of a second.

All these requirements are met in most moderately-priced recorders by a single induction-type motor and a system of drive wheels, belts, control levers, and brake shoes. These complex layouts vary so tremendously from one make of recorder to the next that it is impractical to describe a "typical" unit. However, Fig. 2 shows one transport mechanism to give the reader a general idea of what is under the cover of a recorder. By the way, this discussion will be confined to the popular one-motor type of recorder, and will not consider the more elaborate machines that have separate motors for slow tape drive and fast wind and rewind.

For recording or playback, the tape is placed between a slow-turning metal shaft (capstan) and a thick rubber pressure roller. Then, like clothes going through a wringer, the tape is pulled at a constant speed. In the recorder of Fig. 2, the capstan is the hub of a flywheel. One or both of two standard running speeds are provided on home recorders—3¾" per second for longest possible playing time which will give acceptable frequency response for voice applications, and 7½" per second for improved reception of music. Improvement is obtained at the faster speed because the "magnets" on the tape are less crowded and interaction between them is reduced.

The tape must be loaded on the take-up reel just as fast as it comes through the capstan and roller. If the speed of rotation of this reel is too slow, tape will be spilled; on the other hand, overly fast take-up speed will cause excessive tape tension and possibly breakage. To supply precisely the right amount of torque at all times, a variable take-up speed is required for the reason that the effective diameter of the reel increases as tape is wound on it.

Here's how variable speed is obtained in the unit of Fig. 2: Although the take-up drum is driven at constant speed by a belt attached to the motor shaft, this drum is separated by a felt clutch from the turntable that actually holds the take-up reel. This clutch provides a variable amount of slippage so that the tape is reeled up just as fast as needed—not at full motor speed. Incidentally, this particular machine has no provision for fast forward tape movement.

The recorder of Fig. 1 features a somewhat different approach to the take-up speed problem. The take-up drum drives the reel directly—not through a clutch as in Fig. 2. The required slippage is furnished by the take-up drive belt, which is slightly loose on its pulleys in the "record" or "playback" position. To obtain fast forward tape motion, a tension pulley is pressed against the belt, tightening its grip on the other pulleys so that a positive drive at motor speed is supplied to the take-up reel.

When the machine of Fig. 2 is placed in "Rewind" position, the idler wheel is shifted to make positive contact with the rewind drum, thus driving the rewind reel at motor speed.

The controls of a tape recorder have the job of coordinating the actions of the various mechanical and electrical parts of the unit. For a typical home recorder, the various operating functions or "modes of operation" can be broken down into groups of individual actions as follows:

RECORD—Apply heads, pressure pads, capstan and pressure roller to tape. Drive capstan at slow speed. Operate take-up reel slowly. Connect amplifier output to record head. Activate oscillator that supplies bias and erase current.

PLAYBACK—Operate tape as for RECORD. Connect record head to amplifier input. Disable bias-and-erase oscillator.

REWIND—Disengage heads, capstan, etc., from tape to minimize wear on latter. Disconnect motor from capstan and take-up reel. Connect motor to rewind reel.

FAST FORWARD—Same as REWIND, except that take-up reel instead of rewind reel is driven.

STOP or OFF—Disengage heads, capstan, etc. from tape. Disconnect motor from entire drive system. (Motor continues to run.) Apply friction brakes to both reels.

In some machines (as in Fig. 1), all switching needed to shift the recorder into a particular mode of operation is accomplished by a single push button or switch. Other units have separate control switches to control tape motion and head-to-amplifier connection. Among the auxiliary controls found on most machines are these three:

1. A means of varying capstan speed to allow for a change between 3¾" and 7½" tape speeds.
2. An interlock which must be pressed before the machine can be set up to record. (This prevents accidental erasure.)
3. A "pause brake," an auxiliary unit which momentarily stops tape motion at any desired time during recording or playback.

Trouble Symptoms and Cures

Complaints of poor operation of tape recorders fall into several broad categories:

1. LOSS OF SENSITIVITY—This is often due to a purely electronic defect in the amplifier; however, it can also be caused by a simple mechanical trouble—poor contact between the tape and the record head. For efficient operation, these must be so extremely close together that there is not even room for a coating over the oxide to protect it from friction. A resulting unfortunate characteristic of tape recorders is that some of the oxide wears off and is deposited on the heads, capstan, and tape guides as the tape moves through the machine. After many hours of normal use, the layer of oxide on the head becomes thick enough to hold the tape away from the strong central portion of the small magnetic field around the head gap. The tape then intercepts only the weak fringe of the field, and the sensitivity of the recorder falls off. High frequencies

are affected first because they normally produce a shallower field than the middle and low frequencies.

The remedy is to clean off the oxide periodically with a soft cloth or cotton swab moistened with a solvent suggested by the manufacturer of the recorder—usually alcohol, carbon tetrachloride, or a special preparation. Many recorder users are aware of the oxide problem and keep the heads and capstan clean themselves. By the way, an excess of cleaning fluid has been known to injure certain types of heads, and the soft mu-metal head core is easily scratched by a brush or other coarse cleaning tool. This means that the technician may occasionally have to repair a recorder damaged by over-diligent cleaning.

While the oxide powder tends to polish the head rather than abrade it, normal use of tape over a long period of time will eventually wear down the head until it needs replacement. Because of the way the head is constructed, the gap widens as wear progresses; hence, the high-frequency response (which depends upon small gap width) will be attenuated before the low and middle frequencies are affected.

Dirt, which is much rougher than oxide, will cause rapid wear if it gets between the tape and the head. Uneven head wear—for example, pitting—sometimes occurs. If it does, misalignment or excess tension of the pressure pads opposite the head should be suspected.

Another cause of poor sensitivity, especially at high frequencies, is head misalignment. The gap must be precisely perpendicular to the edge of the tape, and any deviation from a true 90° results in a measurable drop in output. In the usual method of alignment, the technician plays a special test tape on which a steady high-frequency note is recorded. (Such tapes are distributed by many recorder and tape manufacturers.) Meanwhile, he monitors the amplifier output with a meter while he varies an adjusting screw on the head mount for maximum indication. Manufacturers' instructions give details of this procedure for specific machines.

2. DISTORTION AND NOISE—These troubles, like loss of sensitivity, can be caused within the amplifier. Internal noise generated in the preamplifier stage is especially troublesome because it is amplified by the following stages. The 12AX7 tubes frequently used as preamps have some tendency to become microphonic and noisy. When attempting to eliminate amplifier noise, it is helpful to try several 12AX7's or the imported equivalent ECC83's, and to use the tube which gives best performance.

Hum is injected into the amplifier to some extent by AC-powered heaters, and some recorders have a "hum balance" control in the filament circuit so that this noise can be minimized.

If new recordings sound distorted but old ones still sound clear when played back, something may be wrong with the bias-and-erase oscillator, which is active only in the "Record" mode of operation. Most home recorders have a fixed bias level, since oscillator output amplitude is not considered critical in non-professional machines. Nevertheless, output should fall within a fairly narrow range to obtain good operation, and no distortion of the oscillator waveform is tolerable.

Oscillator trouble will not only tend to distort the signal applied to the record head, but will also cause failure of the erase head to demagnetize the tape completely. A background hiss will be left on the tape in mild cases of trouble, and portions of old signals may even remain as background noise in a new recording.

The record head itself will add noise to the tape if its core becomes permanently magnetized. This condition tends to develop gradually during normal use of the machine, and an increase in noise level and a fall-off of high-frequency response will eventually be noticed by the listener—especially if the recorder is used as part of a high-fidelity system. Thus, to maintain peak performance, the head should be demagnetized during routine overhauls. Commercial demagnetizing devices, which are employed in much the same manner as degaussing coils in color TV work, are now becoming more widely available. The demagnetizer is used as shown in Fig. 3—it is stroked *in one direction* across the pole pieces of the head, and then slowly withdrawn before the power is turned off.

3. WOW OR FLUTTER—Perhaps the most common type of distortion in tape recordings is produced by a mechanical cause—namely, irregularity in tape speed. The result is a periodic variation in pitch, as though the recorded material were being frequency-modulated by a sine wave. Slow, distinct variations are termed "wow," while the more rapid variations called "flutter" make themselves known mainly as a general fuzziness of the sound, especially on high notes of music.

Wow can usually be traced to flat spots on drive wheels, or periodic slippage or binding of some part of the drive mechanism. For prevention of slippage, oil and grease must be kept off the surfaces of drive wheels and belts; therefore, extra care should always be used when a recorder is lubricated.

Shaft bearings in the drive systems of many recorders are of an oil-impregnated type and do not require oiling under normal service conditions. If a bearing does not turn freely or gets dirty, a high-grade oil specified by the manufacturer may be applied. Only a drop or two should be used, and the area should be checked after lubrication to be sure that no oil has splashed or crept onto drive surfaces. Grease such as "Lubriplate" can be applied sparingly to pivots and sliding linkages if they are stiff-operating, but the same precautions that apply to oil should be observed with grease. In case any lubricant does contaminate belts or drive wheels, it can be removed with one of the solvents mentioned previously.

Should the tape still fail to move smoothly after the machine has been cleaned and lubricated, look for any of the following troubles: Misaligned shafts, flat spots on drive wheels, stretched or frayed belts, or rough or misaligned tape guides. Deteriorated, crumbling rubber on the rim of a drive wheel calls for replacement of the wheel. Intermittent drag on the tape is likely to be due to dirt. Check to see if any tapes used in the machine have been spliced with ordinary gummed tape, which contains an adhesive that oozes out and sticks to the heads or tape guides. Although defective drive parts should be replaced as a rule, a flat spot on a rubber pressure roller can sometimes be ironed out by running the recorder on "Playback" for an hour or so.

An effect similar to flutter is produced when motor vibrations penetrate through defective motor mounts and reach the record head. Another condition to suspect in cases of flutter is excessive tape tension. This usually results from too much torque on the take-up reel or too much drag on the supply reel. A common postal-type 0-8 oz. spring scale (Fig. 4) is useful in locating the source of this type of trouble. Service manuals often include directions for using this instrument to measure and adjust take-up and rewind torque, as well as pad and roller pressure on the tape. The variable take-up torque in the "Record" or "Playback" position easily becomes misadjusted, since it is based on a controlled amount of slippage in a belt or a felt clutch. Some of the clutches are saturated with oil and then partially dried, and the take-up torque is incorrect if the amount and type of oil in the felt is not in accordance with specifications.

4. TAPE-HANDLING DIFFICULTIES—Improper reel torque or faulty brakes can cause the tape to spill or to break in two. The spring scale comes in very handy for tracking down the reasons for trouble of this kind. If the tape seems to break much too easily, the brittleness may be due to storage under conditions of excessively low humidity—as in a steam-heated room during winter months.

The foregoing hints on tape-recorder servicing have been intended as a general guide. For more specific information, it is best to refer to the service manual for each particular recorder, since the detailed variations between units are many. ▲

Industrial Electronics

(Continued from page 21)

lays, welders, motors and generators, plus hydraulic, pneumatic, and servo systems. Although the list looks formidable, there is in reality very little mystery connected with these units. Most of the circuits have been proven through years of service and are quite standardized. There are few "tough dogs" in industrial electronics, since components are very conservatively rated and circuits follow the proven, dependable plan.

Industrial Symbols

The serviceman will encounter a few symbols in industrial diagrams which may be confusing to him. A comparison of radio and industrial symbols to illustrate the more important differences will be found in Table I. Capacitors and industrial relay contacts are very easily confused with each other, and it will require daily practice to become familiar with the differences in symbols.

Using the chart, follow the circuit in Fig. 1 and notice the simplicity of the industrial symbol. Transformer windings and relay contacts are drawn close to the part of the circuit with which they are concerned, as opposed to being positioned entirely in one place with lines extending to several sections of the diagram. The contacts are not shown near the relay but are identified by the letters 10CR, or 1TD, which means that, when energized, contact relay coil number ten will activate contacts 10CR, and the time-delay relay coil will activate contacts 1TD. All relay contacts are drawn in the deenergized position. The same circuit is shown using radio symbols in Fig. 2; note how the relay contacts in the diagram make circuit analysis more difficult!

Test Equipment Requirements

The test equipment needs of the industrial serviceman are very similar to the needs in servicing TV and radio. The VTVM and multimeter can be used to make all static and some dynamic tests, with the oscilloscope rounding out the dynamic testing. The scope must be portable, but its performance requirements generally are not as severe as those for TV servicing—its sensitivity can be less, and a frequency response of 500 kc is usually ample. Special equipment will depend on the type of industrial devices encountered. For instance, in induction and dielectric heating, a wave meter is essential to tune the heater to the FCC frequency. A tachometer is desirable when servicing motor controls, and work on high-current equipment such as welders is easier with a tong ammeter. New equipment can either be purchased when there is a definite need for it, or all at once, depending on the circumstances. Unlike entertainment-type repair business, it is not absolutely necessary to stock a large supply of parts, but you should become acquainted with the industrial parts stock your local distributor carries.

When you have had time to prepare yourself for an industrial servicing encounter, a short drive through your locality should provide the names of many prospects. Or, some communities have directories of local business concerns which you could use for a list of prospects. And, don't overlook contacting the local Chamber of Commerce for possible leads. In

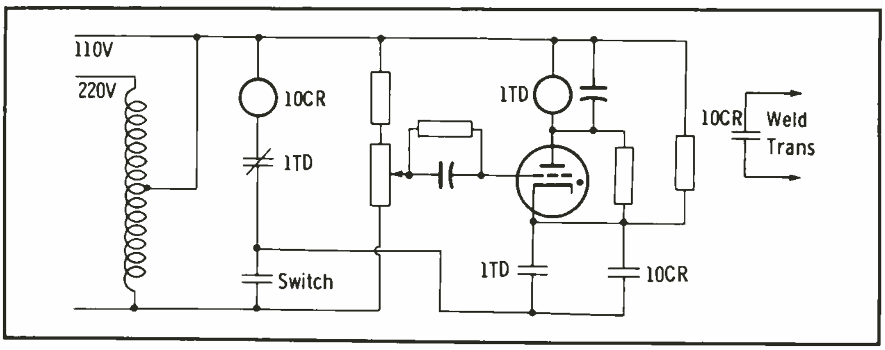


Fig. 1. Industrial schematic of a weld timer.

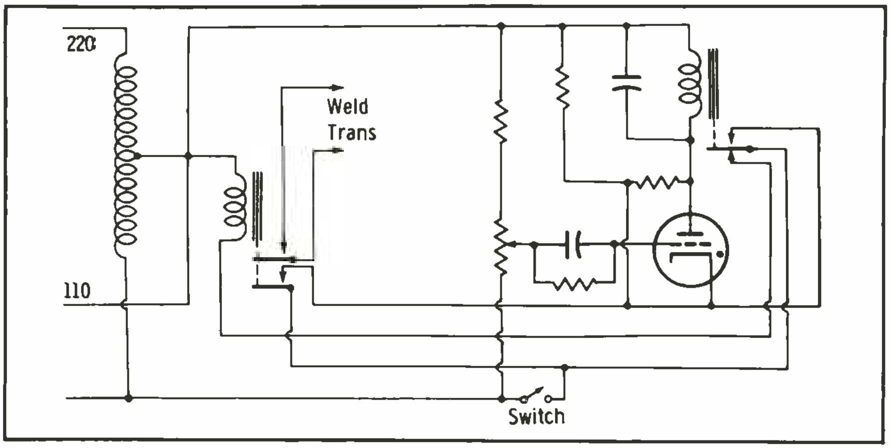


Fig. 2. Weld-timer schematic using radio-TV symbols.

addition, your local parts distributor may be able to pass along a few leads to you—particularly if he handles industrial electronic items.

Likely prospects to approach are the welding and printing shops, candy makers, vegetable packers, and canneries, since they are always pressed for time and least likely to have a service contract with the industrial electronic equipment suppliers.

Frankly, getting industrial servicing business is not as difficult as it might seem. More or less, it's simply a matter of making up your mind that you desire this type of business and then starting in on a slow and gradual basis to get it. Oftentimes, just the fact that you are willing to tackle industrial work will gain you business. Incidentally, many makers of industrial electronic equipment are franchising service centers throughout the country. While this is not necessarily the best way to get into the industrial servicing business, it will enable you to get your foot in the door, as well as let you become fairly familiar with particular types of equipment.

Once you have located your prospects, a letter to the production manager, maintenance superintendent and/or purchasing agent, will announce your intentions. The contents of your letter or brochure should stress the preparation you have made toward the accumulation of knowledge, experience and facilities to serve local industry. Time is the manufacturer's enemy, so stress fast, one-stop service. Don't mention costs—generally, a manufacturer is more interested in speedy, dependable service than in price.

A small advertisement in the classified section of your local phone directory will keep your name in front of prospects, as will promotional mailings, newspaper publicity, etc. One service shop owner who has been servicing industrial accounts, uses a cute gimmick to garner new customers. After the successful completion of a radio or TV repair, he leaves a small 2-page brochure with the customer, explaining the fact that he does industrial servicing as well as entertainment-type repairs. He also points out how the experience gained in one segment of the field helps him do a better job in the other and closes by asking the customer to recommend him to any of his friends who may need either type of service work.

If you're like most servicemen who have cracked the industrial market, your first account will be obtained after you refresh your memory in the basics of industrial electronics, prepare your business for a new type of work, write letters, have cards printed, visit factories, make phone calls, try, try again and almost give up. Then you are rewarded with the first job. If you perform the service well, the word will travel quickly through your locality, and you will have the satisfaction of being in a new business.

In summary, remember this about industrial electronic service work: (1) It's not as difficult, technically, as TV and radio repairs, and (2) the local source of service definitely has the advantage wherever fast service is necessary. ▲

Properties of Color Signal

(Continued from page 25)

The generator must be provided with an attenuator so that the signal level to the video amplifier can be set correctly. This is a much more critical requirement than when the modulated RF output is used, because receiver AGC action will keep the detector output at a usable level. The generator output level must be adjusted rather carefully during video signal injection tests, because with the possible exception of an ACC (automatic chroma control) circuit, no provisions for signal-level correction are present after the picture detector.

It should be clear as to why the test signal must have the proper polarity. Loss of synchronization would be the main problem, besides the fact that all receiver circuits beyond the detector would respond in an abnormal manner. Hence, the generator should be provided with a polarity switch, allowing the user to choose the signal polarity required.

A generator having a low-impedance video output is desirable because the output cable can then be connected across the detector load without the necessity for disconnections of any kind. If the generator has a high-impedance video output, the low-impedance detector circuit will load the generator and cause distortion or attenuation, or both, of the test signal. In such cases, it is necessary to isolate the detector circuit from the grid of the video amplifier and to apply the generator signal directly across the grid load of the tube.

In case you are working with a receiver which has separate luminance and chrominance detectors, remember that signal-substitution tests of the luminance channel require that the video test signal be applied at the output of the *luminance* detector. On the other hand, tests of chrominance-channel operation are made with the signal applied at the *chrominance-detector* output.

The waveform in Fig. 1 shows a sample make-up of a composite color signal. Since separate receiver sections process the sync, burst, chroma, and Y components, effective signal-substitution work requires that the technician know which circuits handle each of the various signals.

Color-Difference Signal Outputs

With the receiver tuned to a monochrome signal and the fine-tuning control misadjusted so that sound bars appear on the screen, the interference thus produced should be predominantly bluish, with some red and practically no green interference visible. If you should observe that the interference is predominantly green, you would know immediately that something must be at fault in the chrominance channel.

The reasons why sound interference is normally blue stem from the fact that the color-difference signal gain factors are not equal (see Fig. 2). If we assume a G-Y output of unity and a chrominance signal amplitude that is constant for all colors, then the R-Y output will be 1.14 and the B-Y output will be 2.03. An FM sound signal (4.5 mc) in the chrominance channel simulates a chrominance signal which is rapidly changing in phase and provides equal drive to the R-Y and B-Y detectors. Note: Receivers which utilize a color killer may require that the threshold be lowered by turning the control counterclockwise before the foregoing observation can be made.

Since the output from the B-Y channel would be greater than the others, we will of course expect to see a bluish interference pattern. A little red also should be visible. An interesting point in this respect is that the setting of the hue (color-phasing) control will have no effect whatever on the colors produced in the interference pattern when the chrominance channels are energized by a signal of this type, the reason being that the 3.58-mc oscillator is uncontrolled (no burst signal present) and continues to operate at relatively the same frequency regardless of the hue-control setting.

Brightness of Colors in a Rainbow Display

A gradual reduction in the setting of the brightness control during the display of a rainbow pattern will cause the blue bars to disappear last in normal re-

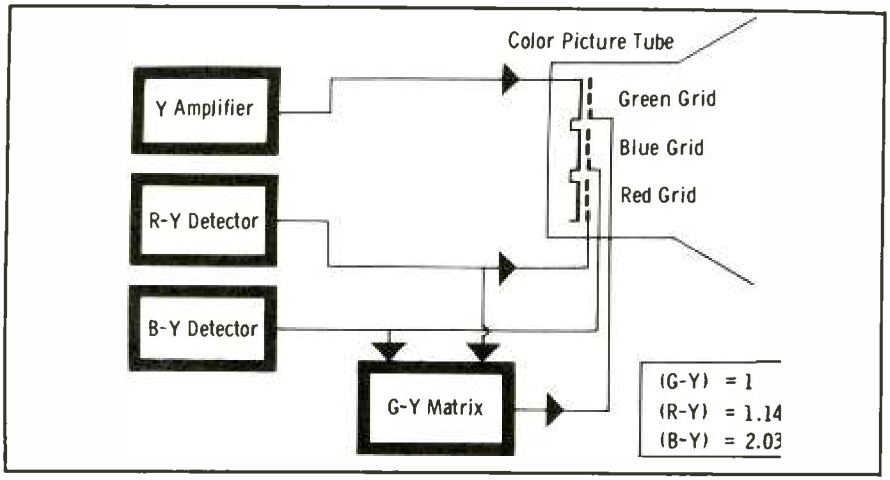


Fig. 2. A typical chrominance detector circuit arrangement. Note the difference in the R-Y and B-Y gain factors.

ceiver operation. This behavior should be expected, based on the difference in signal gains mentioned in connection with Fig. 2. The rainbow signal has a constant amplitude and drives both color detectors equally.

The green bars are the first to disappear, because of the low relative gain afforded the G-Y signal. The red bars should be the next to disappear as the brightness-control setting is further reduced. The blue bars must be the last to disappear, unless trouble is present in the chrominance channel.

At this point, most of you have mentally asked the question, "Why are the amplification factors of the color-difference signals unequal?" The answer is based upon a modification of the R-Y and B-Y signal amplitudes at the transmitter. The receiver must restore these signals to their correct relative levels for true color reproduction.

This transmitter modification is called *adjustment of chrominance values* and is made necessary to avoid overmodulation of the picture carrier by saturated color signals. It is made as follows:

R-Y is reduced to 0.877 of true level.

B-Y is reduced to 0.493 of true level.

Assuming a G-Y amplification factor of unity in the receiver, we find that the R-Y gain factor must equal 1.14, and the B-Y gain factor must equal 2.03 if correct signal drive to the picture tube is to be obtained.

Simple Rule for Aligning Any Color Detector

A color detector will null on a quadrature signal; that is, if we connect a scope at the output of an R-Y detector, we will find a null or zero signal output (no scope deflection) with a B-Y signal input. If we should not find a null in this test, we would know that the phase of the R-Y reference signal is incorrect.

Here are the basic color-difference signals and their quadratures; each demodulator will nor-

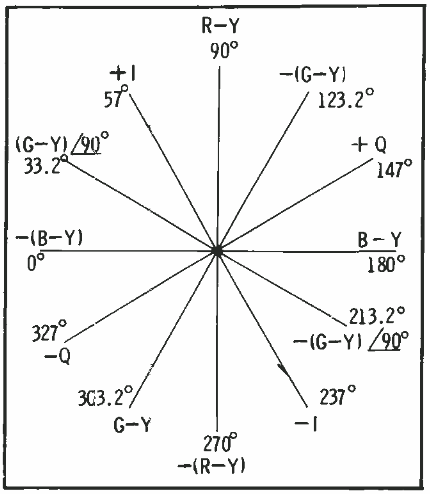


Fig. 3. Chrominance signal phase angles for the color-difference signals.

mally null on the quadrature signal:

- R-Y is in quadrature with B-Y, and vice-versa.
- G-Y is in quadrature with (G-Y)/90°, and vice-versa.
- I is in quadrature with Q, and vice-versa.

These quadrature relations are apparent in Fig. 3, which shows a standard chrominance phase diagram for all the basic color-difference signals. The quadrature relations apply, no matter what color-detection arrangement may be utilized in the particular receiver under test. Here are the arrangements which may be encountered:

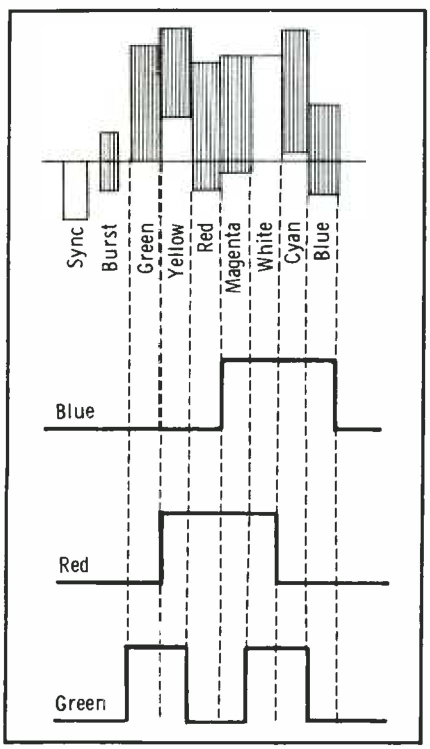
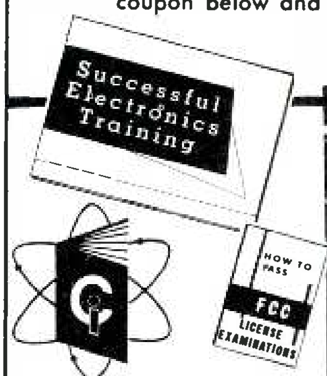


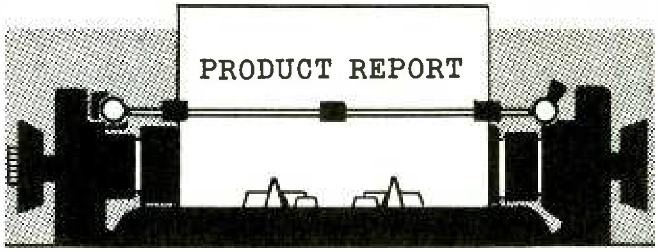
Fig. 4. An NTSC color-bar signal and the picture-tube signals it should produce.

Detectors	*Matrix*
(R-Y) (B-Y)	G-Y
(R-Y) (G-Y)	B-Y
I and Q	RGB
(B-Y) (G-Y)	R-Y

Only the I and Q arrangement requires note; the I detector is checked for a null on a Q signal, and the Q detector is checked for a null on an I signal. Thus, the detector operation is entirely similar to R-Y, B-Y, and G-Y systems. However, the RGB matrix is a luminance mixing section, as well as a chrominance mixer. Hence, an RGB matrix is quite different from a color-difference matrix.

To check RGB matrix action, we use the complete color signal, instead of color-difference signals. Fig. 4 shows how the outputs from the blue, red, and green sections of an RGB matrix appear on a scope screen, when a complete NTSC color signal is applied to the receiver. The signal illustrated comprises the primaries, complementaries, and white, as is customary in service type color-bar generators. ▲

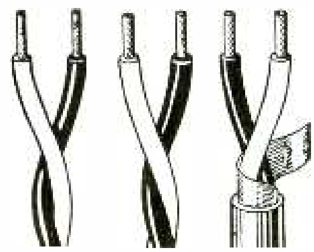




Color TV Harness Kits

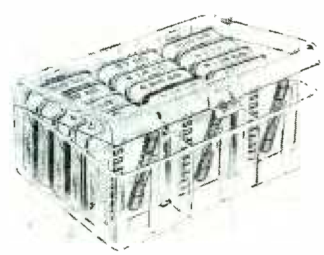
A new line of color TV test harnesses and extension cables has been announced by Eby Sales Co., 130 Lafayette St., New York, N.Y. Two different Color Harness Kits are available—K-132 for most color sets other than RCA, priced at $11.00, and K-314 for RCA as well as other sets, selling for $14.50. Individual items, separately available, are 56-12H Color CRT Extension, $5.35; 57-13H Tuner Extension, $2.03; 57-14H Convergence Extension, $3.95; and 56-1H Hi-Voltage Extension, $1.75.

Speaker Extension Cables



Belden Mfg. Co., Chicago, Ill., has added to its line several moderately-priced audio cables having tinned, stranded copper conductors with vinyl insulation. No. 8460 is an unshielded twisted pair of 18-gauge conductors for speaker extension runs from 200′ to 2000′. No. 8461 is the same, with the addition of a vinyl jacket. Nos. 8470 and 8471 resemble 8460 and 8461, but have 16-gauge conductors for higher-power installations (up to 75 watts) and longer runs (up to 3000′). Nos. 8779 and 8780 are shielded cables with 16-gauge conductors; 8780 features a vinyl jacket over the shield.

LC Fuse Caddy



Littelfuse, Inc., Des Plaines, Ill., is producing a new plastic fuse caddy filled with an assortment of 15 different types of the LC (limited current) fuses which are coming into wide use in recent models of TV sets. These fuses are especially designed to make it impossible to use a higher rating than was originally intended by the manufacturer. The selection is estimated to cover 94% of service needs for the new tab-mounted fuses. Three spare compartments are included in the caddy for storage of additional fuses.

Super-Power PA Drivers

University Loudspeakers, Inc., 80 S. Kensico Ave., White Plains, N.Y., has announced two new high-power driver units for use in public-address systems. Both drivers (Models PA-HF and PA-50) have a continuous-duty power rating of 50 watts, and a boost to 100 watts can be accomplished by attenuating all frequency components below the cutoff frequency of the trumpet before they reach the driver. A special feature included in the PA-50 is a built-in line-matching transformer.

Degaussing Coil

Bushnell Electric Co., 345 Hess St., Bushnell, Ill., is manufacturing a degaussing coil for use in demagnetizing color picture tubes, an essential process in obtaining optimum purity. The construction and performance is certified to meet the standards set by manufacturers of color TV receivers. Coil SE-4290, complete with line cord and on-off switch, sells for $14.95.

Swivel-Mount Auto Antenna

The "Bullet," designed by Tenna Mfg. Co., 7580 Garfield Blvd., Cleveland, Ohio, is an auto radio antenna with a swivel base that allows the mast to remain vertical even if the unit is mounted on a sloping surface or on the side of the car. Either straight or rear-canted masts are available. An extra mounting pad is shipped with each "Bullet" to permit mounting on high crowns of fenders or fins.

Wide-Range Phonograph

Wide frequency response is featured in the Model 1290 table-model phonograph made by V-M Corp., 280 Park St., Benton Harbor, Mich. The instrument includes V-M's "Super-Fidelis" four-speed automatic changer with "Lazy-Lite" control button, a 6″ × 9″ speaker with concentric tweeter cone, a jack for connecting radio tuner or stereo tape-player output to the phono amplifier, and external speaker jacks.

PF REPORTER

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CATALOG and LITERATURE SERVICE

11. AMPHENOL
Data sheet on series UHF solderless RF connectors. *See ad page 46.*

21. BELDEN
Radio-electronic wire and cable catalog No. 857. *See ad page 61.*

31. BUSSMANN
Television fuse chart Form TVC. Shows components protected and proper fuse for all TV and auto radio sets. *See ad page 35.*

41. CBS
Catalog sheet describing new CBS Technician's Handbook and CBS Engineer's Handbook. *See ad page 24.*

51. CENTRALAB
New Pocket Control Guide No. 6—121 pages of the latest replacement control information. Carbon and wirewound controls are listed by ratings and part numbers, together with taper curves and other pertinent information. Also a new 12-page P. E. C. (Packaged Electronic Circuit) Guide which includes 51 schematics, a reference section and a complete listing of replacement parts. *See ads pages 56, 57.*

61. CHICAGO STANDARD
Stancor TV Transformer Replacement Guide and supplemental sheets. *See ad page 43.*

71. CLAROSTAT
Form 753450 on series A47 and A47F 15/16" diameter composition element controls, 500 ohms to 5 megohms. *See ad page 33.*

81. CLEVELAND INSTITUTE
Complete description of the opportunities in electronics for radio-TV servicemen and an outline on how to qualify for them. *See ad page 81.*

91. CORNELL-DUBILIER
Revised edition of Form 200D-4E on twist-prong electrolytic capacitors. *See ad page 70.*

101. E-Z-HOOK
A convenient reference sheet titled "How to Build the Five Most Useful Scope Probes" gives the schematic, mechanical component layout, and a brief description of five scope probes you'll find most useful in your servicing. *See ad page 77.*

111. ELECTRO PRODUCTS
Data on new DC power supply models EFB and D-G12T for transistorized units. *See ad page 82.*

121. EICO
12-page catalog shows how to save 50% on electronic test instruments and hi-fi equipment in both kit and factory-wired form. *See ad page 68.*

131. ERIE
New D-57, 16-page distributor catalog listing all components currently made by the company. *See ad page 83.*

141. FINNEY
Brochure on full line of 1957 Finco antennas (Form No. 20-193). *See ad page 27.*

151. HICKOK
Technical booklet describing the design and application of the new Model 123A Cardmatic laboratory-type tube tester. *See ad page 22.*

161. IRC
DLR-57A (Form S-035A) replacement parts catalog. *See ad 2nd cover.*

171. LITTELFUSE
Handy cross-reference card showing LC fuses and list prices. *See ad 4th cover.*

181. MERIT
Form No. 690 lists exact replacement yokes. *See ad page 75.*

191. PHAOSTRON
Illustrated catalog lists complete line of custom panel meters. Includes comparison chart of Phaostron instruments vs. other brands plus dimensions and features. *See ad page 67.*

201. R-COLUMBIA
Bulletin 23 on "Fono-Magic," a compound which stops stalling and slipping in record changers caused by worn or crystallized idler wheels. *See ad page 6.*

211. RADIART
Rotor Catalog F-904 covering all CDR rotors. See ad page 1.

221. RAYPAR
Bulletins describing picture tube brighteners, voltage adjustor, and TV components and accessories. *See ad page 28.*

231. SENCORE
General two-color line folder of all Sencore products. *See ads pages 76, 77.*

241. STANDARD ELECTRICAL
22-page catalog describing complete line of "Adjust-A-Volt" transformers. Also catalog sheet on PA-1 "Adjust-A-Volt." *See ad page 78.*

251. TACO
Consumer-directed literature for use with Taco's "Antenna Check-Up Time" program. See ads pages 40, 41.

261. TENNA
6-page Auto Antenna Catalog. Also Bulletin No. 109-5-57 on new "Bullet" swivel auto antenna and Bulletin No. 105-5-57 on new "Stratofin" auto antenna. *See ad page 44.*

271. TOBE DEUTSCHMANN
Two-color, 26-page catalog covering Tobe's new line of Quality Service Capacitors, including specifications and prices for molded tubular, metalized paper, ceramic disc, twist-prong and tubular electrolytic, and industrial types. *See ad page 53.*

281. TRIPLETT
New Catalog No. 35-T of company's complete test-equipment line. *See ad page 39.*

291. WEN
Illustrated catalog sheet No. 808 describes new 2-speed, 3/8" power drill. Also folder AL-1 on line of high-grade, low-cost power tools including soldering guns with special-purpose tips, sander-polishers, saws and saw tables, etc. *See ad page 8.*

301. WARD
Mailing folder "The Shape of Things to Come." *See ad page 69.*

311. WINSTON
Literature on Model 850 Induced Waveform Analyzer, Model 828 Intermittent Condition Analyzer, Model 250 Color Convergence Dot Generator and Model 150 Rainbow Generator. *See ads pages 34, 62, 75.*

321. XCELITE
Catalog of new items. *See ad page 64.*

Supplement to Sams August, 1957 Master Index

This Supplement is your handy index to the new models covered by PHOTOFACT since August, 1957. For prior model coverage see the Sams Master Index dated August, 1957. To stay up-to-date, always use the latest issue of this supplement *with* the Sams Master Index—together, they are your complete index to PHOTOFACT coverage of over 28,000 receiver models.

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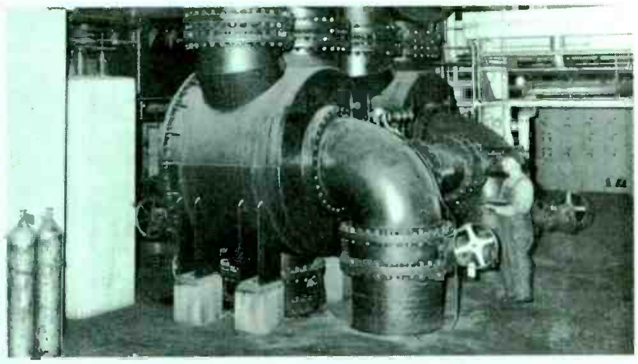

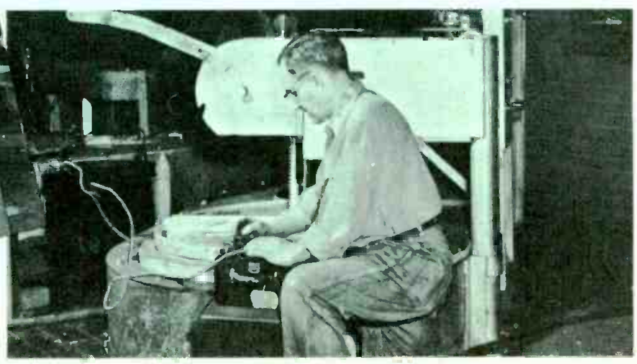

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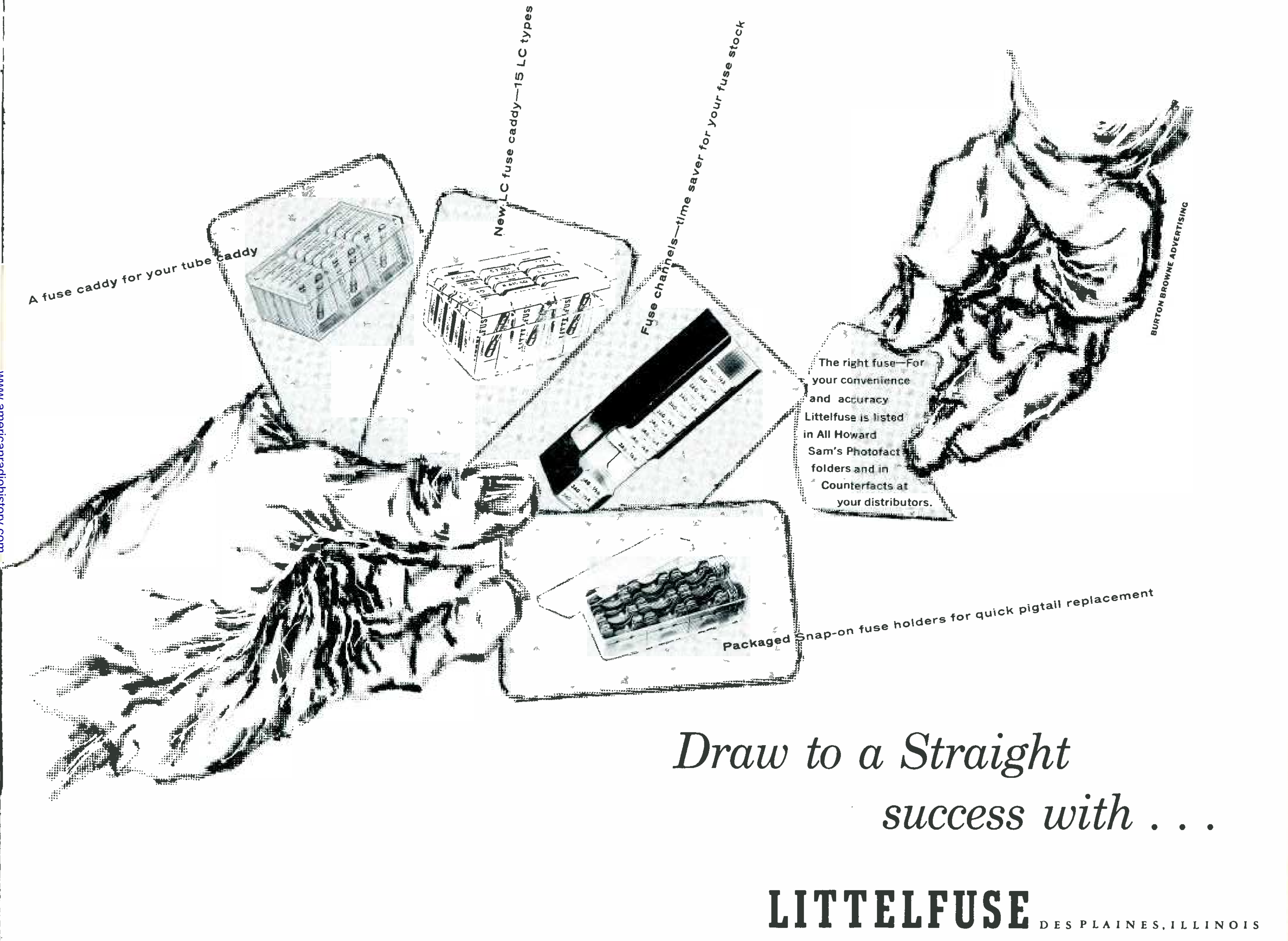

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