DECEMBER, 1959 35 CENTS

PF REPORTER

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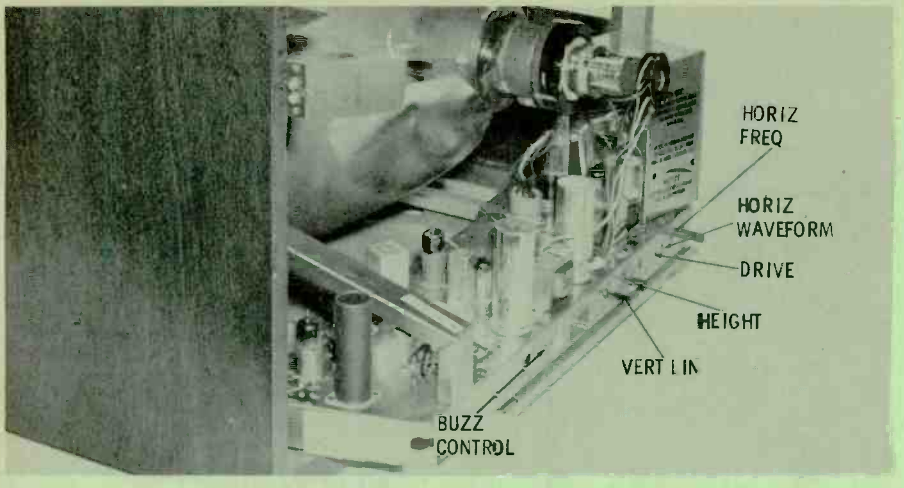
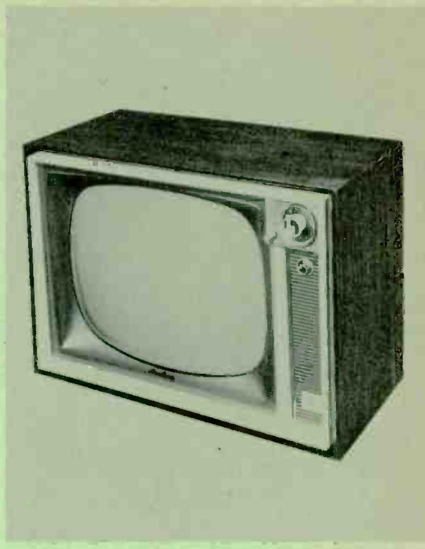
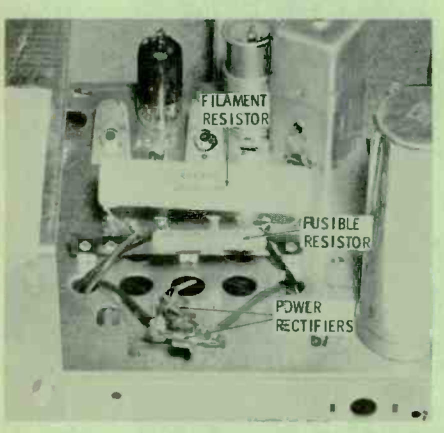
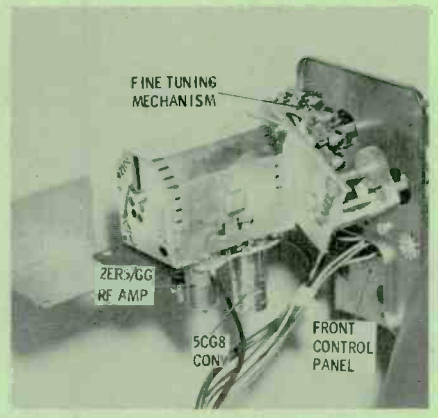
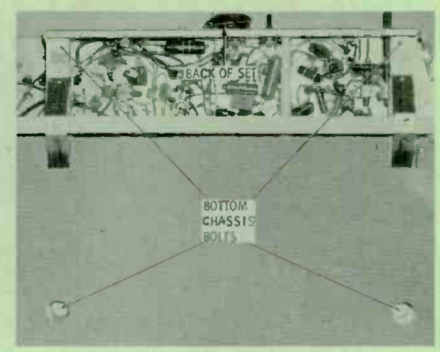
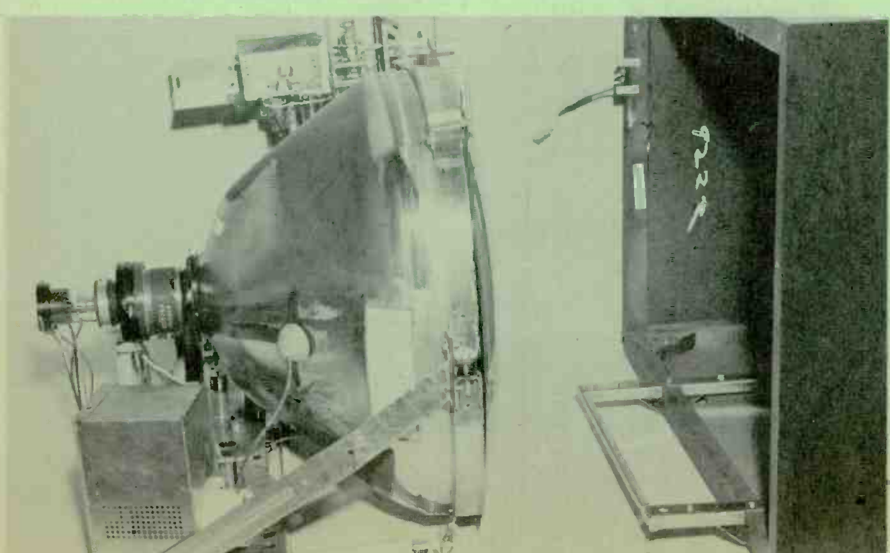












Airline Model WG-4082A

Modern features of this 21" table model include one of the new *Hot-Rod* VHF tuners and a push-type on-off switch. The safety glass can be removed from the front by taking off the top trim strip, which is held by two screws.

The major portion of the chassis, which is all hand-wired, mounts horizontally at the bottom of the cabinet; however, front controls, tuner, and picture tube are supported by brackets attached to this section. You'll find a 4" x 6" oval speaker positioned directly below the control panel at the front of the cabinet. Service adjustments are across the rear as shown in the photo.

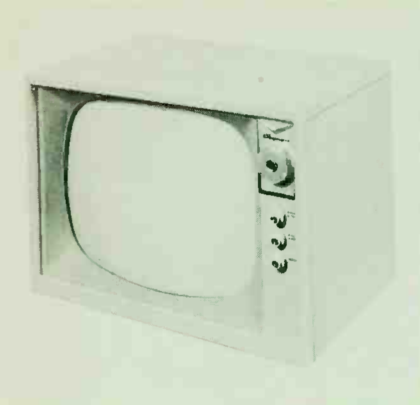
The "hot" chassis is powered by two silicon rectifiers in a voltage-doubler circuit which produces approximately 270 volts. These units are soldered to a small terminal strip on top of the chassis near the left side. Behind the rectifiers you'll find two "sugar-coated" resistors soldered to another, longer, terminal strip. The large 20-watt unit is a 52-ohm dropping resistor connected in series with the filament string, while the smaller one is a 7.5-ohm fusible type protecting the power supply from B+ overload.

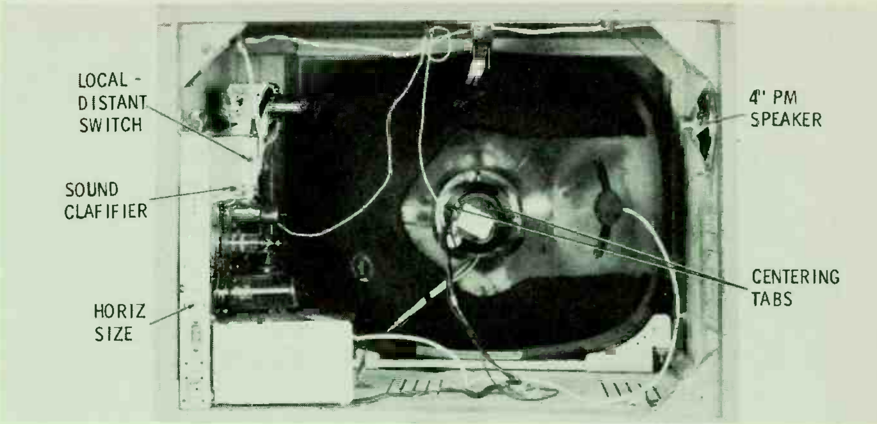
The small tuner is mounted to a frame assembly, which in turn is attached to the front control panel. A set-and-forget fine-tuning arrangement is provided for each channel, and is adjusted with an operator's knob on the front. Aside from those shown in the tuner, the only new tube you'll find in this chassis is an 8BQ5, which is used in both the video and audio output stages.

To pull the chassis for bench servicing, you'll discover it's not only necessary to remove the channel selector and fine-tuning knobs, but also the channel-indicator trim piece. This can be taken off by pulling straight out as pictured. You can then pull off the brightness, range, and vertical-hold control knobs that are partly covered by the piece.

After disconnecting the antenna and speaker leads, remove the 5/16" hex-head screw securing the tuner bracket to the cabinet, plus the four bottom chassis bolts pointed out in the photo.

The entire chassis, including tuner and picture tube, can now be slipped back and off the bottom rails. The rail assembly remains in the cabinet as shown.





Olympic Model TY134 Chassis HY

Here's a new table model with 21" picture tube and VHF tuning you may be running into shortly. The set incorporates only 11 receiving tubes, plus a 90° CRT and two rectifiers. Cleaning the safety glass is no real task if you know where to start. First, remove the channel selector and fine-tuning knobs, and also the name plate which is secured by only one Phillips-head screw. Then, take out the screws holding the top trim strip, and the glass can be tilted out and removed.

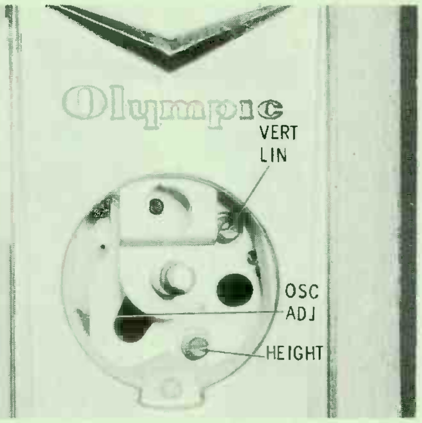
The hand-wired chassis is of conventional horizontal style; however, it has been upended and mounted vertically along one side of the cabinet. The low-voltage supply utilizes a power transformer and 5U4GB rectifier, and the 6CU5 audio output tube is used as a B+ voltage divider. Among the service adjustments on the rear, you'll notice one labeled SOUND CLARIFIER, which is actually a slug adjustment for the quadrature coil in the sound detector stage. The horizontal size control may also be a little misleading, since it is really a trimmer capacitor located in the grid circuit of the horizontal output tube, and varies the amount of drive signal utilized.

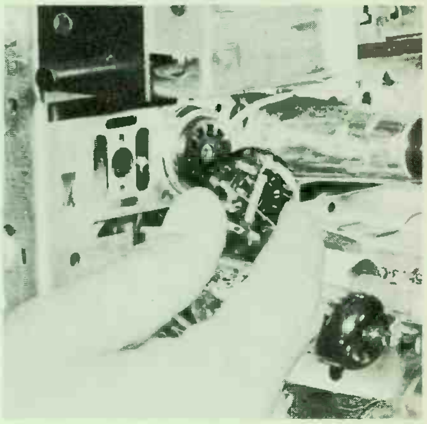
Don't search all over the chassis for the vertical sweep adjustments; merely pull off the tuning knobs to expose the linearity and height controls pointed out in the photo. The tuner oscillator adjustment is also accessible with these knobs removed.

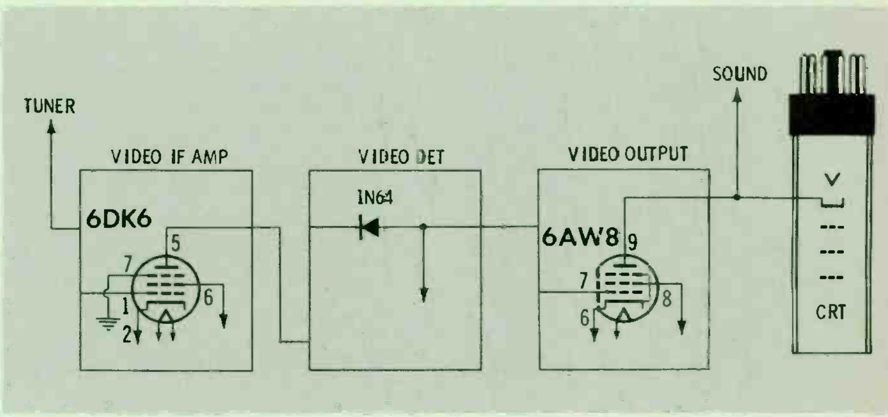
On top of the chassis near the sound detector coil, you'll find an unusual looking plug inserted in a 9-pin miniature tube socket. This socket is a power connection for sets incorporating an additional radio chassis. If you are called upon to service one of the sets with a radio, and want to power the TV chassis by itself, you must use this shorting plug or some sort of substitute.

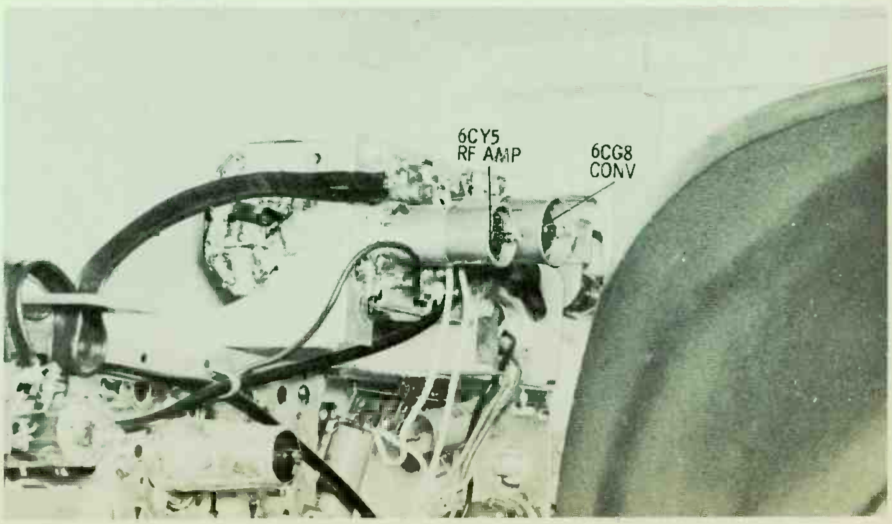
An interesting circuit feature of this receiver is its one-stage of IF amplification. The simplified diagram will give you an idea of the total circuitry between the tuner and picture tube. The lonely IF stage employs a 6DK6 with both grid and plate circuits tuned to 44.5 mc.

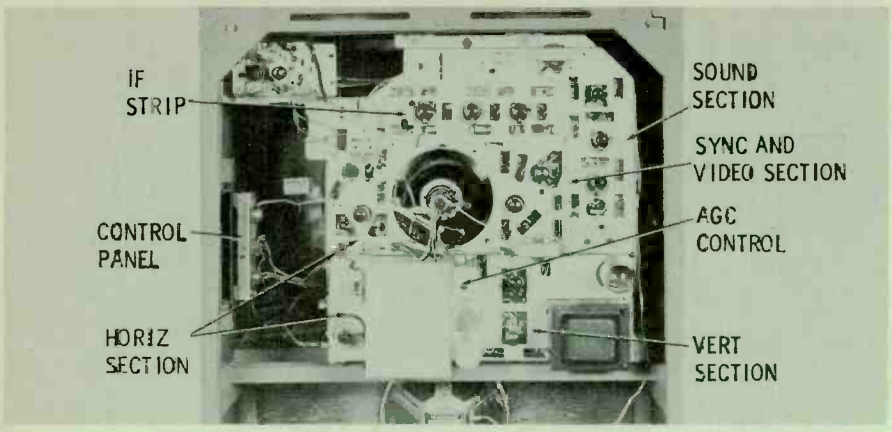
The VHF tuner is a small turret type attached to the chassis near the top of the cabinet. Both tubes have captive telescoping shields; therefore, you may find it difficult to orient the pins when making a tube substitution so far forward in the cabinet.

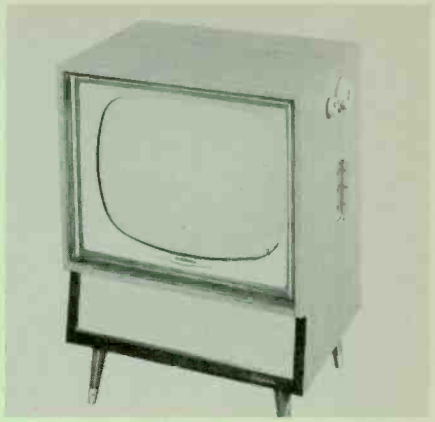


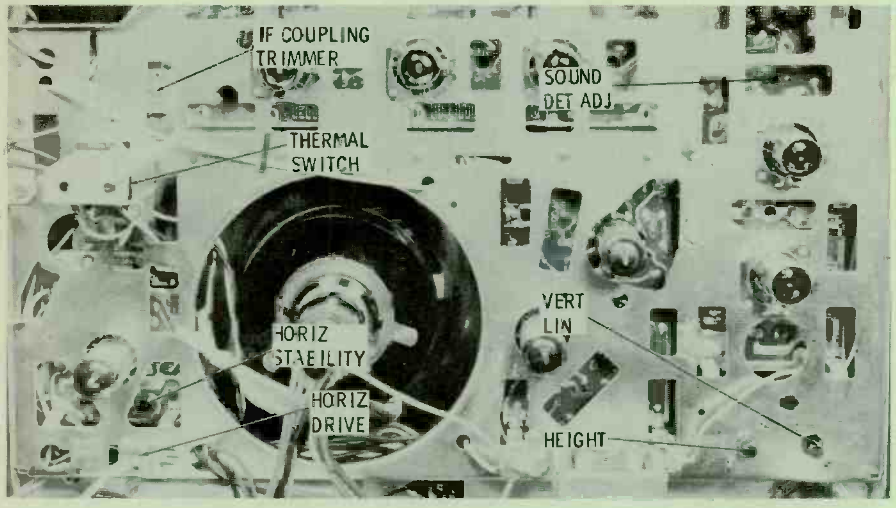


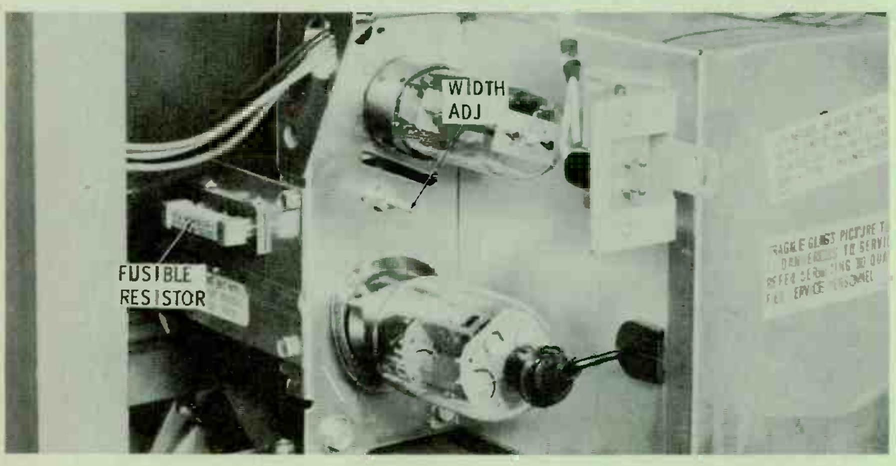


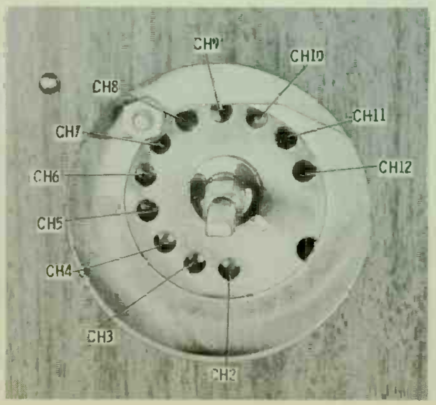


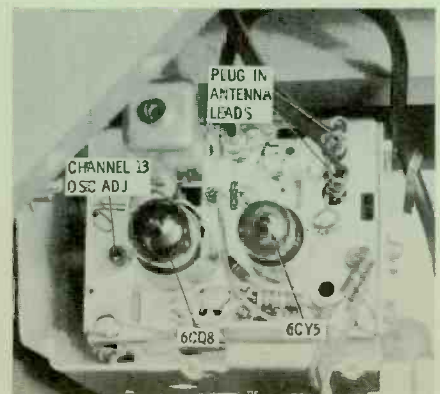












RCA MODEL 21T9266
Chassis KCS124C

This 21" *Ashley* console is equipped with VHF tuner, 8" PM speaker, and an all-wood cabinet. Knobs for channel tuning, contrast, and volume with push-pull on/off are located on the right near the top edge of the cabinet. Directly below these controls is a small compartment housing the brightness and hold controls. The safety glass can be removed from the front by taking off the trim strip across the top of the mask.

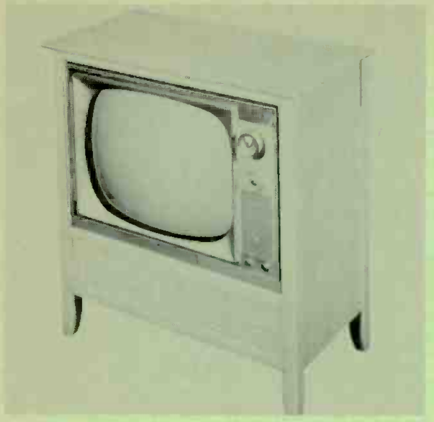
The transformer-powered chassis is a vertically-mounted assembly that fills most of the upper cabinet area. Five separate printed boards are employed, with tubes mounted on the exposed side and circuit components on the opposite side. Most of the tubes are of familiar types, except the 6DS5 output tube in the audio section and the 6EM5 in the vertical section.

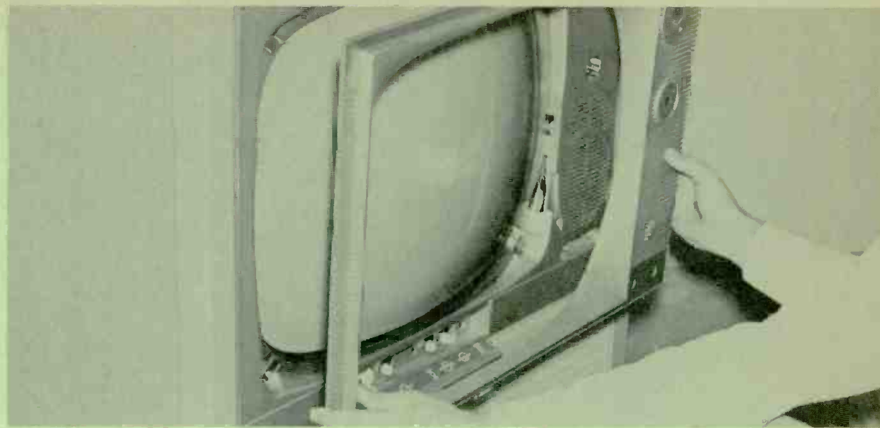
Taking a closer look at the well-perforated chassis, note the locations of various service adjustments. Horizontal stability, the waveform adjustment of a modified *Synchroguide* circuit, is accessible from either side of the chassis and requires a hex-shaped tool. The frequency coil in this particular circuit is fixed, and therefore will require no adjustment. Up toward the tuner, you'll notice a thermal switch device protruding from the chassis. The function of this unit is to protect the power supply from overload caused by excessive B+ current. The resistive element of the device is connected in series with the primary of the power transformer. The switch, however, is in series with the B+ line, and opens whenever the heat produced by the resistor reaches a certain predetermined level.

You'll find the width-coil adjustment between the damper and horizontal output tubes. In this same vicinity, but positioned on the side of the chassis, is a fusible resistor. This plug-in component is rated at 9-ohms and protects the power supply in the event of excessive drain by either sweep circuit.

To adjust the oscillator frequency of the switch-type tuner, merely remove the channel-selector and fine-tuning knobs to expose the slugs for channels 2 through 12. As shown in the photo, they are positioned in a semicircle around the tuning shaft.

You'll find it necessary to remove the back of the set to adjust the oscillator slug for channel 13, which is located on the tube side of the tuner as pictured.





Zenith Model D2464L Chassis 17D20

This new 21" console highlights an audio system with tone controls and four individual speakers. The base of the cabinet houses a 6" x 9" oval speaker and two electrostatic tweeters. Another oval unit measuring 5" x 7" is located behind the grille of the control panel. Most of the service adjustments, including focus and *fringe-lock* controls, are behind the trap door beneath the front of the picture tube.

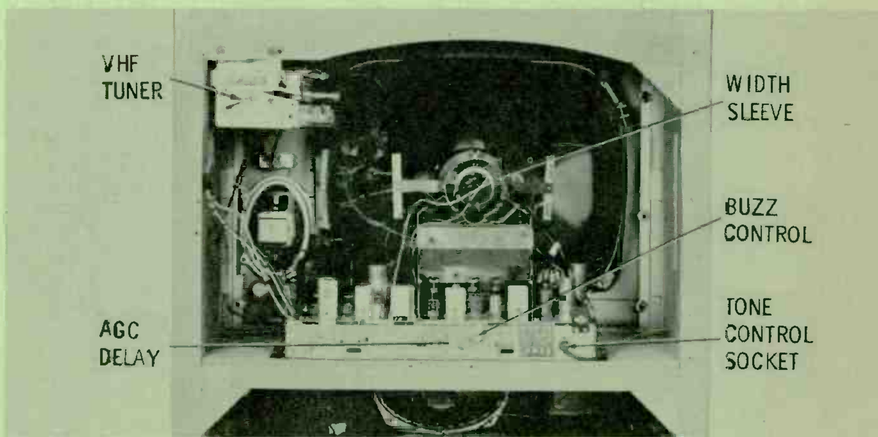
The safety glass and mask assembly is removed as follows: First, remove the front control knobs and two ¼" hex-head screws inside the service adjustment compartment. The mask may now be removed as illustrated. Proceed by taking out the screws holding the glass at each corner. It's best to support the glass with one hand while removing these.

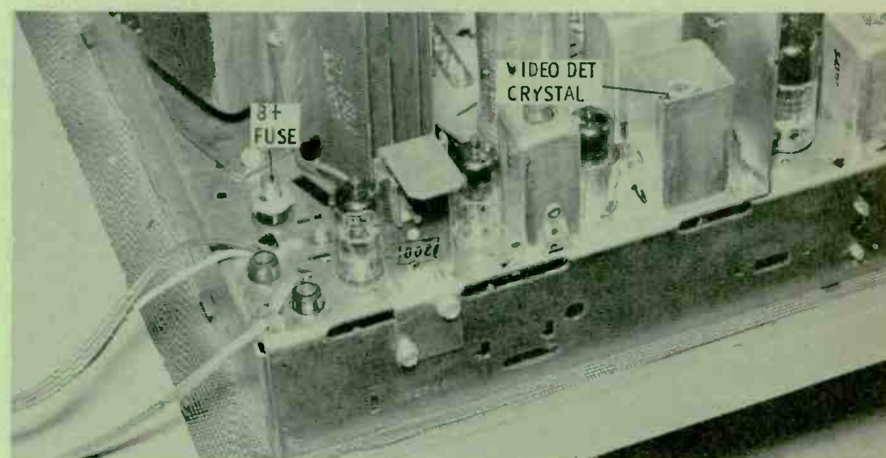
With the rear cover off, you'll find a transformer-powered, hand-wired chassis that employs a 5V3 rectifier. An alternate for this tube is the 5AU4. Other recent tube types used include a 6EB8 serving both video and sound circuits, a 6BQ5 in the audio-output stage, a 6CK4 vertical output, and a 6GH8 horizontal oscillator.

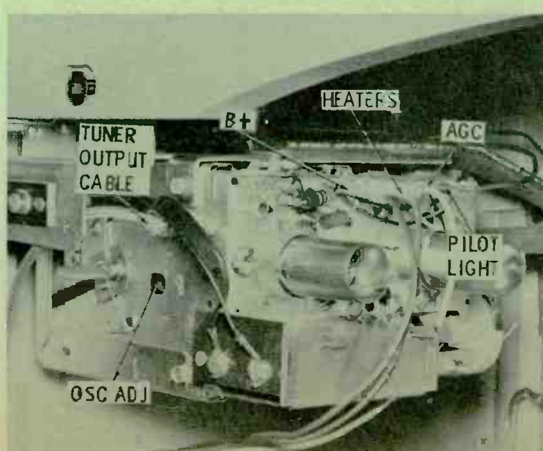
You can't help but notice the power transformer with its large cooling fins extending down through the chassis. Right beside it, near one corner of the chassis, you'll see an "N" type fuse which is connected in series with the main B+ line of the set. This is a slow-blow unit rated at 700 ma. The only other fuse is a 1¼" length of #24 wire used in the parallel filament circuit. Incidentally, when removing the chassis from the cabinet, watch out for the screen shielding stapled to the mounting shelf.

It's interesting to note that the *Bull's Eye* tuner is mounted separately up in one corner of the cabinet. When removing the chassis, it isn't necessary to pull the tuner, too. All leads are of a plug-in nature and can be easily reached, as evidenced in the photo. Although the oscillator adjustment is located at the rear of the tuner, you can make the setting for each channel without removing the back cover.

The channel indicator is unique in that the center disc is counterbalanced and, although free to turn, stabilizes with the indicator window at the top as the selector is rotated. The operating channel number is illuminated by a pilot bulb.







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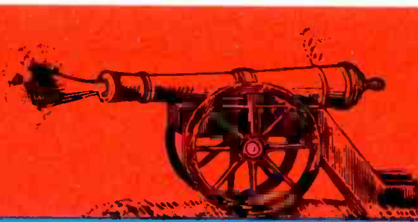
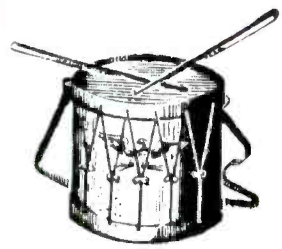


EVERY DAY IS INDEPENDENCE DAY



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We're lucky in these United States that every day is Independence Day. Independent buying, selling, and servicing is the very lifeblood of American business. Let's keep it that way.

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PF REPORTER

including Electronic Servicing

VOLUME 9, No. 12 — DECEMBER, 1959

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ABOUT THE COVER

Helping customers to obtain the best performance from their hi-fi systems is a growing part of the serviceman's job. While we can't guarantee that all your customers will be as charming as the lass on this month's cover, we can guarantee that you will be charmed by the "Audio Facts" series starting on page 30 in this issue.

Merry Christmas from the Entire Staff

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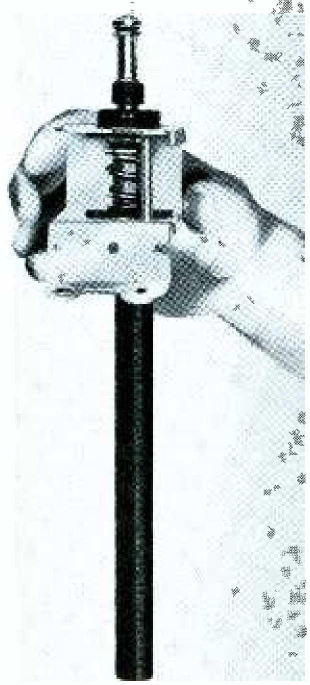

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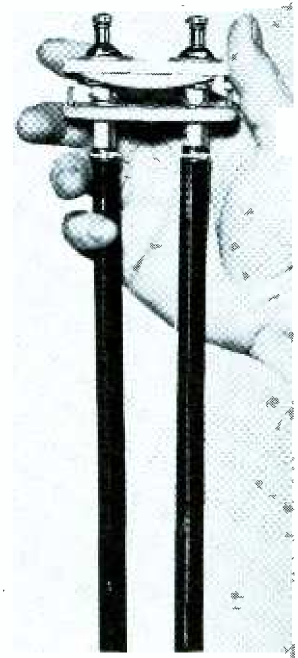

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Letters to the EDITOR

Dear Editor:

Bravo for Mr. John Standen from Cleveland!

If Mr. R. J. Dennis can brag of a well-equipped shop, it seems to me he's degrading the TV service industry — because any well-equipped shop with a good technician should make enough income not to have to work somewhere else. If Mr. Dennis can't find enough service work to keep himself busy all day, it must be the result of poor business ethics. And what happens when Mrs. Jones wants her TV repaired, and Mr. Dennis is busy at his regular job? That, in itself, is poor business ethics.

I, for one, started as a part-timer, but it certainly was not because I wanted to. I started on my own only after being turned down by every full-time shop. They just couldn't hire me because of the business they had lost to part-timers.

After having a TV station in our area for just a little over three years, our TV Association — of which I am President — has a list of 20 of these part-timers. They earn their livings mostly underground (in the mines), and hardly a week goes by that at least one of them doesn't come into our shop with sets they can't repair.

So while you can see that I'm not against the spare-timer who is forced into it, I'm definitely against those who believe spare-time servicing is the thing to do.

ZE MAD JACQUES LATOUR
Conrad Radio-TV Centre
Timmins, Ontario

Dear Editor:

The full-time TV and radio serviceman operating a shop must pay for a business license and abide by other laws covering his business. I wonder how many part-timers obey these same regulations. I agree with the letter from Mr. John Standen.

DON MARSHALL
Marshall & Holl
San Mateo, California

Dear Editor:

I like your magazine, and side with the letters you are receiving from part-timers.

I started as a part-time serviceman myself — mainly because no one else would hire me. I tried to get a job with several different TV service businesses, but most of them didn't want me or wouldn't pay enough for me to live on.

So I started working on my own in addition to my regular job. I finally made the business big enough to let me quit my other job. Now I run my own full-time Radio-TV service.

DELVIN IRELAND
Ireland Electronics
Star, Idaho

Dear Editor:

Being a rather recent entrant into the radio and TV field (about 3 years), I read with considerable interest "Letters to the Editor" in the October issue. I am a part-time serviceman and would like to give my point of view.

First of all, by working part time, I and others have a chance to put profits back into the business, to make stock inventories more complete and up-to-date, and to build up a good supply of test equipment — all of which is quite a job.

I try to keep abreast of the new developments in the electronics field and perform my service work to the best of my ability.

Some day in the near future, I would like to operate full-time, but to do so without more practical experience and a sizable investment in equipment and stock would be a poor business venture.

FRED HOFFMAN
Trenton, New Jersey

Dear Editor:

I can't see why anyone that knows a tube from a light bulb would want to knock your fine magazine and its editor.

I am a part-time serviceman, but I spend 40 hours or more a week in electronic servicing, nights and weekends. I have over $5,000 in parts alone, over $700 in textbooks, over $1500 in test equipment. I work for cash, buy for cash, and sell for cash. My labor charge is $1.00 per hour more than most full-time servicemen get in my town.

W. LEE TERRELL
Newnan, Georgia

Dear Editor:

I would venture to say that the vast majority of part-timers are merely starting on this basis, with full intention of building up the business to a full-time potential as soon as possible. This is my own intention, and I know that many other full-timers started out this very same way!

Most of us part-timers have spent just as much time and money getting our education in this field as Mr. Standen has, and we have also spent every bit as much money to obtain adequate stock and equipment.

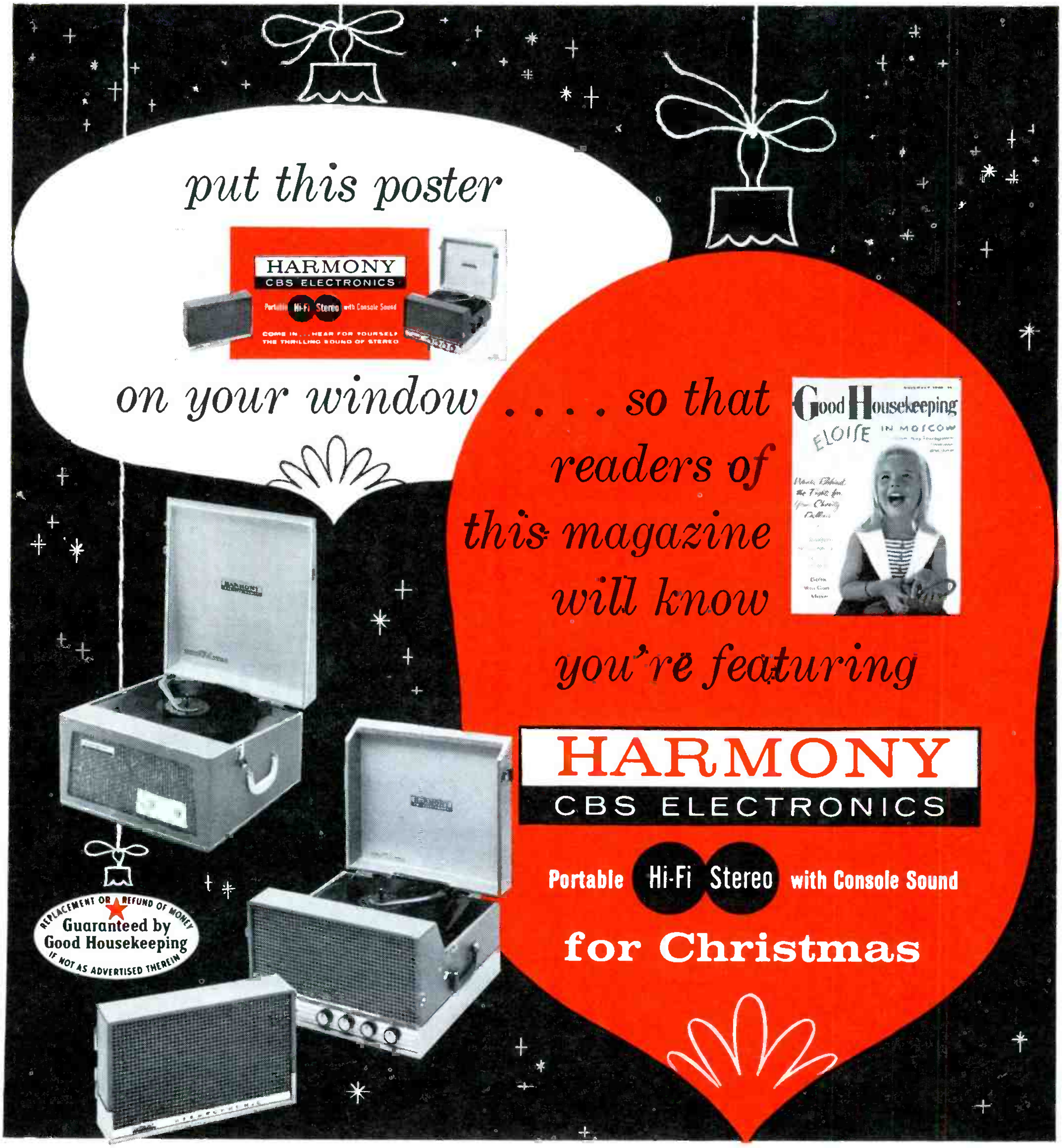
When I hear that we part-timers are taking away a full-timer's bread and butter, I can only say that we can't be blamed for that — since a satisfied customer will most certainly not look elsewhere for service.

To he who thinks I would be angry if someone were to take away my factory job, I say baloney — since this factory job is just a stepping stone to my ultimate goal, and he is entirely welcome to that factory job if he wants it!

To you, the editors of PF REPORTER, I take off my hat. I firmly believe that you have the finest publication of its kind to be found anywhere. Keep up the good work.

KEITH WOLFMAN
Milwaukee, Wisconsin

• *Please turn to page 20*



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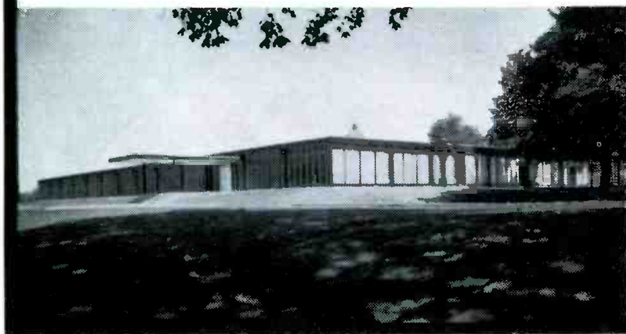

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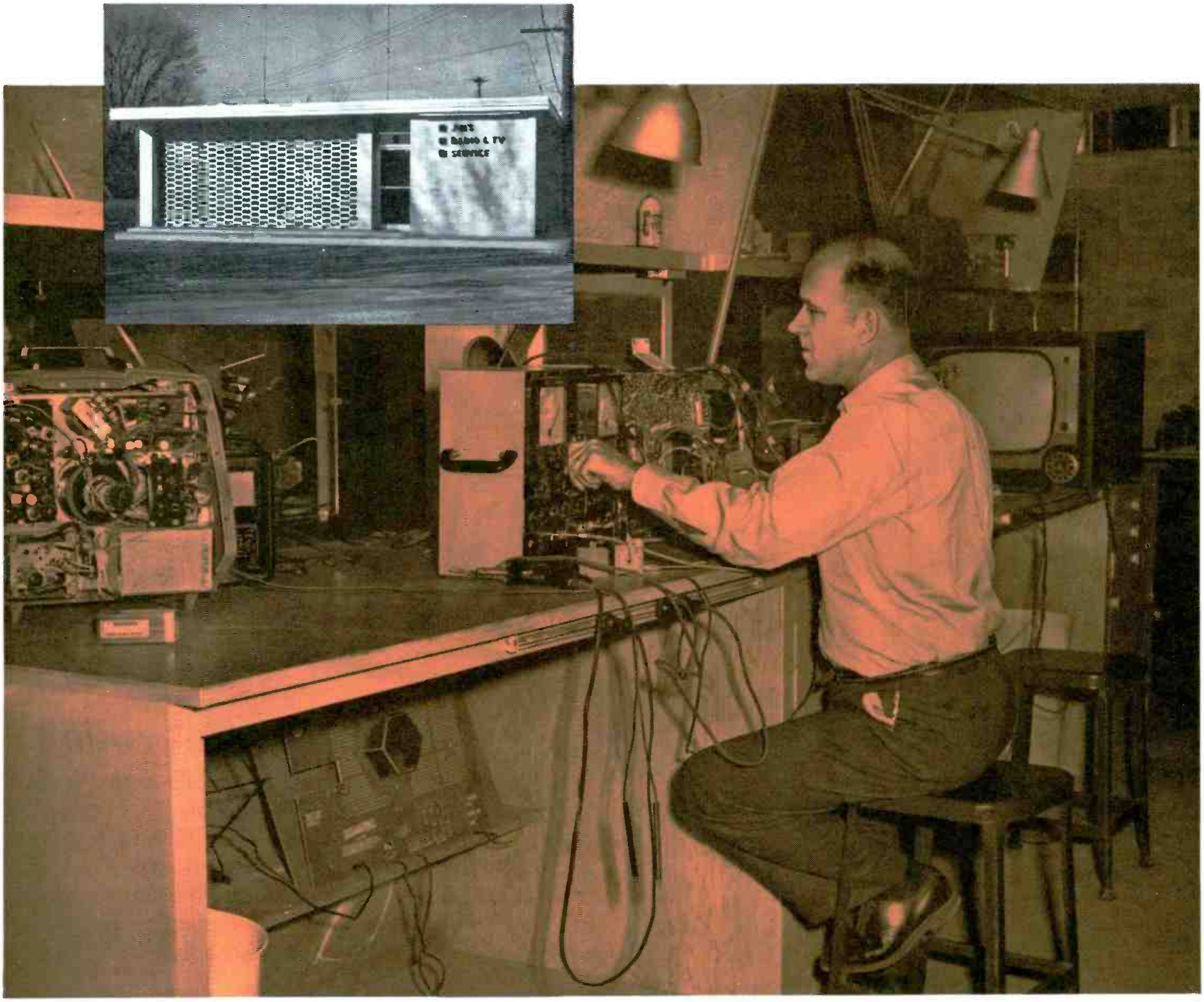
TV Technician JIM CARPENTER says...

"Service Is Our Only Business... That's Why We Use Mallory



Jim Carpenter started his own business—Jim's Radio & TV Service—in Springdale, Arkansas. Over a period of ten years it has grown from a one-man operation to a firm that employs six full-time men. Recently Jim moved to the new building shown above.

Concentrating on dependable service gave Jim a reputation which allowed business to grow quickly. Jim and his men handle radio and television service throughout their trade area.

Jim is a Major in the active Army Reserve. He carries a commercial card and is branching out into commercial mobile work.

Letters

(continued from page 14)

Dear Editor:

Hooray for your explanation to John Standen. Mr. Standen does not seem to believe in the right of every American to engage in free enterprise.

Here in Beckley, two of the best equipped shops, including everything needed for color TV work, are operated on a part-time basis. My own shop includes a PHOTOFACT Library and $2300 worth of test equipment.

I and a few other part-time men of my acquaintance are often called for advice on the dogs. Does that sound like incompetence?

JOHN J. KODAK, JR.

Beckley, W. Va.

Dear Editor:

I was both surprised and pleased to see my letter printed in your October issue.

To be sure, there are many well-qualified part-time servicemen. My wish is that we could make this field attractive enough for them to make it their full-time occupation.

Too, I wish that there were some way of impressing members of our trade with the thought that it takes more than a knowledge of electrons to be an asset to the industry. It is regrettable that more of us don't realize the benefits that could be accrued if only we could be one strong voice.

PF REPORTER is truly the best publication in our industry. The technical articles are all very well written and attractively illustrated. May your publication enjoy even greater success in the future.

JOHN STANDEN

Wind-A-Meer Radio & TV Service
Cleveland, Ohio

Dear Editor:

I find myself using back issues of PF REPORTER more and more for reference as I run into "dogs" and new circuits. However, I would subscribe to your magazine even if I weren't in the service business. It is excellent!

EUGENE M. VESTAL

Donie, Texas

The guy who wisecracks that even the "fibs" are biggest in Texas gets his subscription cancelled. By the way, if you weren't in the service business, you couldn't *subscribe to* PF REPORTER.—*Ed.*

Dear Editor:

This is to thank you for your immediate telegraphic response to my S.O.S. for a PHOTOFACT listing on a "dog" portable television receiver. The TV service industry as a whole should be made aware of the fact that your organization stands behind them, whether big or small, with a helping hand.

ELLIOTT J. DULLEA

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Maple Shade, N. J.

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Blue Chip Quality TUBES • TRANSISTORS • DIODES

by Stan Prentiss

ANALYZING FM-DETECTOR CIRCUITS

Browsing through some of the 1959-60 TV schematics, I noted that most of the current crop of sets are using some type of quadrature-grid sound detector — with the locked-oscillator variety (6DT6) leading the gated-beam type (6BN6) in popularity. However, the time-proved dual-diode types of sound detectors are far from obsolete. Several manufacturers (for example, Sylvania and General Electric) are clinging to the ratio-detector circuit, while Philco, Emerson and Muntz have included a discriminator (the original FM detector circuit) in many recent models — among them Philco's new transistorized portable TV.

Of course, you'll find a ratio detector or discriminator in the great majority of television sets made during the past several years. These dual-diode circuits have operated reliably year after year; but sooner or later, as a set ages, its sound section is likely to require service. When the performance of an FM detector begins to fall off, the cause often cannot be revealed by ordinary voltage and resistance checks—so the serviceman needs to understand how this type of circuit works before he can restore it to "like-new" condition.

Both types of dual-diode sound detectors have the same basic purpose—converting *frequency* variations of the incoming signal into the *amplitude* variations that comprise the audio output signal—and they both accomplish this job in a similar manner. However, there are some key differences to keep in mind.

One characteristic of a discriminator (you might call it a drawback) is its tendency to respond to variations in *amplitude,* as well as *frequency*. In a TV set, such amplitude modulation is mainly in the form of buzz, hum, and random noise similar to radio "static." To keep this AM "trash" out of the audio channel, it must be removed from the signal somewhere ahead of the discriminator stage. For this purpose, a *limiter* stage is usually placed just ahead of the discriminator. This is often a sharp-cutoff pentode such as a 6AU6, operated at low plate and screen voltages so that peaks of the input signal will drive the tube into saturation and cutoff. (This action levels off both positive and negative peaks, effectively removing AM from the signal.) Two sound IF stages are generally required ahead of a discriminator—one for sound IF signal amplification, and the other for limiting.

The ratio detector's most notable feature is its built-in ability to suppress most of the AM "contamination," and therefore no limiter is needed. Thus, a set having this type of circuit can generally get along with just one sound IF stage.

The intercarrier type of TV sound system has been used so widely for the past eight or ten years as to be considered almost universal. Therefore, you can expect nearly all television sound detectors to be tuned to a "center" frequency of 4.5 mc, which is standard for intercarrier circuits. Of course, modulation will cause the frequency at any given instant to vary by as much as 25 kc above or below the center frequency.

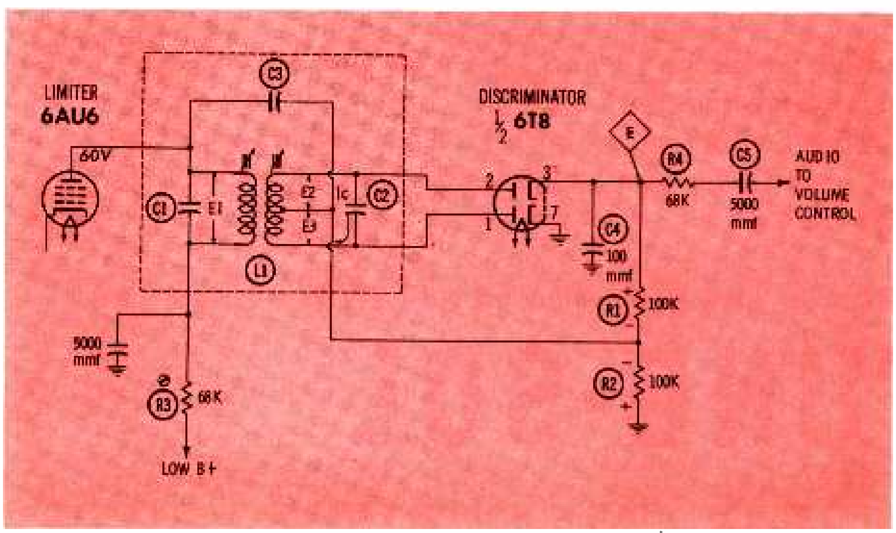

Fig. 1. Discriminator output signal appears across resistors R1 and R2.

Discriminator Action

In a typical discriminator circuit (Fig. 1), sound IF signals are coupled from the primary to the secondary of input transformer L1 in two different ways — capacitively through C3, as well as inductively across the transformer windings. The two signals applied to the secondary differ in phase from each other, and the phase angle between them constantly changes with the frequency of the input signal. This fact is fundamental to the circuit's operation, because the phase-shifting action causes the current through the diodes to vary in such a way as to develop an audio output signal.

• Please turn to page 64

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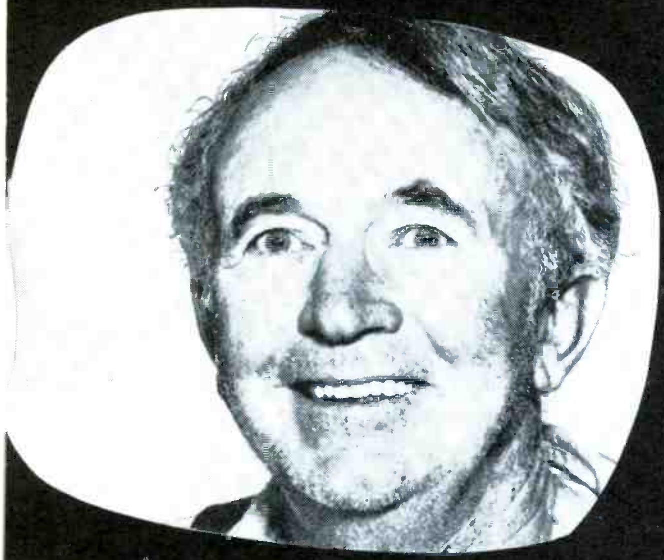
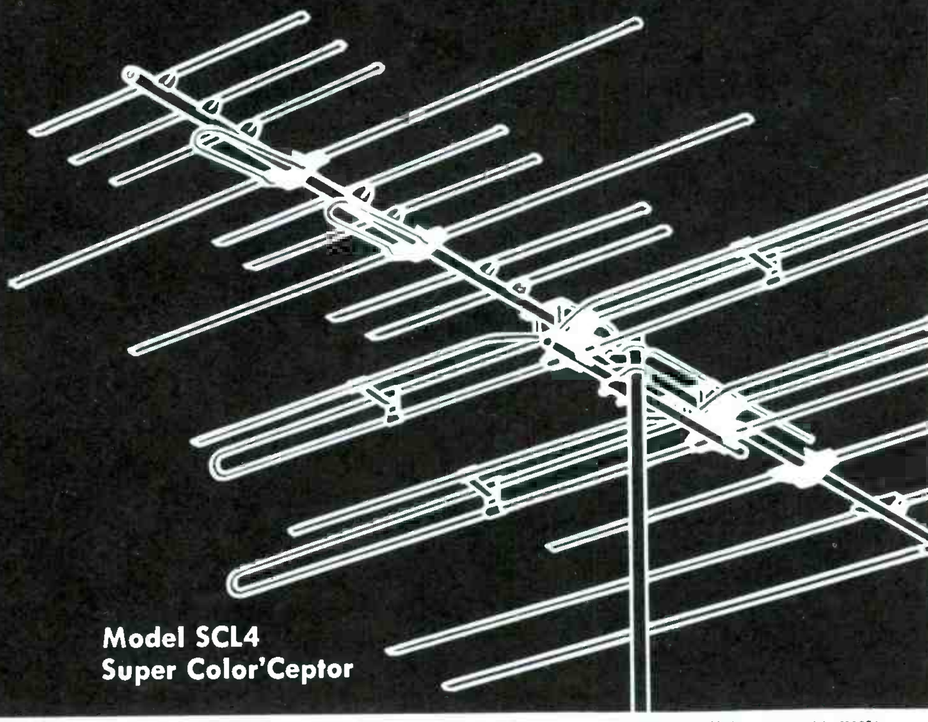


★ *Walter Brennan*



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LARGE-CURRENT

Getting acquainted with thyratrons

Tubes used in industrial electronics for the control of large currents function somewhat differently from low-power types. Gas-filled, hot-cathode tubes are widely used instead of vacuum tubes because of their greater efficiency in heavy-duty applications. The gas within the tube ionizes during normal operation; thus, the voltage drop across the tube is low in value and independent of plate current. By contrast, a vacuum tube has a considerable internal voltage drop, and its plate voltage changes as the plate current fluctuates. (This is often a disadvantage in industrial electronic circuits.)

Thyratrons

In principle, thyratrons are merely gas-filled triodes, but their construction is quite different from that of ordinary vacuum-type triodes. The grid in a gas-filled tube must be arranged so as to prevent *all* electron flow when the tube is biased into cutoff. A minute amount of current can be tolerated in a vacuum tube while it is in the cut-off state, but even a very small electron flow in a thyratron is sufficient to ionize the gas and drive the tube into full conduction.

Fig. 1 illustrates a thyratron with a tubular grid structure. The grid is designed to serve also as a cathode shield. In this way, it completely controls electron flow, helps contain the cathode heat, and also shields the cathode from external stray fields. This type of grid structure results in a heavy grid current.

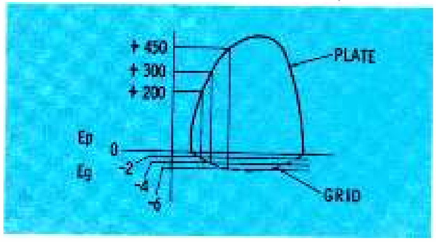


Fig. 3. Critical grid-voltage curve.

Some thyratrons use *shield-grid* construction, as shown in Fig. 2. Note that a separate shield grid surrounds not only the cathode but also the control grid. Less current flows from cathode to control grid, and the tube is also more sensitive to changes in control-grid voltage. The shield grid in a small tube is usually tied to a base pin. If this grid is at cathode potential, the shield-grid thyratron and the simple triode thyratron have about the same grid-voltage and plate-voltage relationship. But, if the shield grid is made more negative than the cathode, the control grid must then be driven slightly positive to cause conduction.

In a thyratron, the grid controls a very large plate current—in some cases as much as 40 amperes—but not in exactly the same way as in a vacuum tube. For any given value of plate voltage, there is some definite value of grid voltage required to prevent conduction. The higher the plate voltage, the greater this negative grid voltage must be. For example, if the plate voltage of a certain thyratron were increased from 200 to 450 volts, the grid voltage would have to shift from —2 to —6 volts to keep the tube cut off (see Fig. 3). The points on the grid-voltage curve in this figure are called *critical values* — the minimum voltages required to prevent the thyratron from firing (conducting). In most cases, it can be assumed that the thyratron will fire when the grid potential is zero (or slightly positive), provided the plate is positive with respect to the cathode.

Once the tube fires, it cannot be cut off again by simply making the grid voltage more negative than the critical value. To bring tube current to a halt, the gas in the tube must be deionized by greatly decreasing the potential difference between plate and cathode. The simplest means of doing this is to use AC for the plate-supply voltage, so that the negative alternations will cut off the tube and permit the grid to regain control.

Three basic methods are used to enable the grid to control the firing of the tube. These are (1) changing the phase relationship between the AC grid and plate voltages, (2) changing the value of the DC grid voltage about which the AC signal alternates, and (3) using a waveshape other than a sine wave on the grid to act as a trigger.

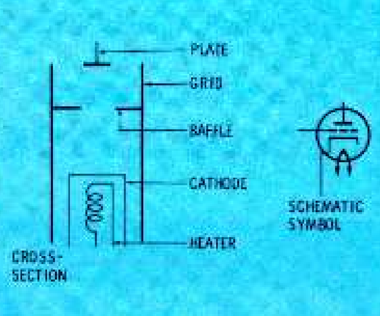


Fig. 1. A single-grid thyratron.

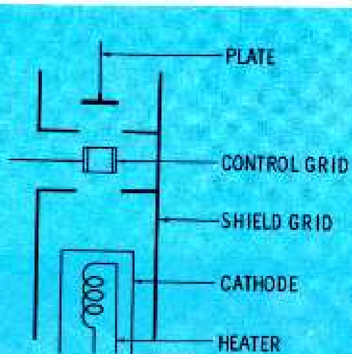


Fig. 2. Thyratron with shield grid.

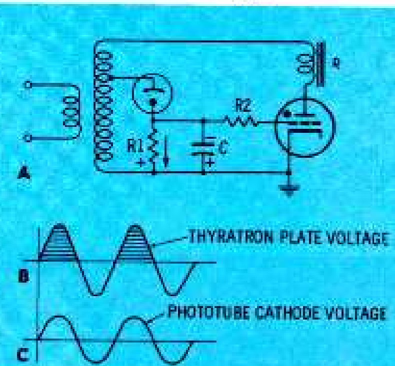


Fig. 4. Photoelectric thyratron control.

ELECTRON TUBES

and ignitrons . . . by Allan Lytel

An example of a thyratron control circuit is shown in Fig. 4 where a phototube and a thyratron are used with an AC power supply. An AC voltage (Fig. 4B) is applied to the thyratron plate, and the tube conducts only when the plate is positive. The phototube cannot conduct while its cathode is positive (which is at the same time the thyratron is conducting).

When the phototube is dark, it will not conduct if its cathode is negative. The grid of the thyratron then remains at ground potential, and the thyraton fires on the positive alternations of plate voltage. The resulting plate current energizes relay R.

When light hits the phototube, this unit acts as a rectifier, conducting on alternate half-cycles of input voltage when the cathode is negative with respect to the anode. The current through the phototube charges capacitor C to the peak value of the AC voltage applied to the phototube.

This charge keeps the grid voltage of the thyratron below cutoff. As long as light shines on the cathode, the phototube holds the thyratron grid negative enough to prevent thyratron conduction and keep the relay open. Interruption of the light removes the grid bias (since the capacitor discharges through R), fires the thyratron, and closes the relay.

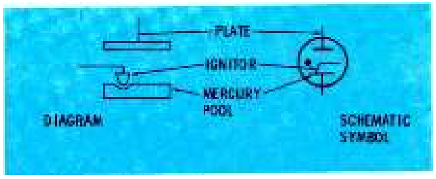


Fig. 6. Elements inside an ignitron.

Ignitrons

An ignitron is a gas-filled diode used to control large currents from 40 to 10,000 amperes. There are many different ignitron types, most of which bear little physical resemblance to small vacuum tubes. Ignitron diodes can rectify very large AC currents, since they are able to carry steady loads of several hundred amperes. However, their greatest use is in the handling of heavy surge currents of several thousand amperes for short times, as in an AC switch. In effect, the ignitron replaces a mechanical switch; but it operates with little maintenance and has no moving parts.

The drawing in Fig. 5 shows the construction of an ignitron. A heated cathode is used, but a pool of liquid mercury takes the place of a solid filament. The unit is surrounded by a jacket through which water is circulated for cooling purposes.

A small, tapered piece of boron carbide is used as the starter or ignitor, and touches the mercury pool as illustrated in Fig. 6. Although the boron carbide and mercury are in contact, there is a small resistance (100 to 500 ohms) between them because of the physical nature of the materials. When a current of about 40 to 50 amperes flows through this junction, it develops an arc which frees a large supply of electrons and allows the tube to conduct from cathode to plate. After conduction starts, the ignitor circuit is turned off. The anode keeps the cathode in operation with very small current flow.

The action of an ignitron as an AC switch can be understood from Fig. 7, an elementary circuit of a welding control. When terminal A of the power supply is positive, the tube cannot conduct. When A is negative, the cathode is negative and the plate is positive. Conduction from the cathode mercury pool to the ignitor is now possible if the ignitor switch is closed. This conduction starts the mercury arc and causes the tube to begin operating as a half-wave rectifier. Controlling the switch action will permit control over the current flow through the transformer to the welding arc.

An actual circuit is shown in Fig. 8. Two ignitrons are connected back-to-back or anode-to-cathode. The copper-oxide rectifiers prevent harmful current flow from ignitor to mercury pool in both tubes. (Normal ignitor current is from the mercury pool to the ignitor.) When

•Please turn to page 70

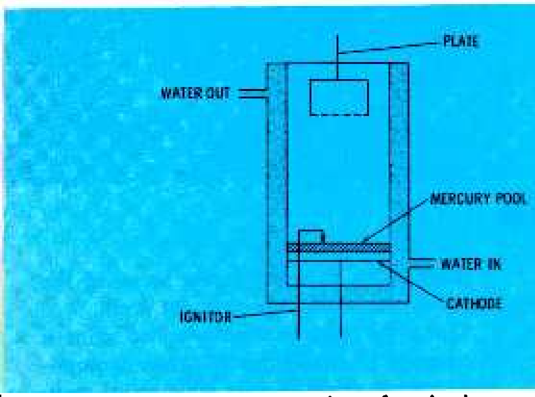


Fig. 5 Cross-section of an ignitron.

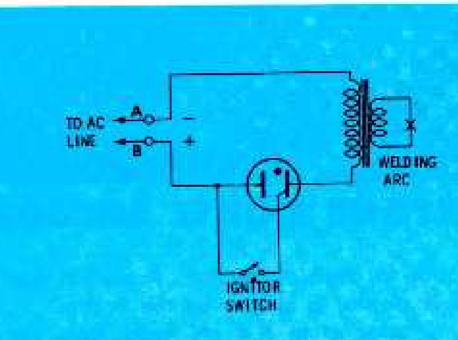


Fig. 7. Simplified ignitron circuit.

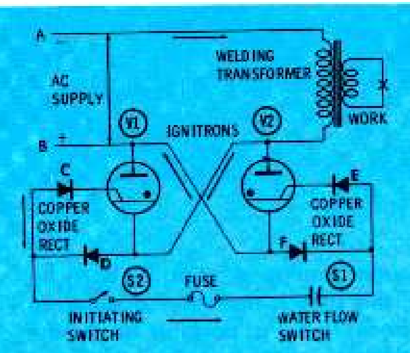


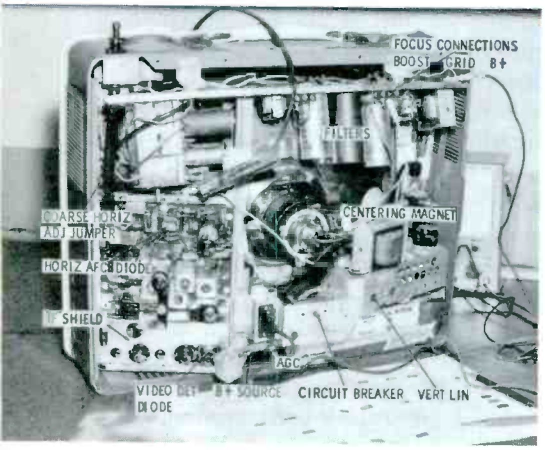
Fig. 8. Circuit using two ignitrons.

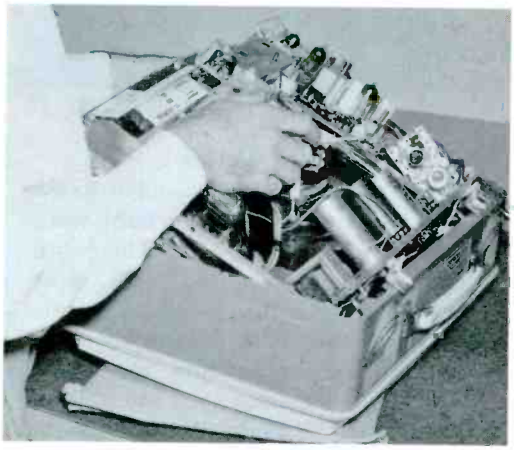
Portable TV's are a special breed. Because of their low initial cost, owners are reluctant to pay the usual service charges—and yet, in many instances, the compact design of portable sets increases service time. Thus, the problem facing the serviceman is how to effect minimum-cost repairs.

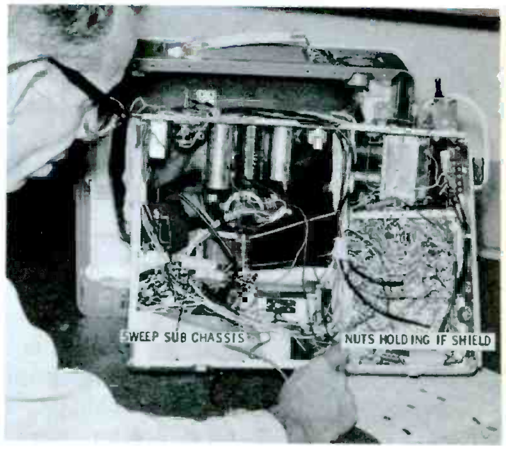
This does not mean you should reduce your hourly service rate; however, you should take every advantage of set design to make the most effective use of your time, talent, and equipment. For example, having the customer pickup and deliver the set saves him the usual fee for this service. Additional savings will result if the set can be repaired in the cabinet (even if **you** make the pickup and delivery).

To help you with this last point, we've analyzed four different portable designs to show you how their specific features can be used to advantage in cutting servicing time. These hints, combined with your own ingenuity, will go a long way toward having portable owners return to you for **all** their work.

SERVICING





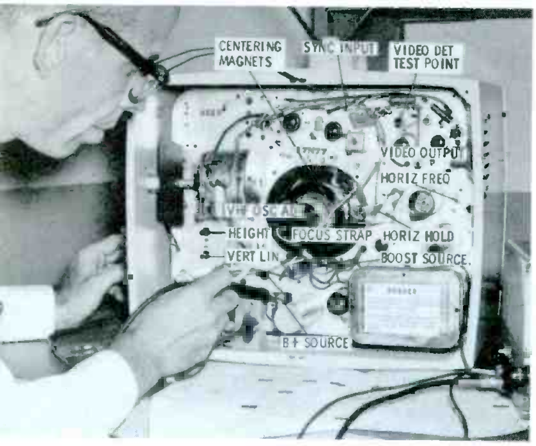


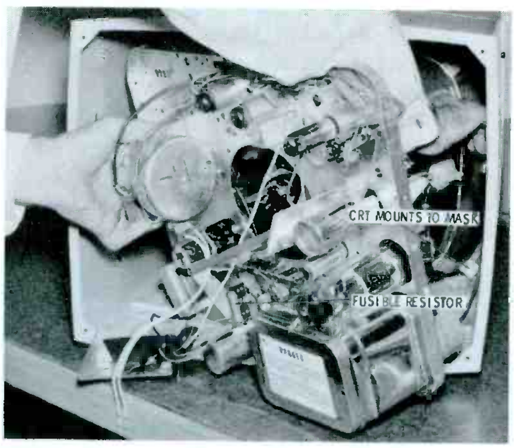
ADMIRAL MODEL PL17F31B

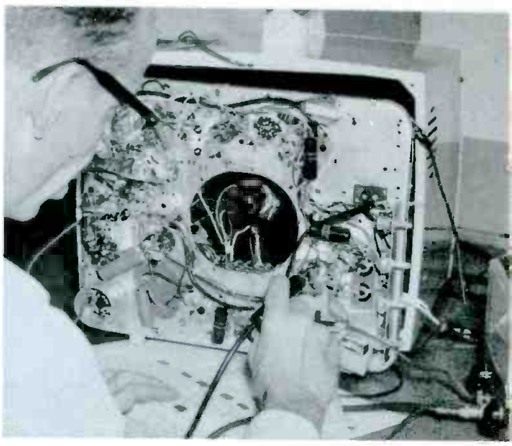
Removal of the rear cover on this set permits waveform analysis in all except the vertical circuit, and voltage measurements in all except the video IF and deflection amplifier circuits. The IF strip is covered by a shield which must be removed from the bottom. Components are located so that most of them can be replaced without disassembling the set.

In the event the chassis does have to be removed, there are just four easily-accessible plug-in connections, and 7 chassis bolts. Tilting the chassis as shown permits it to be easily slipped out.

Bottom shields have been removed, exposing the entire printed board for circuit tracing. The nut indicated is one of two which hold the IF shield on top. Removing three metal screws permits the sweep subchassis to swing back, and makes servicing easier.





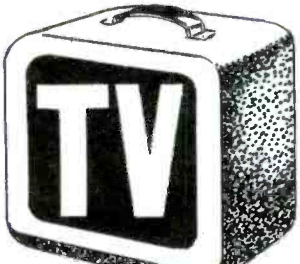


TRUETONE MODEL 2DC3030A

Although equipped with a carrying handle, this style is more like a standard table model than a portable (note the conventional vertical chassis). B+ and boost voltages as well as video output and sync input signals may be checked prior to chassis removal. A plug-in fusible resistor is hidden by the probe.

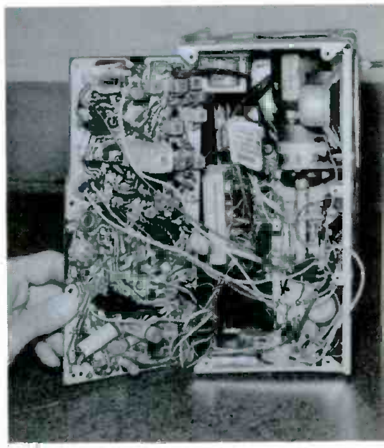
Disconnecting the HV lead from the CRT is a small problem on this set. The front, to which the CRT is mounted, can be removed to service the chassis in the cabinet. The forward screw securing the handle also holds the cabinet front.

Once the conventionally-wired chassis is removed, circuit tracing and component replacement require no special techniques, but a HV lead is needed.



PORTABLES

by Joe Groves



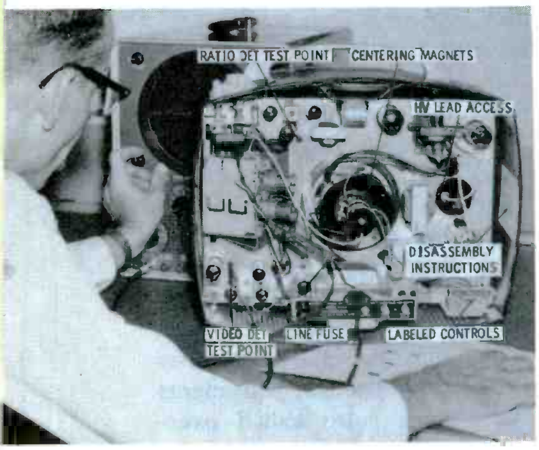
PHILCO MODEL H2010L

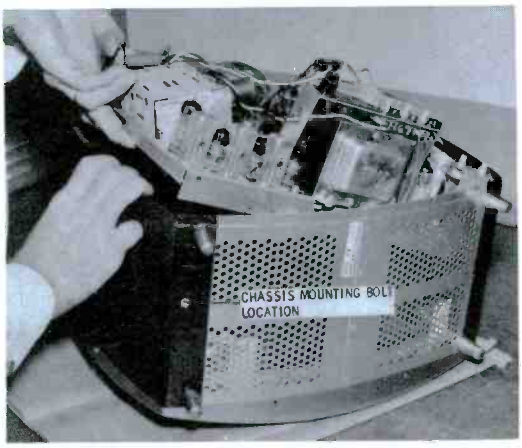
Trends toward extreme compactness are exhibited by this transistorized design. Note that the lower part of the case must be removed to reach setup adjustments. Use of printed boards permit all circuit tracing to be accomplished at this point of disassembly.

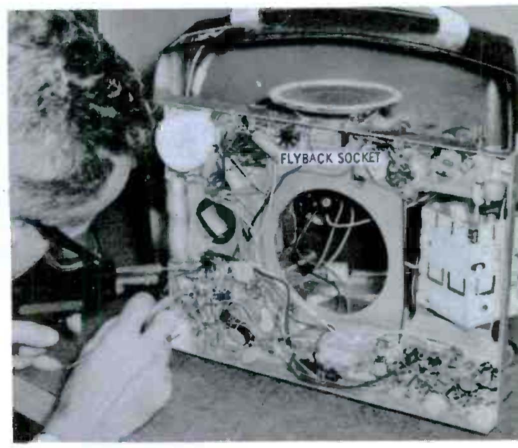
Removal of battery compartment, top, and optical system is necessary for CRT removal and access to the main chassis.

Opening the HV cage exposes the two 5642 HV rectifiers. The cage is a part of the "main chassis," and the printed-board sweep subchassis fits around it. Hidden by the lid are the vertical hold, horizontal hold and brightness controls.

Both IF and sweep subchassis swing out for access to the printed-board components. Boards are held in place by metal screws, which also serve as ground connections to the chassis.





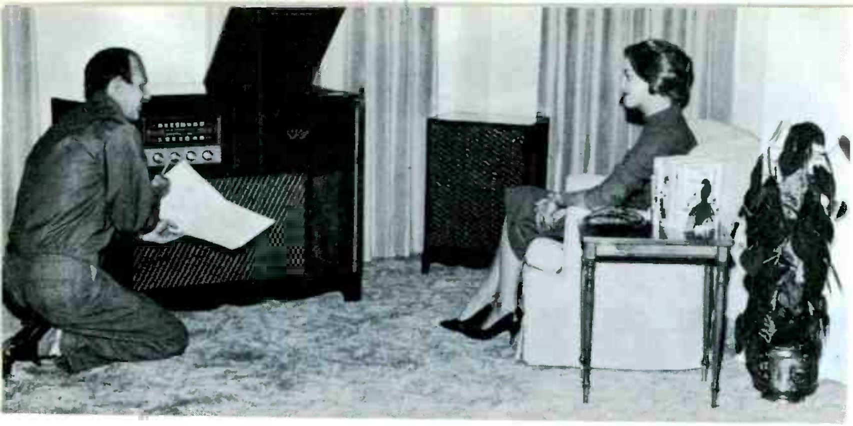


SETCHELL-CARLSON MODEL P66

This conventional vertical chassis, while providing test points for only the video and audio detectors above the chassis, can be removed from the cabinet in a matter of a few minutes. Note the plug-in yoke and the chassis cutout for access to the HV lead. The speaker mounts to the chassis.

Only one bolt need be removed, after the knobs are off and the CRT and yoke have been disconnected, to remove this chassis. Tilting the left side up as shown allows the chassis to slide off two retaining posts holding the right side.

Troubleshooting and accessibility of components present no problems with the chassis in this servicing position. Note the special feature of a plug-in flyback.



Customer

One of the biggest assets of any firm is satisfied customers—the kind who provide repeat business and recommend you to their friends. And one excellent way to keep customers satisfied is to be ready with expert advice on *any* problem they may have with electronic equipment.

Like many radio-TV men, you may have been steering clear of the audio field because you lack the specialized knowledge you need to deal satisfactorily with serious hi-fi fans. It's true that this branch of electronics harbors quite a few perfectionists, who may complain of equipment faults which you have difficulty in even recognizing; however, hi-fi has become enough of a mass-market item to appeal to listeners with ears no more "golden" than your own. You'll be surprised how much you can help a nontechnical person to improve the performance of his hi-fi set, just by instructing him on the proper adjustment of amplifier controls and the care of phonographs.

Yet, if you haven't been keeping pace with audio developments, you may not be well enough versed in such things as equalization, tone, and loudness controls to give accurate answers to the average customer's questions. If you're in this unfortunate state, read on for a discussion of several pertinent subjects which often come up in dealing with hi-fi owners.

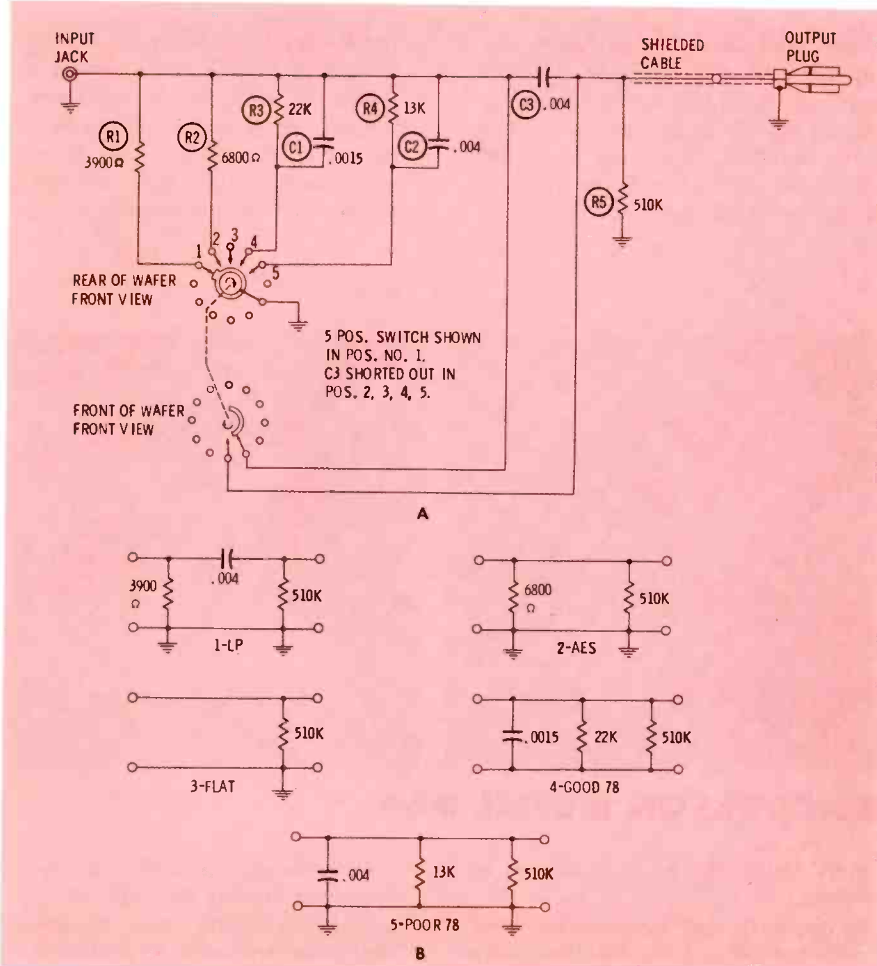


Fig. 1. 5-position equalizer. (A) Complete circuit; (B) Individual circuits.

Equalizers

The program material on a phonograph record exists in the form of tiny, almost invisible ripples in the record grooves. Although its width is constant, the groove follows a snakelike path with periodic side-to-side motions. (In stereo records, cuts are also made at a downward angle into the walls of the groove.) For high notes, the groove ripples are faster (closer together) than for low notes. For louder sounds, the sideward displacement is much greater than for sounds of lower intensity.

Music is reproduced as the playback stylus (needle) rides in these grooves. As the stylus follows the pattern of "wiggles" created during the recording process, its physical motions cause electrical signals to be induced into the phono cartridge. These electrical variations comprise the audio signal to be handled by the hi-fi system.

The walls of the record grooves are not completely smooth, and whenever the stylus passes by any minute rough spots, noise signals are introduced along with the music. In making the discs, recording companies try to minimize the noise; however, enough is still present to be a potential nuisance. The high-frequency components of music, which consist primarily of notes from the higher-pitched instruments and harmonics (also called overtones) of the other instruments, have less intensity than the low frequencies; if recorded at their natural amplitude, they tend to be blotted out by noise. To remedy this problem, the "highs" in the audio signal are *pre-emphasized* during recording. In other words, the amplitude

Satisfaction From Hi-Fi

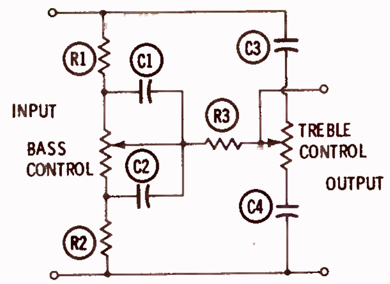


Fig. 2. Bass and treble control circuits.

of high-frequency signals applied to the cutting stylus is purposely increased so that the resulting groove variations are larger than the groove irregularities which produce noise. In this way, the signal overrides the noise interference. Large-amplitude, low-frequency signals cause greater side-to-side variations in the grooves, thus limiting the number of grooves and the amount of music which can be put on a disc. So, in recording, these "lows" are *de-emphasized* (reduced in amplitude) so that the grooves can be placed closer together without danger of overlapping. This enables each disc to give a longer playing time.

If played as recorded, a disc would provide insufficient strength for bass notes, and entirely too much treble and noise. Therefore, equalizers are employed in hi-fi amplifiers to reduce the high-frequency amplitude and to boost the lows, giving more natural sound. The different recording companies have been somewhat slow to standardize on how much to change the amplitudes during recording; as a result, several different recording curves have been used, especially on older records. The correct equalizer setting must be used during playback — otherwise, the balance between treble and bass may not be correct. The problem confronting the hi-fi owner is to select the proper equalization.

Fig. 1A is a schematic of a five-position equalizer. The selector switch is shown in No. 1 position, which is for the LP (long playing) recording curve. The other positions are: 2, AES (Audio Engineering Society); 3, Flat; 4, Good 78; and 5, Poor 78. The simplified diagrams in Fig. 1B show the applicable components for each of the five positions. This equalizer is a self-contained unit, but those built into preamps follow the same general circuit design. Other equalizing circuits are also used, each for a specific recording curve.

Many records list the recording curve on either the label or the record jacket, and wherever possible the set owner should set the equalizer to the suggested position. If the correct setting is not available, then the closest one to it should be used, and the difference compensated by adjustment of the tone controls. Once a hi-fi user discovers a satisfactory combination of control settings, he may wish to note them on the record jacket for future use.

Tone Controls

Equalizers are used to adjust amplifier response so that the most natural sound is produced from records. Additional variables are also needed, so most systems include two tone controls—one to regulate the treble, the other the bass.

A typical tone-control arrangement is shown in Fig. 2. C1, in series between input and output, decreases bass response, while shunt-connected C2 increases it; thus, if the control is set midway in its range, the bass amplitude is not altered. With the arm set at the "top" end of the control, C1 is shorted out, and maximum bass results. If the arm is at the bottom, C2 is shorted out and bass response is minimum. The values of R1 and R2 set the range over which bass response can be varied. For the treble control, C3 determines the treble boost and C4 the treble cut, while a "flat" condition occurs at the mid-range setting. Maximum treble is produced with the control arm all the way up, and minimum treble is obtained when the arm is all the way down.

"Bass boost," "maximum treble," etc., are relative terms, since our ears respond to sounds in relation to other sounds. An example of how this is put to use is the tone con-

• *Please turn to page 75*

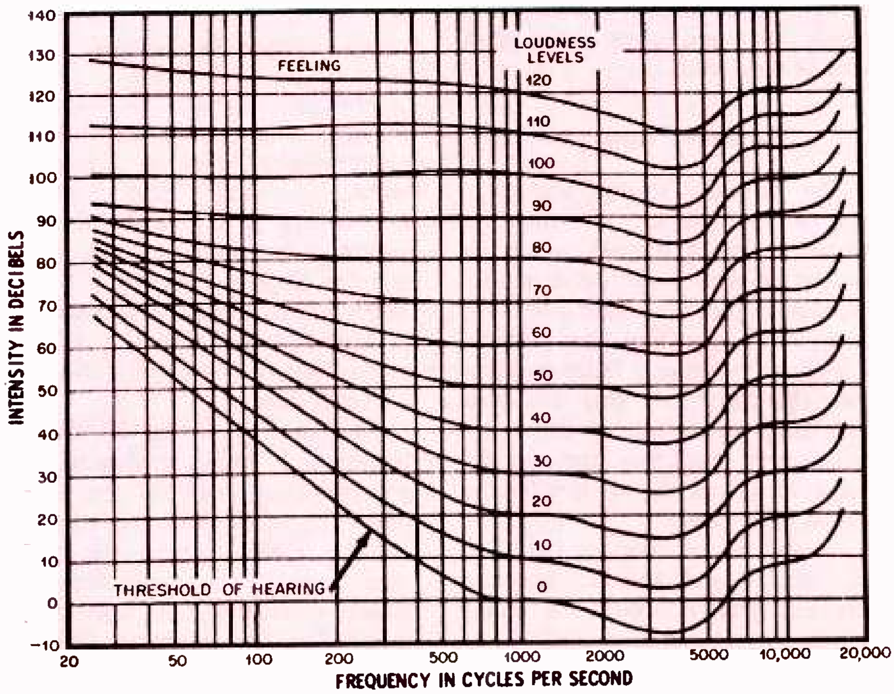


Fig. 3. Frequency response of ear varies with loudness, as these curves show.

AUDIO TROUBLES can be tricky, too!

by Calvin C. Young, Jr.

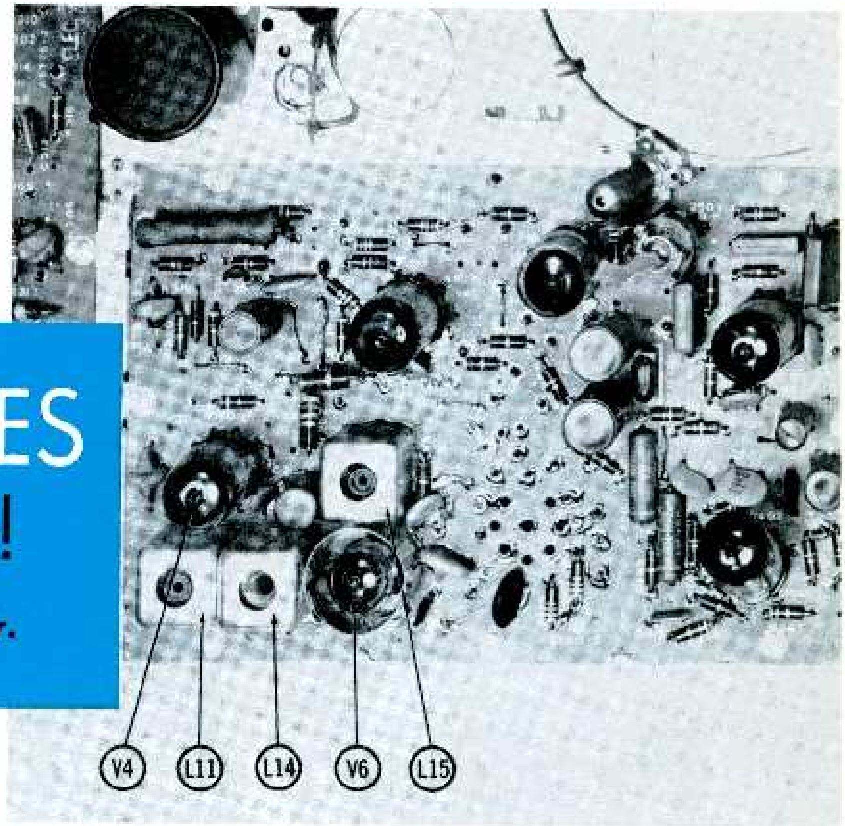


Fig. 1. Audio IF and detector component section used in Admiral receiver.

An Admiral Model LHR21F321 TV set that came into the shop recently did a good job of reacquainting me with the fact that audio troubles aren't foreign to TV receivers. In all probability, your awakening won't come as a result of a similar brush with the same make of receiver; however, the lesson I learned should help rekindle the old thought processes and enable you to "think out" and solve audio problems as they arise.

The Initial Approach

The problem started out as a routine complaint of distorted sound, which I figured would be cleared up with a new tube or two. Replacing all of the sound and audio tubes, and adjusting the detector and IF transformers, failed to eliminate the distortion. This was quite surprising, since one of the push-pull output amplifiers and the detector tube had tested defective in a good tube tester.

A quick visual check of the chassis, cabinet and speaker hookups revealed that it would be much simpler to take cabinet and all to the shop. (Because of the nature of the trouble, I deemed it necessary to take the speakers as well as the chassis. Connection for the four speakers, two on each side of the low-boy cabinet, were wired and soldered, thereby complicating their removal and reinstallation.) Luck was with me, since the man of the house was at home and willing to offer his brawn to help get the set into the service truck.

Shop Procedure

Further analysis of the problem in the shop indicated that the audio distortion had at least two causes. The sound was mushy and garbled at low volume levels, while a rattling condition was noted at high volume settings. It also seemed that maximum volume wasn't loud enough—at least it wasn't what I considered normal for four speakers and a 10-watt amplifier.

Realignment of the IF and detector stages in accordance with the procedure outlined in the service literature failed to improve sound quality at all. Tapping the chassis near some of the components disclosed unusually high microphonic tendencies. The condition seemed to be worse when the areas around L11, L14, L15, V4 and V6 (all shown in Fig. 1) were tapped. The tubes were rechecked and the detector and output tubes previously found defective were now replaced. As I expected, this had little effect on the trouble.

The next step was to remove the TV chassis. Then the reverse side of the printed wiring board was carefully checked. Voltage readings were observed at key points while the three IF transformers (L11, L14 and L15 in Fig. 1) were tapped and twisted in several directions. At one point, I was able to get the sound to cut out when exerting a slight force on the shield housing L14. After removing this shield, the dual-winding transformer was carefully removed from the printed board. A subsequent visual inspection revealed traces of excess solder, which I could only assume was shorting one of the secondary coil terminals to the grounded transformer shield.

A little heat from a miniature soldering iron caused the excess solder to be drawn to the terminals. (This same principle can be employed if you desire to remove a component from a printed board. Simply heat the lead of the component to be removed, being very care-

why the most advanced professional cartridge...

Electro-Voice® NEW MAGNERAMIC *31 MD7

has ceramic elements!

For more than 35 years, Electro-Voice has been a leader in the development and manufacture of dynamic microphones and loudspeakers. Why then, with this extensive experience in designing and producing electro-magnetic devices, is Electro-Voice introducing the new Magneramic 31 Series stereo cartridge using ceramic elements?

The reason is that Electro-Voice is genuinely convinced that a precision ceramic cartridge is the finest type that can be made today . . . definitely superior to the magnetic type. The superiority of the Magneramic 31 is demonstrated in these three areas.

GREATER FLEXIBILITY — The 31 Series cartridge will operate perfectly at any stylus pressure from 2 to 20 grams. The same stylus assembly can be used for operation on both turntable and record changers; performance need not be compromised by using a special, stiff stylus assembly for record changers. Record wear is the only criterion in setting stylus pressure — cartridge operation is not affected. Thus, when converting from a changer to a turntable, or vice versa, replacement of the stylus assembly is not necessary when using the Magneramic 31.

HIGHER OUTPUT — Along with the trend toward less efficient speaker systems, more amplifier power has become a necessity. While most stereo amplifiers are now designed with input sensitivities to match the typical 5-millivolt output of magnetic stereo cartridges, nearly all monaural amplifiers were designed for at least 8-millivolt input. These cannot be driven to full output with a magnetic stereo cartridge. The Magneramic 31 develops a full 8-millivolt output and couples directly into any "magnetic" preamp unit. This higher output should especially be considered by those planning conversion to stereo utilizing existent monaural amplifiers.

FREEDOM FROM HUM — The increased amplifier gain required to satisfactorily drive low-efficiency speakers coupled with decreased cartridge output has significantly increased system hum problems. Also, conventional methods of hum elimination used in monaural magnetic cartridges become difficult or impossible to apply to stereo magnetics. The Magneramic 31 completely eliminates these problems — it is non-inductive and has adequate output.

The Electro-Voice Magneramic 31 MD7 cartridge directly replaces any monophonic or stereophonic magnetic cartridge now on the market. It feeds into the preamp input-jack specified for magnetic cartridges and does not require adaptors or circuit modifications.

SPECIFICATIONS — MAGNERAMIC 31 MD7

Response Range: 20 to 15,000 cps ± 2 db
Compliance, Vertical: 3.5 x 10^{-6} cm/dyne
Compliance, Lateral: 3.5 x 10^{-6} cm/dyne
Isolation: 28 db @ 1000 cycles
Tracking Force: 2 to 4 grams in transcription arms
4 to 6 grams in changer arms
Styli: .7 mil diamond
Output: 8 millivolts
Recommended Load: 22,000 to 47,000 ohms (Magnetic phono inputs)
Elements: 2, Lead Zirconium Titanate (Ceramic)
Weight: 8 grams
Terminals: 4, standard .050" connectors
Mounting Centers: ½" and 7/16" fits both
Audiophile Net: $24.00

Want more information? Write to Dept. 129R for the booklet entitled, "FACTS ABOUT THE ELECTRO-VOICE MAGNERAMIC CARTRIDGE"

Electro-Voice® INC.
BUCHANAN, MICHIGAN

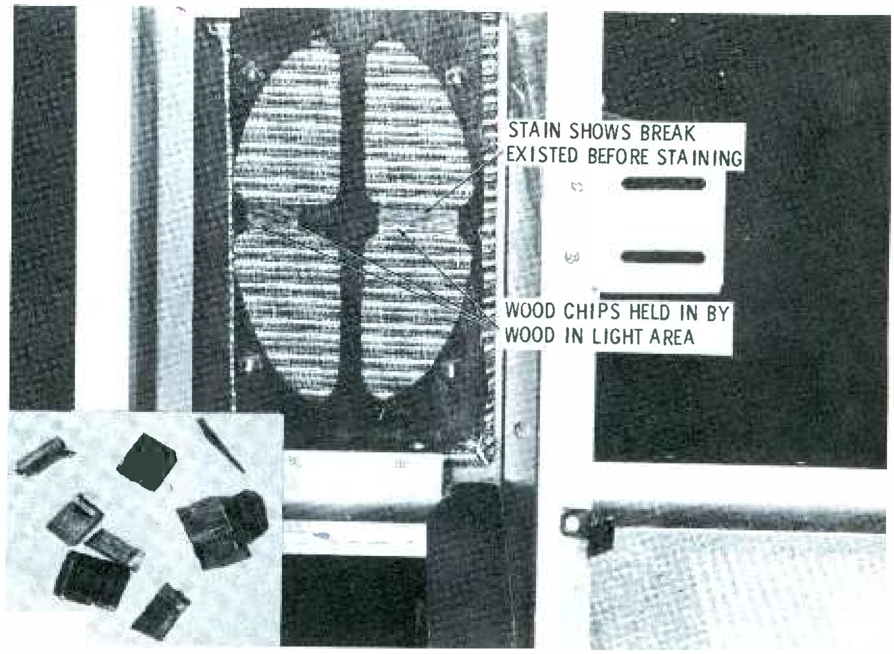


Fig. 2. Loose wood in 6" x 9" speaker cutout rattled at high volume levels.

ful not to heat the foil surface itself, and the solder will be drawn to the heat of the iron. A stiff brush is also useful for removing surface solder as it becomes molten. When most of the solder has been "worn away" in this manner, the remainder should be drawn to the heated lead, leaving it free from contact with the board.)

Getting back to the Admiral, I felt that since one of the IF transformers had revealed traces of excess solder, the others could bear investigation. Each of the shields was removed, and the extra solder was drawn back to the hot iron. Replacement of the shields and a touch-up of the IF alignment cleared up the sound distortion at low volume levels.

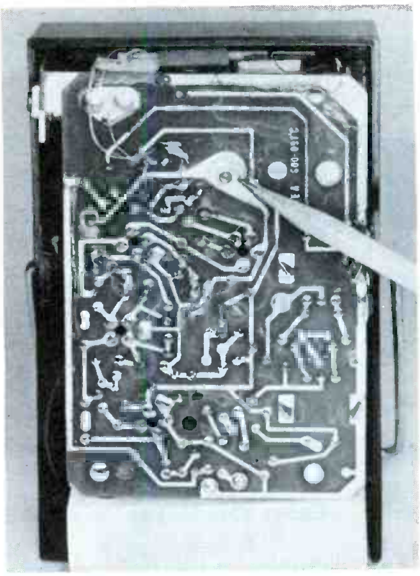
Because one of the audio output tubes had proved defective, the audio amplifier (located on a separate chassis) was given a quick check for leaky coupling capacitors, burnt resistors, etc. No defects were noted. This left only one possible source for the high-level rattling still present—the speakers themselves.

The four speakers were carefully removed and given the usual tests for rubbing voice coils and unbonded cone edges. No evidence of either type of defect was noted. The next step was to connect the amplifier output to the shop's speaker system —a 12" coaxial unit enclosed in a bass reflex cabinet. There was no trace of the distortion, so the cause for the trouble was definitely isolated to the speakers—but they still didn't show signs of any defect that could cause the trouble. However, the speakers were connected to the audio amplifier and given a test in free air. This time the volume was slightly lower and fidelity was off a bit, but there wasn't a trace of the rattle.

Suspecting a rattle in the cabinet, I started a careful inch-by-inch check of the cabinet. Almost immediately, I found the cause—some loose wood on the cross member of the 6" x 9" speaker cutout (see Fig. 2). One layer of the plywood was loose and rattling. The bright spots pointed out are the places where the wood still held the loose layer to the board. All the evidence indicated that the defect had been present before the set left the factory. However, after talking to the customer, it was concluded that the condition didn't actually develop into a trouble until the set had been in operation for awhile.

The final solution to the problem included removal of all the loose wood chips (see Fig. 2 insert) and application of a layer of wood glue to the plywood around the speaker cutout. In lieu of a suitable glue, a heavy coat of varnish can be used.

My experience served to emphasize that you should not be too hasty in making a decision to take only a part of a TV receiver into the shop for repairs when the trouble could be caused by a portion left at the home.



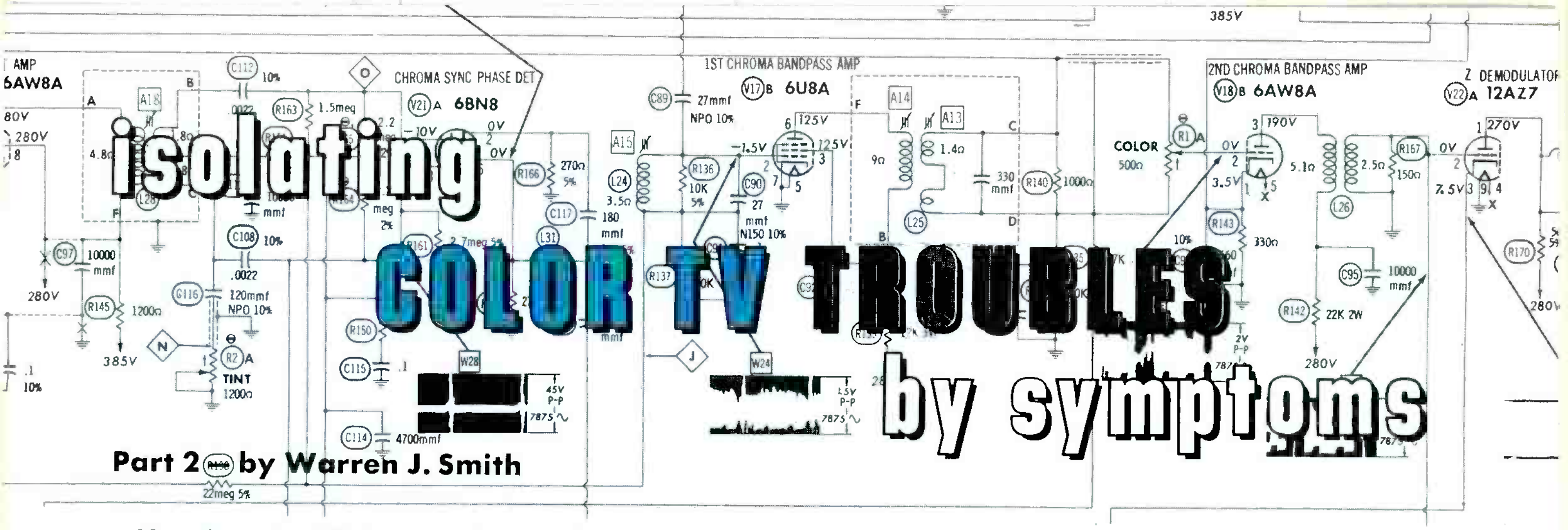
Something to Watch For

Here is a trouble which *you* can cause quite innocently by merely checking or replacing the batteries in many of today's transistor portables. It has to do with the printed-board retaining bolt and nut, which also serves, in conjunction with a thumb screw, to secure the rear cover to the case. The secret is that it *also* bonds the ground line of the printed board to the remainder of the chassis.

Quite often, loosening the thumb screw will also loosen the ground connection. The result is intermittent operation, dead set, low gain, etc., which may correct itself when the case is jarred or moved. It's good practice, when working on portable radios that incorporate this design, to tighten the nut holding the board as soon as the back is removed. ▲

Guess Who . . .

. . . wouldn't be caught dead watching T.V. ten years ago because it was just a crazy fad"



isolating COLOR TV TROUBLES by symptoms

Part 2 by Warren J. Smith

Now that color TV has passed its fifth birthday, a vast amount of field experience has been accumulated on color sets. Thus, the serviceman has the opportunity to learn not only theoretically what defects can develop in color circuits, but also what types of breakdowns actually do develop. The October installment touched on some common defects which have been observed in receivers now in use. More of these often-encountered troubles are described in the following paragraphs.

The Color Killer

As its name implies, the color killer blocks the chrominance section to prevent noise pulses in the 2- to 4-mc range from producing colored snow (or confetti, as it is sometimes called) in black-and-white pictures. Intermittent operation of the color section can often be traced to the killer circuit, especially when the receiver is operating on color signals of marginal quality. This symptom usually shows up when the hue control is varied; just as the correct setting is approached, all color will abruptly drop out of the picture. Moving the antenna lead-in around or changing the antenna orientation slightly will produce the same effect. The difficulty is due to a weak burst signal which cannot completely cut off the color killer, but which can still synchronize the subcarrier oscillator. All of the later-model color sets have some sort of killer threshold control (see Fig. 1) which can be adjusted for the prevailing signal level. Some receivers (particularly the earlier models) are not equipped with any control for this purpose, so the color killer in these sets must operate at a fixed level. When such a receiver is used in a weak or marginal signal area, or with a low-gain antenna system, the color killer will not function properly. The result is a black-and-white picture only, or color constantly fluctuating in and out of the picture as the signal level changes. Replacing the color-killer input resistor with a linear potentiometer of equal value will permit optimum adjustment of the killer control voltage. If preferred, a SPST toggle switch can be installed in series with the cathode lead to permit the viewer to completely disable the color killer at will.

Color Oscillator

As mentioned in the first part of this series, the burst signal is applied directly to the subcarrier oscillator in some of the later-model color sets, instead of controlling the oscillator indirectly through a phase detector and reactance tube. One version of this "crystal-ringing" circuit is shown in Fig. 1. When the crystal circuit is excited with burst energy from V23B, it oscillates at its resonant frequency (3.579545 mc) for a short time after the source of excitation has been removed. The resulting CW output is applied to a bias rectifier, which in turn is coupled to the color killer. After rectification, the CW signal is filtered to produce a negative DC voltage which biases the color killer below cutoff.

The plate of the color killer is keyed by positive pulses from the horizontal output transformer, instead of being fed a DC voltage from the B+ supply. When the killer stage is in a conducting state (no output from the bias rectifier), each

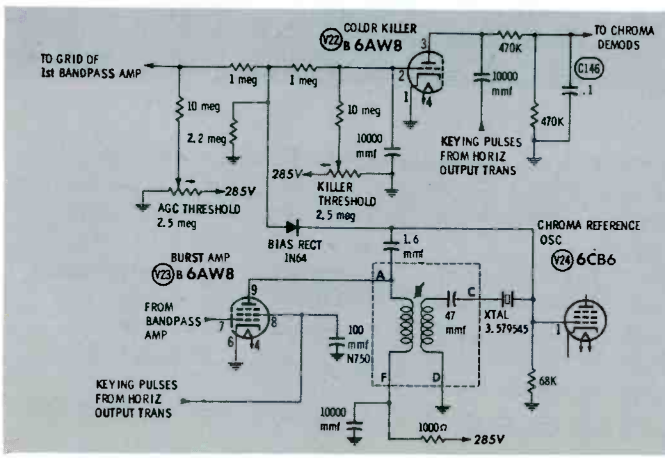


Fig. 1. Color oscillator synchronized by burst signal applied directly to crystal circuit. (RCA Chassis CTC5AA)

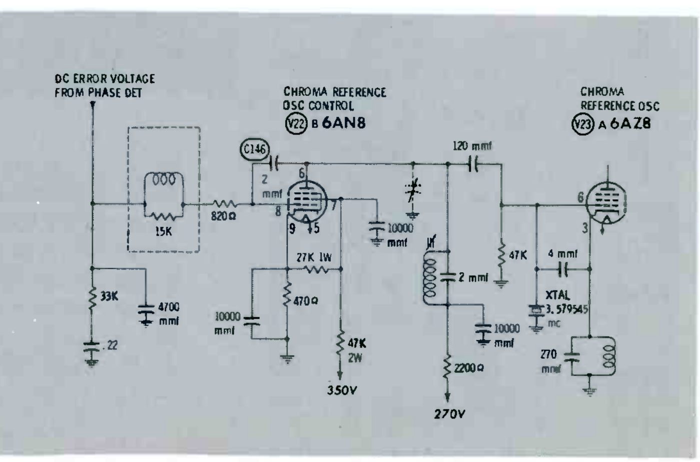
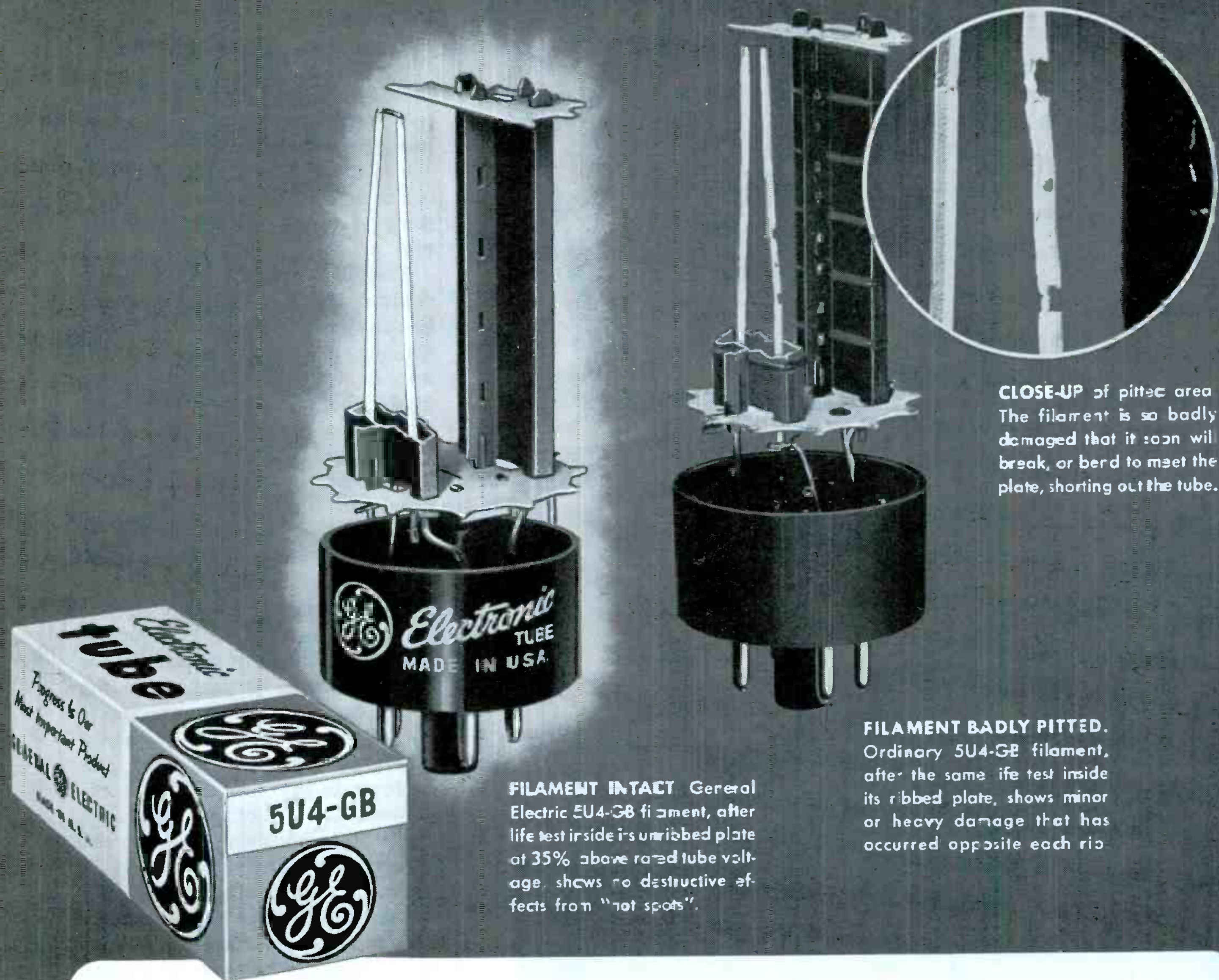


Fig. 2. Color oscillator synchronized by a reactance tube driven in turn by a phase detector. (RCA Chassis CTC4)



FILAMENT INTACT. General Electric 5U4-GB filament, after life test inside its unribbed plate at 35% above rated tube voltage, shows no destructive effects from "hot spots".

FILAMENT BADLY PITTED. Ordinary 5U4-GB filament, after the same life test inside its ribbed plate, shows minor or heavy damage that has occurred opposite each rib.

CLOSE-UP of pitted area. The filament is so badly damaged that it soon will break, or bend to meet the plate, shorting out the tube.

Smooth Plates of G-E 5U4-GB Protect Filaments!

Service-Designed Tube is free from "hot spots" that damage filaments of less dependable 5U4-GB's with ribbed plates!

Install the rectifier tube with the smooth, unribbed plates—General Electric's Service-Designed 5U4-GB! No raised metal lips to collect contaminants! These build up into ridges which serve as sources of back emission, causing "hot spots" that melt and eventually destroy the filaments of ordinary tubes (see photographs above, right).

Dependable from the moment you install them, Service-Designed 5U4-GB's mean fewer callbacks and less chance of a rectifier-tube short-circuit, with risk of transformer burnout—a costly possibility in many modern TV sets. See your G-E tube distributor! *Distributor Sales, Electronic Components Division, General Electric Company, Owensboro, Ky.*

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keying pulse creates a surge of plate current which charges filter capacitor C146 (Fig. 1) to a high negative potential. This potential is applied to the chroma demodulators (or to the grid of the bandpass amplifier in some set designs), cutting them off during monochrome reception.

Trouble with this circuit is generally confined to bad tubes, defective capacitors, or a defective keyer winding. In one particular case, the trouble was traced to a defective crystal, but as a rule crystals give little or no trouble. Those that are found to be defective are probably the result of overheating or careless handling.

In sets where the color subcarrier oscillator is controlled by a reactance tube, minor faults in this control stage can cause a wide variety of color-sync and color-reproduction difficulties. The most troublesome is increased value, or leakage in the small plate-to-grid coupling capacitor (C146 in Fig. 2). Leakage causes the grid to go positive, and an increase in value results in excessive shunt capacitance across the crystal, thus impairing or killing the subcarrier oscillator. Once in a while, the latter defect results in a "hunting" action of the oscillator. This produces incorrect or continuously changing colors in the picture which cannot be corrected with the color phasing control. In some receivers, C146 is omitted, and the stage operates on the grid-to-plate capacitance alone. Due to variations in internal capacitance among tubes of the same type, it may be necessary to try several before finding one which will work satisfactorily.

Wrong Color

Incorrect color values can often be quickly localized by observing a monochrome picture while the contrast control is at its minimum setting. Color in the raster indicates poor color purity or an incorrect balance among the red, green, and blue beam intensities. Nonuniform coloring in the picture is caused by a purity defect, while a uniform tint of one color indicates a lack of CRT beam balance. Fringing at the edges of objects in the picture, or the appearance of color when the contrast control is turned up, may indicate incorrect convergence or focus adjustments, or possibly a defect in the video or chrominance signal circuits.

When a monochrome picture is correctly reproduced in black and white, but a color picture shows incorrect hues, one of three faults may be indicated. First, and most common, the hue control is improperly adjusted for the correct reference phase. Second, there is an incorrect phase relationship between the CW signals applied to the demodulators by the oscillator; in this case, misalignment caused by drift of the quadrature amplifier may be the difficulty. The third possible defect is an imbalance among the relative amplitudes of the color-difference signals in the demodulator or color-adder circuits. Misadjustment of the color gain controls may be the trouble. In I/Q receivers, a lack of I signal results in a picture without cyan and orange values, while a loss of Q signal means a picture without values of magenta and yellow-green. To locate the cause, check the operation of the associated demodulator stage.

Hum in the chroma circuits results in horizontal bars through the picture, just as in monochrome receivers, but the bars have colors associated with the stage in which the hum is introduced. This makes the fault fairly easy to locate. For instance, a 60-cycle hum voltage introduced in the Q demodulator produces bars with Q colors in the picture; during one-half cycle the hum bars will be yellow-green, and magenta in the next half cycle. Hum occurs in color sets as often as in black-and-white sets, and usually for the same reason — heater-to-cathode leakage.

We have called your attention to a number of typical color-set troubles to simplify the task of diagnosing color faults. The foregoing information is intended to save you time by providing clues on "where to look first."

Helpful as they are, however, these hints cannot solve all color-circuit problems for you. To aid you in following a methodical procedure for locating all color defects — no matter how obscure — the next article in this series will consist of a thorough, systematic step-by-step troubleshooting guide for color receivers. ▲

DOLLAR & SENSE *Servicing*

by Thomas A. Lesh

Time Tip — V. Worry is like a short circuit in your mind. Any unsettled doubt or dread wastes mental energy instead of channeling it into useful work.

Big worries, like a "dead short," are usually disabling enough to get immediate attention. People thus manage to cope with problems such as illness in the family, or a threatened lawsuit, because they at least know what's troubling them. Not so easy to pin down are the smaller, more vague worries which may not even be consciously recognized as such. These "fusses and frets" are like leaky capacitors in your mental circuits; they let you go ahead with your normal work, but they cut down your efficiency and cause unnecessary wear and tear on your whole personality.

Everybody has his share of little worries; and, since they keep piling up, it is important to get rid of each one as soon as you possibly can. One of the best ways to do this is to give each problem your undivided attention for a short period—at least long enough to come up with a solution "for the time being." If you don't habitually attack worries head-on, they will continually try to claim the attention of your subconscious mind while your conscious thoughts are directed at something else. The usual results are daydreaming, carelessness, lack of progress in your work, and a "worn-out" feeling at the end of the day.

At times when you feel stymied by your work, take a few minutes for a "worry break." Try to analyze the distractions which are holding you back, make up your mind what to do about them, and then force them out of your head until you can take some action.

Sometimes you'll have to conclude that the worries are too big, or too numerous, to be taken care of right away. In that case, put them off—but promise yourself that you'll think the problem through at some definite time in the near future. Maybe an evening session in the shop, or a Saturday afternoon out fishing, will give you a chance to work out a solution.

A properly-handled "worry break" clears the air and enables you to concentrate on the job at hand. Remember, you can't afford to let unsolved problems interfere with your work; this only adds one more worry to the heap.

$ & ¢

Winter Changeover. The following list of "winterizing" services was submitted by ABC-TV of Libertyville, Ill. (with apologies to the auto service industry). We suggest, however, that you don't let any of your customers see this list, or some of them are liable to insist on having these services performed—and will watch over your shoulder to make sure you do!

Change transformer oil.
Grease flybacks.
Add antifreeze to tuner.
Rotate tubes.
Check oil level in capacitors.
Clean and regap ion trap.
Adjust timing of linearity coil.
Remove stray ions from ion trap.
Tranquilize all self-excited oscillators.
Set tube heaters to 212°
Advance spark at second anode.
Check trigger for electron gun.
Repeak all IF's to prevent snow accumulation on flat-topped responses.
Make sure the cathode follower is in step.
Clean drain on vertical sync.
Integrate the discriminator.
Reseat all standing waves.
Boresight electron gun.
Re-blue electron gun.
(Special for color sets) Re-blue the blue gun; re-green the green gun; re-red the red gun.
Empty grid leak pan.
Plug all grid leaks.
Remove and clean all IF cans.
Blow out all fuses.
Remove bias from discriminator.
Dredge all channels.
Clean all filters.
Renew holster for electron gun.
Sweep all frequencies.
Install new beaters in the mixer.
Apply tourniquet to all bleeder resistors.

SAVE ½ THE TIME

in TV Trouble-Shooting

Make *Twice* The Profit!

THIS EASY
SIGNAL INJECTION
POINT-TO-POINT
DIRECT VIEWING
WAY

B&K

MODEL 1075 TELEVISION ANALYST

New Technique Makes TV Servicing Easier, Faster, More Profitable

Thousands of service technicians already save thousands of hours every day with the amazing B&K Television Analyst. Enables you to inject your own TV signal at any point and watch the resulting test pattern on the picture tube itself. Makes it quick and easy to isolate, pin-point, and correct TV trouble in any stage throughout the video, audio, r.f., i.f., sync, and sweep sections of black & white and color television sets—*including intermittents*. Makes external scope or wave-form interpretation unnecessary. Enables any serviceman to cut servicing time in half, service more TV sets in less time, really satisfy more customers, and make more money. Color generator provides both rainbow pattern and color bars.

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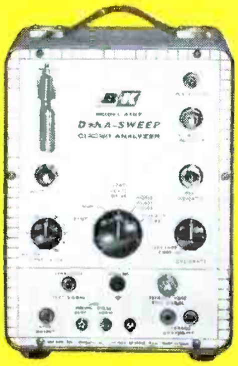

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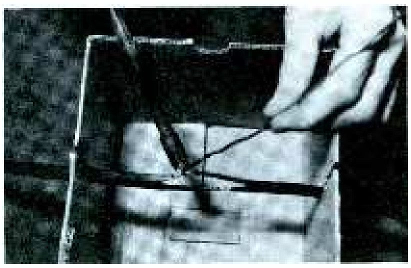
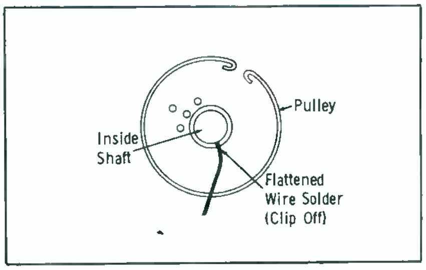


Box Is Wire-Soldering "Vise"

Soldering joints in TV lead-in wire and other electrical wires is a troublesome three-handed operation. A person needs one hand to hold the soldering iron, another to hold the solder, and a third to hold the wire until the freshly-soldered joint has had sufficient time to set. A cardboard box slit down either side as shown makes a handy "vise" for holding wires while they are being soldered. A weight may have to be placed in the bottom of the box to hold it stationary.



Tuning Pulley Repair

Although it doesn't happen very frequently there are times when the dial cord drum pulley on the shaft of a tuning capacitor will work loose and slip around the shaft. Solder usually won't stick to the shaft, so remove the pulley and take a piece of wire solder that has been hammered flat, place it in the shaft hole and force the pulley back on the shaft. The hammered piece of solder will act as a wedge to bind the pulley tightly to the shaft and prevent it from turning.

Springs Protect Test Leads

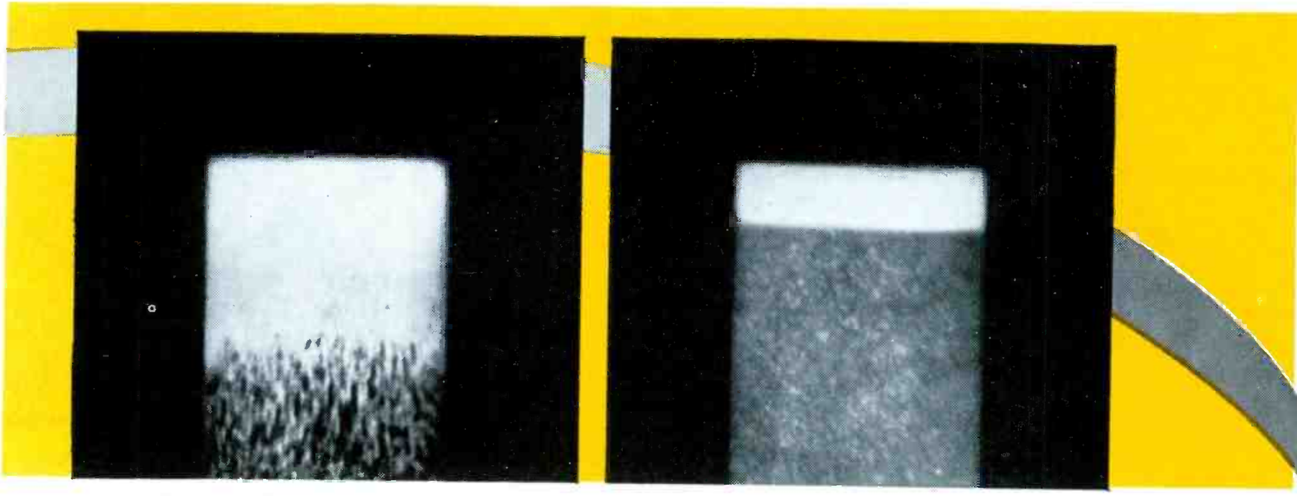
Test leads are about the most often used item found on the service bench. Naturally this makes them more vulnerable to wear, and the wires will often break inside the insulation at the point where the test lead leaves the prod handle or pin plug. This condition usually results in false meter readings, often sending the unsuspecting serviceman off on a time-consuming and unprofitable wild goose chase. To keep your test leads from breaking internally at these points, remove the pin plug and slip a couple of stiff, snug-fitting springs over the lead; then replace the plug. Slide one spring up to the point where the lead enters the prod handle, and slide the other near the instrument's plug as shown. The springs will provide additional support to keep the wires from receiving too much flexing or being bent at too sharp an angle.

Fuse Clips as Prod Hangers

If you need some neat way to hang up your pairs of test prods on a wall panel, here's how. Attach some fuse clips to the panel and just snap the prods into them as shown. Be sure to break off or bend the "ears" on the clips so that the prods will fit in easily and without damage.

Printed Board Sockets

The next time you have to replace one of those wafer-type tube sockets used in the printed circuits of auto radios or other gear, here's a tip you'll find particularly helpful. Break the top socket wafer with a screwdriver or knife, tip the chassis over and heat the socket contacts from the underside. The contacts will then effortlessly drop out one by one on the bench.



Inherent physical superiority of Sylvania's exclusive Sarong cathode, right, over a conventional cathode, left, is evident in this photomicrograph comparison. The texture, thickness, sharp coating edges and overall uniformity of Sarong represent major improvements in the heart of the electron tube never before achieved in mass production.

Only Sylvania has SARONG—

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Fewer call-backs due to intermittents and shorts . . . reduced noise and less arcing...these are some of the benefits available to you *now* with this "can't be copied" Sylvania development.

The Sarong cathode is a completely new development that transforms conventional sprayed cathode coating into a thin uniform film, precision-wrapped and securely bonded, around each cathode sleeve.

Now in use in nearly 1 million receiving tubes, Sylvania Sarong is a field-proven development setting new standards of efficiency and quality in electron tube performance.

First tubes to incorporate Sarong are tv tuner types 6BZ7, 6BQ7A, 6BC8 and 6BS8. Eventually Sarong cathodes will be utilized in a full line of Sylvania receiving tubes.

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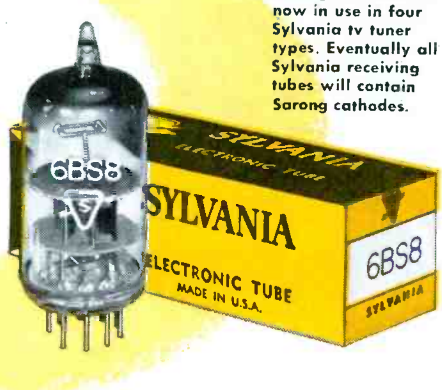

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Shaving Mirror Aids Servicing

A magnifying shaving mirror is a useful gadget to keep around the radio-TV service bench. You can use it to view a TV picture when working behind the set. And, when you have a hard time seeing into a dark corner of a chassis or cabinet, you can use it to reflect light. When you need to concentrate heat on various circuit parts to find an intermittent, but someone else is using your heat lamp, use the mirror to direct the rays of the sun on the suspected parts. When working on a tiny soldering job (coils and such), you can also use the mirror's magnifying quality to advantage. In addition, when you have to do some work on the inside of a cabinet, why work by feel alone when the mirror can let you see what you are doing?

Soldering 'Trough"

When soldering in a circuit where there's a danger that drops of hot solder will fall down among parts and wires, you'd better make a "trough" to roll the drops out onto the bench. Take a piece of thin cardboard about 1" wide and 12" long and fold it lengthwise down the middle. Lay one end under the joint you are soldering, and rest the other end on the bench as shown.

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Detachable Cord for Your Gun

Do you waste a minute or more untangling the cord of your soldering gun every time you take it from the tool kit? Chances are that you do. If you've ever wished your gun had a detachable line cord, why not give it one? Just take your soldering gun apart, unsolder its power cord, widen the opening in the bottom of the pistol grip handle with a file, and install a male AC connector to fit your cheater cord. Use self-tapping screws as shown to mount the connector. This arrangement will also save space in your tool kit, since you will use the same "cheater" cord for TV sets.

Gadget Bag is Meter "Caddy"

Those VTVM's, VOM's, and other small portable test instruments that are carried to the job on house calls are delicate instruments and should receive the best of care. The bang-about wear and tear conditions present in the average technician's tool box are something most meters can't withstand too long. For those who want long meter life, a photographer's gadget bag is an ideal instrument caddy. Most gadget bags are lined with shock-absorbing material and have compartments roomy enough to accept the average VTVM or VOM. They are mighty easy to carry, too. You can buy one from most any photographic store for a small price compared to the cost of a new VTVM or VOM.

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CAT. NO. Printed Circuit Types	CAT. NO. Regular Standard Types	FREQ.	USE
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13-PH2	12-H2	262 KC	Output transformer
13-PH6	12-H6	262 KC	Output transformer with diode filter
13-PC1	12-C1	455 KC	Input transformer
13-PC2	12-C2	455 KC	Output transformer
13-PC6	12-C6	455 KC	Output transformer with diode filter
13-PC7	12-C7	455 KC	Input transformer for battery radios
13-PC8	12-C8	455 KC	Output transformer for battery radios
13-PC9	12-C9	455 KC	Input transformers for AC-DC radios
13-PC10	12-C10	455 KC	Output transformer for AC-DC radios
	12-C11	455 KC	IF transformer (G.E.-RTL 143 and 163)
	12-C12	455 KC	Tapped Pri. I.F. transformer
	12-C45	455 KC	Discriminator
	13-W1	1500 KC	Input and interstage transformer
	13-W2	1500 KC	Output transformer
6203-PC	6203	4.5 MC	Input or interstage transformer
6204-PC	6204	4.5 MC	Discriminator transformer
6205-PC	6205	4.5 MC	Ratio detector transformer
6206-PC		4.5 MC	Ratio Det. (GE-RTD-026)
6207-PC		4.5 MC	Ratio Det. (GE-RTD-025)
6208-PC		4.5 MC	Ratio Det. (GE-RTD-C20)
1463-PC	1463	10.7 MC	Input or interstage transformer
1464-PC	1464	10.7 MC	Discriminator transformer
	1464-WB	10.7 MC	Discriminator 900 KC Peak to Peak
1465-PC	1465	10.7 MC	Ratio detector transformer
	1465-WB	10.7 MC	Ratio detector 800 KC Peak to Peak
	6260	21.25 MC	I.F. Transformer
	6261	21.25 MC	Discriminator transformer
	6262	21.25 MC	Ratio detector transformer
6230-PC	6230	44 MC	TV Converter I.F. Transformer
6231-PC	6231	44 MC	TV First I.F. Transformer
6232-PC	6232	42.5 MC	TV second I.F. Transformer
6233-PC	6233	42.5 MC	TV third I.F. Transformer
6234-PC	6234	44 MC	TV fourth I.F. Transformer

Miniature I.F. Transformers for printed circuit transistorized applications. These miniature I.F. Transformers have tuned primary and untuned secondary windings. Proper impedance match between primary and secondary insures optimum performance.
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CAT. NO.	FREQ.	SPECIFICATIONS
2031	455 KC	10K Ohm pri. to 600 Ohm Sec., Input
2032	455 KC	10K Ohm pri. to 1000 Ohm Sec., Output
2041	455 KC	25K Ohm pri. to 600 Ohm Sec., Input
2042	455 KC	25K Ohm pri. to 1000 Ohm Sec., Output
2051	455 KC	100K Ohm pri. to 1000 Ohm Sec., Input

Sub-Miniature I.F. Transformers for printed circuit transistorized applications. To our knowledge the smallest I.F. Transformers in existence. Ferrite cup core construction permits the use of extremely small shields without adversely affecting transformer operation. A high impedance, tapped primary winding coupled to a low impedance secondary provides optimum energy transfer between stages.
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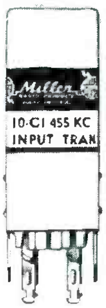
CAT. NO.	FREQ.	SPECIFICATIONS
9-C1	455 KC	25K Ohm pri. to 600 Ohm Sec., Input
9-C2	455 KC	25K Ohm pri. to 1000 Ohm Sec., Output



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CAT. NO.	FREQ.	USE
10-C1	455 KC	Input transformer
10-C2	455 KC	Output transformer

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TEMPERATURE-COMPENSATING CAPACITORS

Where and why they are used, plus some hints on making replacements in tuners and critical oscillator circuits. — by George D. Philpott

With understandable reluctance, some TV technicians shy away from making relatively minor tuner repairs (such as replacement of small capacitors) simply because they feel they are not well enough versed on temperature - compensating capacitors, circuit tolerance requirements, installation procedures, and the exacting alignment job which sometimes must follow a tuner repair. However, by keeping a few significant facts in mind about these apparently difficult problems, a serviceman may solve them profitably—in addition to providing greater satisfaction to his customers.

Approaching the task, it hardly seems necessary to explain in any great detail why RF and oscillator circuits in the average FM or TV tuner present a touchy problem. We know this from experience — and some of it sad, indeed. Change one relatively insignificant-looking capacitor in the "fingers-off" section of a TV tuner, installing a unit which does not meet every circuit requirement, and "ouch!"—you've got trouble. On the other hand, use the correct type of capacitor, paying careful attention to circuit dress, and high-frequency circuits like tuners are not much more difficult to repair than any other section of a television receiver.

The first thing to remember concerning capacity requirements in a resonant RF circuit is that *oscillator-frequency drift will occur unless the capacitors employed in the circuit are designed to compensate for temperature variations.* Receiver manufacturers have known this for years and design their equipment accordingly. So, the service technician must watch out for these special capacitors in RF circuits, lest his tuner jobs get sadly fouled up.

To avoid time-consuming errors along this line, you should have a reasonable working knowledge of at least two different types of temperature-compensating capacitors in common usage—namely, the negative-positive-zero (NPO) and the negative-coefficient N-type.

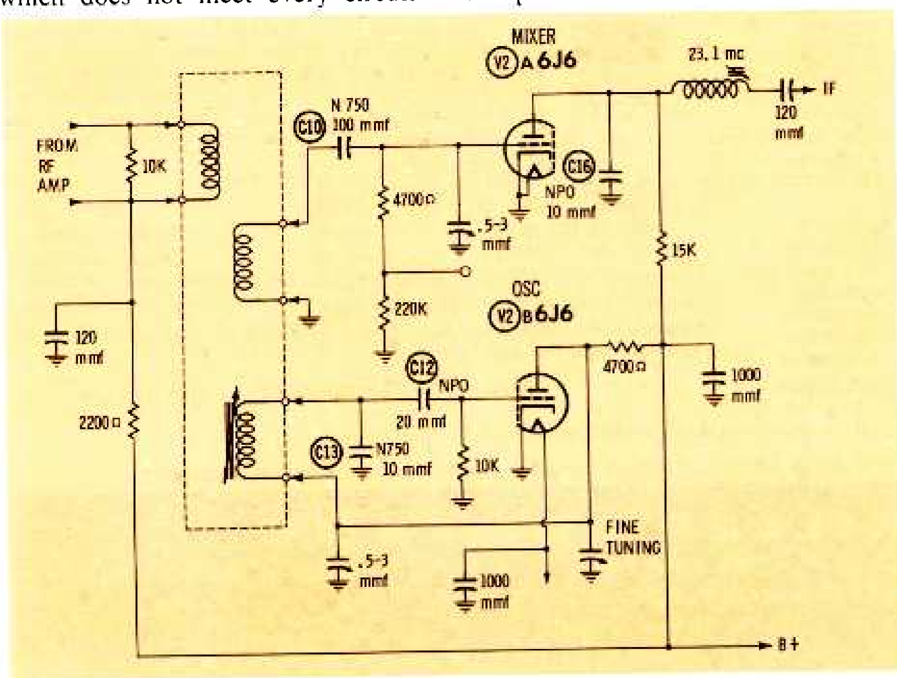


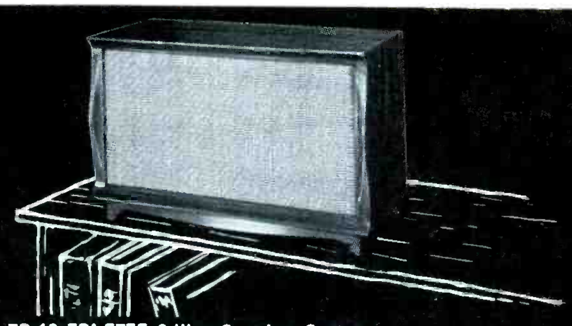
Fig. 1. Temperature-compensating capacitors help stabilize RF oscillator.

The NPO capacitor is commonly employed in tuners for DC isolation and coupling purposes. In Fig. 1, for example, C12 (20 mmf, 500 WVDC) is being used for coupling the oscillator grid to the tuned tank. If this unit were permitted to change capacitance in either direction, the oscillator frequency would be altered. Also in Fig. 1, we find NPO unit C16 "holding the line" capacity-wise in the tuned plate circuit of the mixer. If a capacitance change occurred at this point in the circuit, the tuned frequency of the stage would vary.

At this point, it is worth mentioning that NPO-type capacitors are not restricted to the RF sections of television receivers, but also have their place in the video, sound, and even sweep sections of many models. Fig. 2 depicts an NPO unit (C30) being used as a coupling capacitor in the sound take-off circuit at the plate of the video detector. (A change in capacitance here would cause misalignment in the 4.5-mc tuned circuit of the first sound IF stage.) Some FM and TV receivers also use an NPO capacitor in the tuned secondary circuit of the discriminator or ratio detector. Furthermore, many receivers have NPO units in critical portions of the vertical and horizontal oscillator sections.

Studying all these various uses, we can conclude that these special capacitors are a "must" in circuits where frequency stability is important. They are not needed, however, in most plate, screen, and cathode bypass applications, nor in noncritical coupling circuits.

NPO's may be purchased in numerous values within the approximate range of 0.5 to 300 mmf. All are designed to avoid appreciable change in capacitance over the



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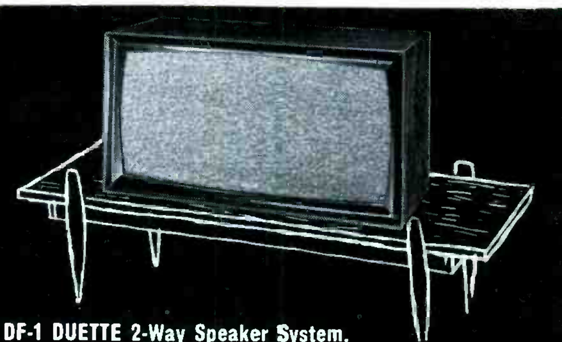

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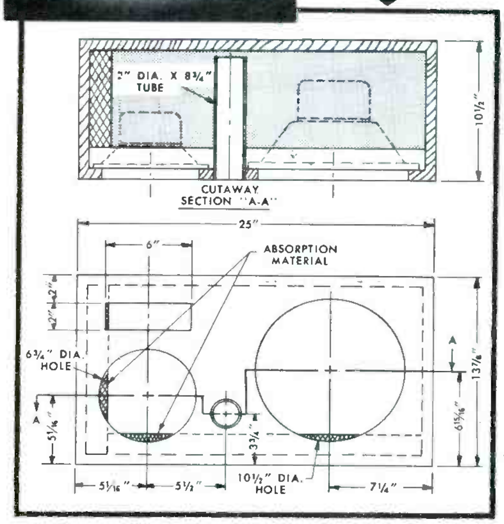

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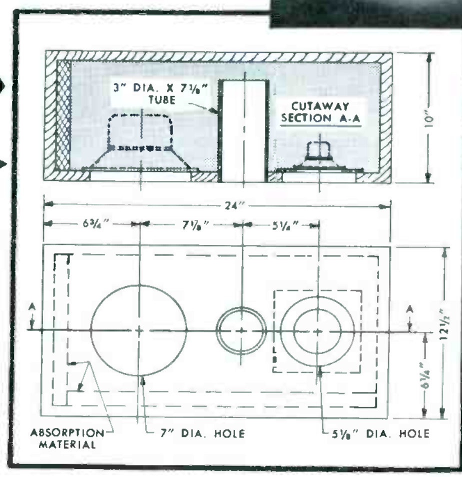

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temperature range from −20° to +85°C. In other words, the NPO will hold capacitance (within the rated tolerance) to 185°F—hot to the touch! In this day of compact circuitry, we can easily understand the necessity and usefulness of this type of capacitor.

The N750 type of capacitor is different from the NPO and general-application types, inasmuch as it undergoes a reduction in capacitance value as temperature increases. Precisely speaking, it decreases in capacitance at the rate of 750 parts per million for every degree C of temperature rise. So here we have a capacitor capable of resisting frequency drift due to an increase in capacitance of the rest of the circuit. N-values besides the popular N750 are available in a wide combination of temperature coefficients, capacitances, and tolerances. The N750, and counterpart units with negative temperature coefficients of anywhere from 33 to 1500 ppm/°C, are available in capacitance values from about 3.3 to 750 mmf. They are extensively used in tuners to form part of the capacitance across the various tuning coils. Note, for example, C10 and C13 in Fig. 1. When a temperature rise attempts to cause an increase in the general shunt capacitance of the tuned circuit, the N750 unit compensates for this effect and holds the over-all circuit capacitance reliably constant. By proper selection of the right values of N750-type units, it is possible to compensate for nearly any temperature-induced frequency deviation.

Fig. 3 shows N750-type units being used in conjunction with an NPO-type capacitor in an oscillator circuit of an FM radio set. Even though this receiver has automatic frequency control, it is sometimes desirable to operate the set with the AFC feature disabled (for example, when listening to a weak station near a strong one on the dial). Thus, the set manufacturer considered it advisable to minimize oscillator frequency drift by using temperature-compensating units.

Sometimes a capacitor with a certain desired combination of capacitance value and temperature coefficient is not immediately available. In such cases, an NPO unit can be

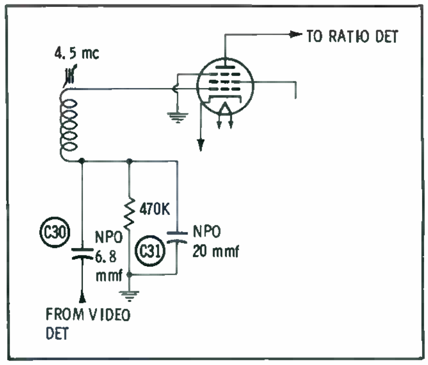


Fig. 2. NPO units in sound take-off circuit prevent drift in the sound IF.

paralleled with an N750 to give a great variety of intermediate capacities and temperature coefficients. The correct values to use can be determined by a simple formula:

Multiply the desired capacity in mmf by the desired temperature coefficient, and divide the answer by 750. The resultant figure will be the value in mmf of the N750 unit needed. To find the value of the proper NPO capacitor, subtract the computed value of the N750 unit from the desired value; the result will be the required capacitance of the NPO unit.

Example:

A 100-mmf capacitor is needed for repairing a tuner, and its desired temperature coefficient is to be N330 — corresponding to a negative change of 330 parts per million per degree Centigrade.

Multiply: 330 X 100 = 33,000;

divide: 750/33000 = 44 mmf, the N750 value;

subtract: 100 − 44 = 56 mmf, the NPO value.

For all practical purposes, units of the nearest standard values may

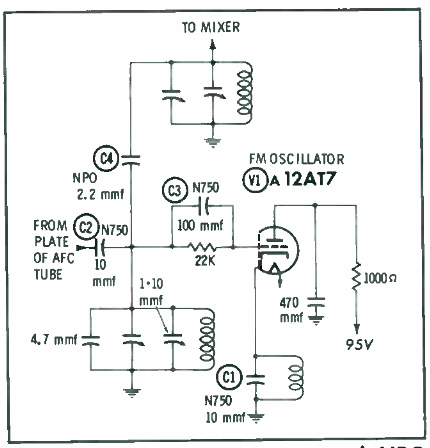


Fig. 3. FM tuner uses N750 and NPO capacitors as added "drift insurance."

be used. However, in the rare cases where it is necessary to have the exact capacitance and temperature coefficient, units of the *same type* may first be paralleled to achieve the desired values. These may then be combined according to the formula.

Important note: Before using any combination of capacitors to replace a single unit, consider these two points—the space available for the replacement combination, and the possible increase in stray capacitance due to the additional connecting leads, etc.

To aid the service technician in identifying temperature-compensating capacitors as to type, it would be a good idea to review a few facts about color coding. Tubular ceramic units with a 5-dot code have the "temperature-coefficient" dot at the left end. (This dot can be recognized by its position, extremely close to the end of the component.) On ceramic disc capacitors, the "temperature" dot is located beneath the value and tolerance dots—on the side of the disc toward the leads. The NPO-type capacitor is coded black, the N220 yellow, the N330 green, and the N750 violet.

As a further hint to technicians making tuner repairs, it is well to remember that "weak" tuners may sometimes need only replacement of a coupling capacitor—say the unit between the local oscillator and mixer. Snowy pictures and poor sensitivity quickly result from a defective capacitor in any coupling network. Defective bypass capacitors usually result in badly distorted output, recognized as overloading, interference patterns in the picture, etc.

By adhering to the wise rule of not making any component changes in the critical circuitry of today's tuners unless the correct replacement is recognized and used, the average technician will encounter little real difficulty in handling some seemingly "impossible" jobs like an expert.

If any mystery remains concerning these small temperature-compensating capacitors, perhaps it concerns the brain-tickling question, "What about capacitors with *positive* temperature coefficients?" The answer is simple—these are the "firecrackers" that made temperature compensation necessary in the first place! ▲

NOTES on test equipment

by Les Deane

A Square Deal

Fig. 1. The Model 1715 may be used with scope to test amplifier response.

With the growing need for precision instruments to perform specialized tasks, I thought it fitting to report on one such unit this month. My selection was the Model 1715 square wave generator featured in Fig. 1, which is manufactured by RD Instruments (a division of Hickok Electrical Instrument Co., Cleveland).

Although the Model 1715 has many general applications, it is primarily designed for use in conjunction with an oscilloscope to check frequency response and phase-shift characteristics of audio and video amplifiers.

Specifications are:

1. *Power Requirements—115 or 230 volts ±10%, 50/60 cps; power consumption 195 to 210 watts; self-regulated supply overcomes variations in line voltage; 2.5-amp line fuse provided.*
2. *Generated Frequency — 6 ranges from 1 cps to 1 mc; symmetry control provided for balanced square wave signal; frequency dial calibrated linearly from 1 to 10.*
3. *Output Connectors—75-ohm coax-type BNC and 600-ohm banana jack; low impedance output 7 volts p-p with .02 u-sec. rise time; high impedance output 55 volts p-p with .1 u-sec. rise time; amplitude control provided for each output plus a 0 to 60 db step attenuator for 75-ohm output.*
4. *Synchronized Operation — requires positive-going sync signal or sine wave; recommended peak signal 5 volts, minimum 3 volts; type BNC coax-input connector provided.*
5. *Size and Weight—10" x 14½" x 15¾"; 30 lbs. net.*

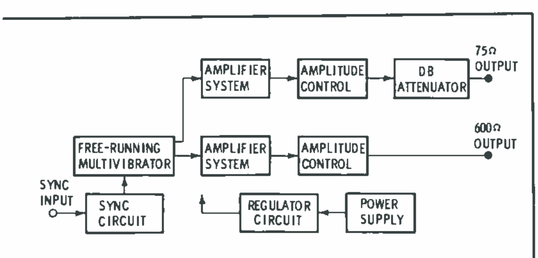


Fig. 2. Block diagram of Model 1715 Generator. Note its dual output feature.

The 1715 is housed in an aluminum case equipped with a carrying handle; all controls and terminals are located on the front panel. On the left side of the panel, you'll find all of the controls and jacks associated with the 75-ohm output, while those associated with the 600-ohm output, plus a frequency range selector, are located on the right. The large dial is a fine frequency adjustment which is calibrated in divisions of .2 from 1 to 10. The control located directly below the dial, labeled SYMMETRY, is used in equalizing the positive and negative segments of the generated wave to produce a symmetrical output signal.

The chassis is of vertical construction, and with the wrap-around sides of the case removed, is easily maintained. Heat rise in the instrument is reduced by both natural and forced air ventilation. When I first turned the unit on, I thought the humming sound might be the generator grinding out the square waves, but I found that it was actually the motor on a small exhaust fan mounted in the rear of the case.

The instrument employs a total of 15 tubes (including power rectifier and regulators) in circuits sectionalized as shown by the diagram in Fig. 2. The heart of the generator is a free-running, plate-coupled multivibrator, which produces the square-wave signals. By switching in various capacitors, and by adjustment of the frequency vernier, this circuit oscillates over the range of 1 cps to 1 mc.

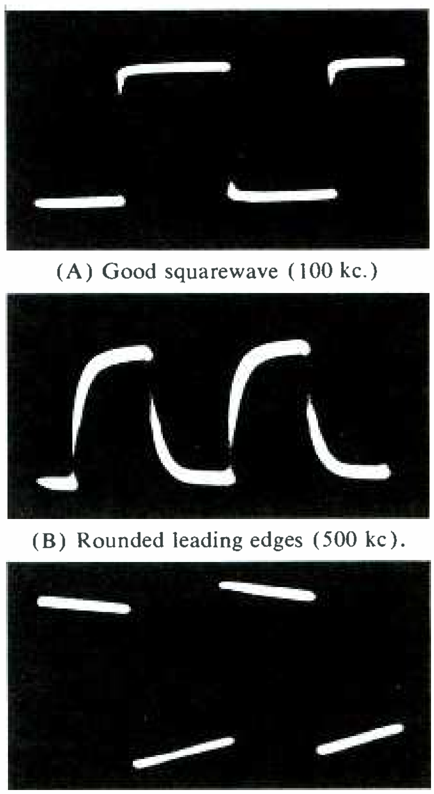
The multivibrator can also be controlled by an external sync signal. The sync circuit amplifies, shapes, and rectifies positive-going pulses. The resulting trigger voltage is then applied to one of the plate circuits of the multivibrator for synchronized operation.

Two separate channels are employed for the amplification of the generated square wave. Both channels incorporate clipper amplifiers, power amplifier, and individual amplitude controls. The 75-ohm channel also features an output step attenuator which is calibrated in decibels. Incidentally, the two outputs may be used either one at a time or simultaneously.

The low-voltage supply makes use of a power transformer and 5U4GB rectifier, while the regulator circuit employs three separate tubes to insure a constant plate supply free of ripple and noise.

Since square waves possess such steep leading and trailing edges, they are ideal for testing wide-band amplifiers. A square-wave signal is actually a combination of sine waves at the fundamental and odd harmonic frequencies. For most practical test applications, a square wave can be considered to contain frequencies from 1/10 to 10 times the fundamental rate. Thus, if we use a 60-cycle square wave as a test signal, we can consider that it represents a frequency range of around 6 to 600 cycles. It should be pointed out, however, that the frequency range represented by signals from the Hickok generator is somewhat greater than this, as evidenced by the rapid rise time specifications of .02 and .1 microsecond.

For an actual application of the generator, let's suppose you encounter a TV picture that exhibited smear or loss of detail. Such symptoms are an indication of inadequate frequency response in the video amplifier stage. A video amplifier

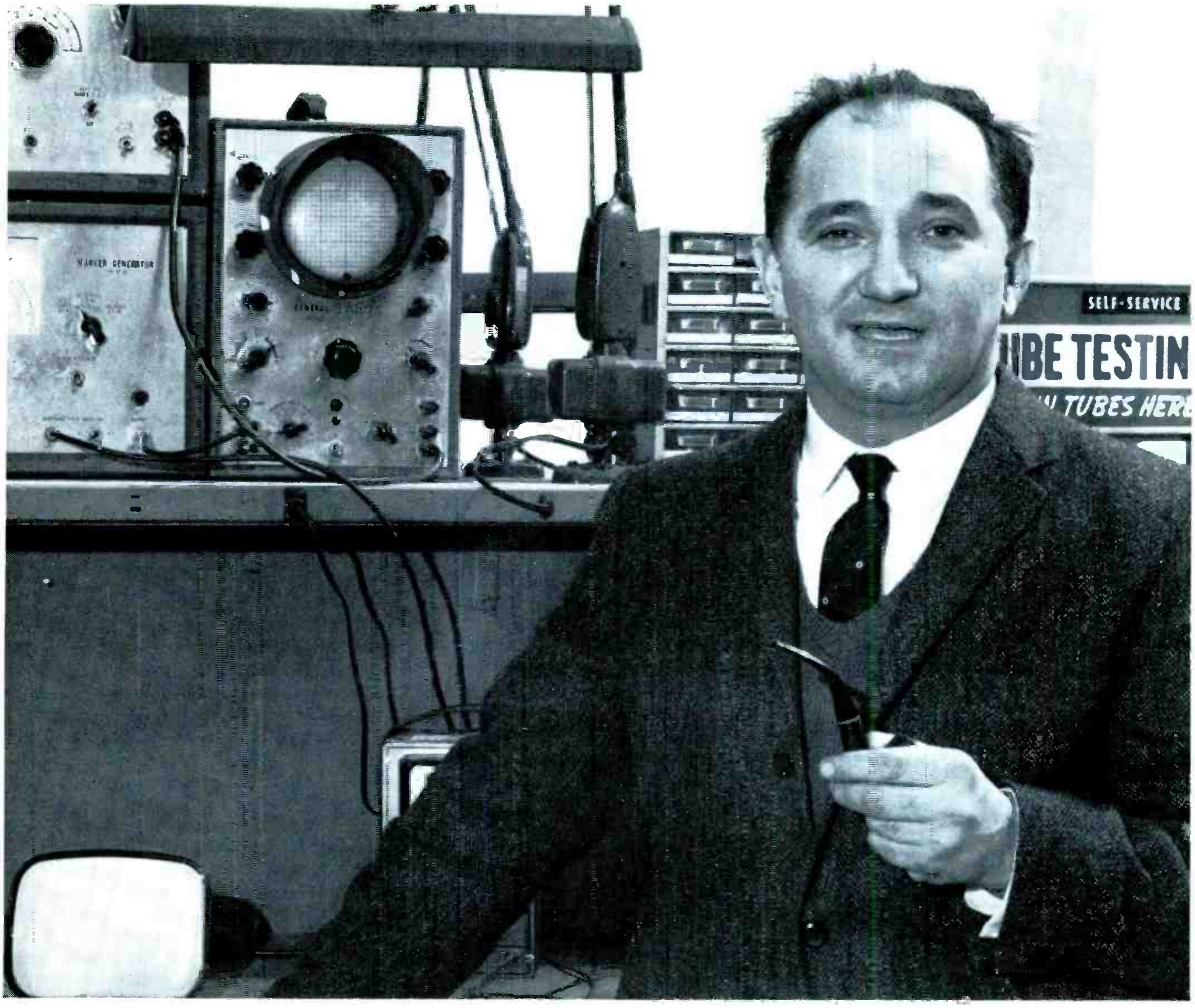


(A) Good squarewave (100 kc.)

(B) Rounded leading edges (500 kc).

(C) Sloping top (60 cps).

Fig. 3. Output waveforms of a typical video amplifier under square-wave test.



"YOU'LL RARELY SEE a General Electric 'Designer' in the shop,"

says Richard Vician, West Branch Manager of Television Engineers Inc. and Certified Television Service Inc., Chicago, Ill.

"Our men seldom have to pull the chassis of a General Electric 'Designer'. They can do 9 out of 10 repairs in the home, because most key check points are easy to get at when you take the back off."

Mr. Vician and Glenn W. Geist, President of the firm—Television Engineers Inc. and Certified Television Service Inc.—agree this makes money.

As Dick Vician puts it: "The easy availability lets us get more service calls done in a working day . . . more calls per man and more profitable operation. It means happy customers, too, because their bills are easier to take and sets stay in service."

You can leave the "Designer" chassis in the set and still get at *both sides* of the printed boards. All tubes are easily replaceable. Fuses are accessible and you can get at key check points.

Precision Etched Circuitry is the name General Electric gives to its reliable, uniform circuitry. Each board has a *painted* schematic so that you can find your way through it easily. Service one and you'll be thoroughly familiar with it.

"Designer" TV—the easiest-to-service sets in television! General Electric Company, Television Receiver Department, Syracuse, N.Y.

GENERAL ELECTRIC

should have fairly flat response from about 30 cycles to over 3 mc for good, clear picture reproduction.

Before I performed a square wave test on the video amplifier stage of a set in our lab, I first checked the response of the scope I intended to use. If the scope itself introduces any distortion to the wave, you must take this into consideration when testing the amplifier.

Since peaking components are usually added to both the input and output circuits of a video amplifier in commercial receivers, I found that it's best to connect the generator output across the video detector load rather than the grid of the amplifier tube. The AC input to the scope is attached across the plate load of the tube.

In Fig. 3, I have shown the output waveforms obtained from a typical video amplifier test. Note that A shows response with a square-wave frequency of 100 kc, which indicates that video circuit response is flat from at least 10 kc to 1 mc. Running the generator frequency up to 500 kc, I obtained the waveform in Fig. 3B, which exhibits excessive rounding off of the leading edge. This is indicative of very poor response at the higher frequencies, in this case above 5 mc. With the generator frequency at 60 cps, the flat top of the square waves became tilted as shown in Fig. 3C, which tells us that response is down at 6 cps and below.

I noted that the output of the Model 1715 remained absolutely constant in amplitude over its entire frequency range, which is an important factor in making precise frequency-response and phase-shift tests. And for hi-fi servicing, you couldn't ask for more exacting specs in a square-wave generator.

Let's Check Tubes

The portable instrument pictured in Fig. 4 is the most recent addition to the line of tube testers manufactured by Vis-U-All Products Co., Grand Rapids, Mich. Identified as the Model V1003, it is designed for speedy tube testing, with a simplicity of use suitable for self-service counter operation.

This new tester incorporates features of an earlier model, the V1002, plus two separate functions for testing transistors and portable radio batteries. Physical improvements include a wrap-around plexiglass meter, increased visibility of the setup markings on the panel, and a newly-styled leatherette-covered case with a lid locking provision. The Model V1003 is sold complete with "cheater" type power cord, test leads, and adapter cable for checking picture tubes.

Specifications are:

1. *Power Requirements — 105/125 volts, 60 cps; power consumption in standby less than 5 watts; one self-contained 1.5V battery; overload indicator and meter fuse provided.*
2. *Tube tests—emission automatically indicated on* BAD-?-GOOD *scale of panel meter; grid-to-cathode and heater-to-cathode leakage and shorts, as well as gas content, indicated by neon bulb on panel; six test sockets provided.*
3. *CRT Test — 53° to 90° picture tubes checked by using special adapter cable, general operating condition of tube indicated on panel meter.*
4. *Transistor Tests—relative leakage and gain measurements for all medium and low power* PNP *and* NPN *types, special* GOOD-FAIR-POOR *leakage scale and two test sockets provided.*
5. *Battery Test — checks 1.5 to 90 volt units under load conditions; battery evaluated by reading on linearity scale of meter; two test leads provided.*
6. *Size and Weight — portable case 17" x 6" x 12"; 16 lbs.*

Examining this tester in the lab, my preliminary analysis was confined to the panel. The instrument makes use of only 6 test sockets, including a separate octal type for 0Z4's, and a 7-pin miniature type for portable radio tubes such as the 1R5, 1U4, 3S4, etc. The lower-left corner of the panel contains a conventional interlock receptacle for the power cord. You might consider this as an on-off switch, for power is applied to the unit automatically when this connection is made. Directly above the interlock is an 11-position filament selector which provides a choice of heater voltages from 1.5 to 117 volts. In the lower right corner, you'll find a SHORT TEST lever and METER REVERSE button. The shorts lever has two positions — one for filament-to-cathode and the other for grid-to-cathode shorts and leakage indications. With the neon bulb as an indicator, I found the sensitivity of the leakage test to be about 3.5 megohms. When

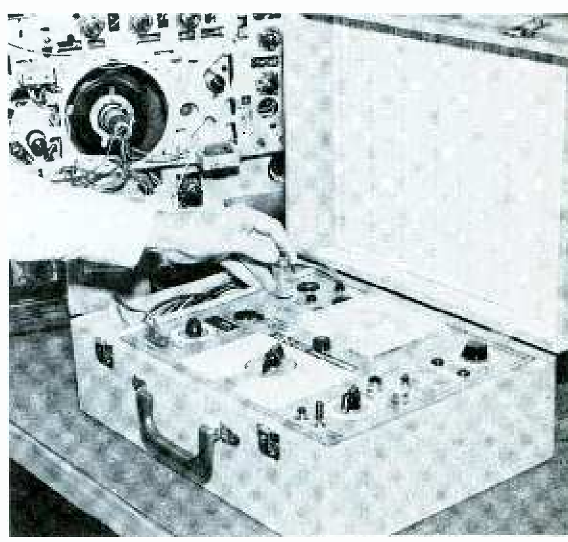
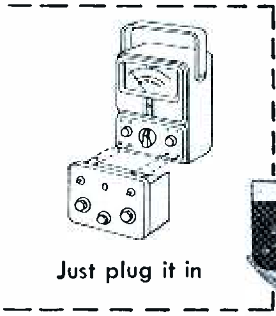


Fig. 4. The Model V1003 has a built-in compartment for leads and adapter.

New Simpson "Add-A-Testers"



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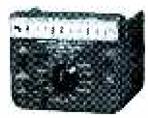
Frequency Range: 50 cycles to 3000 cycles

AUDIO WATTMETER, Model 654......**$18.95**
Load Ranges: 4,8,16,600 ohms
Wattage: Continuous 25 watts (8,600 ohms)
50 watts (4,16 ohms)
Intermittent 50 watts (8,600 ohms)
100 watts (4,16 ohms)
Accuracy: ±5%, with 260 ±10% nominal
Direct reading scale from 17 microwatts to 100 watts

MICROVOLT ATTENUATOR, Model 655..**$18.95**
Ranges: 2.5 microvolts to 250,000 microvolts continuously variable in decade steps
Frequency: DC to 20 KC
Accuracy: ±1db

BATTERY TESTER, Model 656.........**$19.95**
Checks all radio and hearing aid batteries up to 90 volts at the manufacturer's recommended load, or any external load.



Note: All Simpson 260 Adapters provide for normal 260 usage without disconnecting the adapter.

I checked several gassy tubes in the Model V1003, I noted that the short bulb either flickered or glowed continuously, thus indicating the tube should be rejected.

The reverse button is used to obtain proper meter deflection during the emission check for certain tubes. Also in this section of the panel, is a load adjustment which has linear calibrations from 0 to 100. It must be set to the exact value prescribed in the tube setup information.

In the center of the panel there is a 4" meter at the top, with a 1/500-amp fuse directly below it, and a large area at the bottom devoted to a 12-position switch surrounded by tube data. Each position of this switch is numbered, and the different positions permit the operator to make various tube-element connections for 5 of the 6 panel sockets. Although there are over 400 different tube settings listed on the chart inside the lid of the tester, almost 100 of the more common types are printed on the panel in groups around the selector switch. A load setting is given after each listing; therefore, if you know the proper filament voltage, you need not refer to the large lid chart.

In a few cases, I noticed that a "hot" tube (i.e., one with an emission higher than average) caused the meter pointer to go off scale. By quickly changing the load setting, however, I was able to bring the needle back to a reasonable reading and complete the test. When testing tubes in any checker, it's always a good idea to have the tubes warmed up. A hint in the V1003 manual suggests that you pre-heat them by pulling the low-voltage rectifier in those sets employing parallel filament circuits. This leaves the other tubes lit, yet eliminates shock hazard and excessive conduction in one tube due to removal of another.

One extra feature of the Vis-U-All unit is its ability to test portable radio batteries. The section of the panel devoted to the battery test is shown in Fig. 5. Two test leads are supplied—one red and one black. The selector switch above the test jacks is marked off in 11 different battery potentials, each representing a given load for the particular unit to be tested. Observing the correct polarity, the test leads are placed across the battery terminals, and

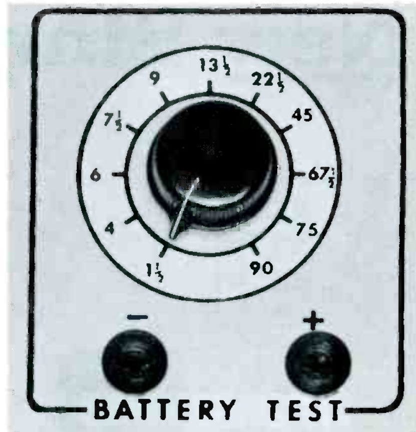


Fig. 5. Provisions for checking portable radio batteries on Vis-U-All tester.

the condition of the battery is indicated on the linear 0 to 1 scale of the meter. If the reading is not .8 or better, the battery should be replaced.

The other extra of the Model V1003 is its transistor test (see Fig. 6). On the right side of the panel, you'll find two transistor sockets and a test button. Since the test circuit makes use of a built-in penlight cell, the battery voltage should be checked before a transistor is tested. This is accomplished by inserting a 1000-ohm resistor between collector and emitter on either test socket. If the battery is satisfactory, the meter should read .8 or better.

To test a transistor, you must first determine whether it is a PNP or NPN type. After plugging it into the appropriate socket, leakage is automatically indicated on the bottom meter scale which is calibrated in three sections—GOOD-FAIR-POOR. In the gain test, you merely depress the gain button and note

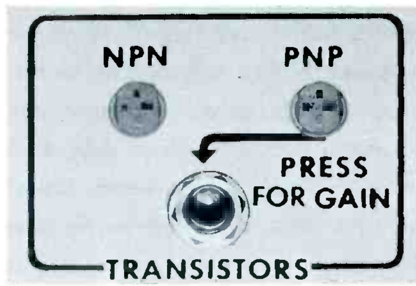


Fig. 6. Transistor test section of V1003. Leakage and gain are read on meter.

the increase in meter deflection. If the increase is at least one division on the gain scale, as compared to the leakage reading, the transistor is okay. A shorted transistor will cause a full-scale reading in the leakage test, while an open one will produce no deflection in either test.

To sum up my investigation of the Model V1003, I found it to be one of the fastest tube checkers I have ever used and, for this type of tester, it is reasonably accurate. Since it is simple to operate, it is an ideal self-service instrument for the front counter of any service shop.

New Waveform Watcher

Waterman Products Co., Inc. of Philadelphia, has recently developed a 5" oscilloscope especially for the TV and hi-fi service industry. Identified as the Model S-16-A *Craftscope,* it features portability and a usable frequency response from DC to 7 mc. The instrument comes complete with combination probe and instruction manual.

Specifications are:

1. *Power Requirements — 105/125 volts, 50/400 cps; power consumption 65 watts; 2-amp line fuse provided.*
2. *Vertical Input System—wide-band response within 2 db from DC to 3.58 mc, +½—3 db to 5.7 mc, sensitivity 100 mv/cm; high-sensitivity response +½—3 db from 3 cps to 800 kc, sensitivity 7 mv/cm; 400 volts maximum input; input impedance 1 megohm shunted by 40 mmf; pulse rise time .07 microsecond; both DC and AC input connectors provided.*
3. *Horizontal Input System — frequency response +½—3 db from 3 cps to 300 kc; sensitivity 28 mv/cm; input impedance 1 megohm shunted by 120 mmf.*
4. *Sweep System—internal frequency range of from 5 cps to 50 kc in four ranges, preselected sweep rates of (V) 30 and (H) 7,875 cps; external sweep and sync input on front panel; ± internal and line sync with amplitude and phase*

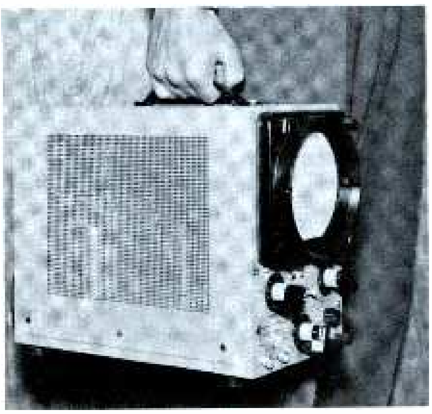


Fig. 7. Waterman's Model S-16-A wideband 5" scope is compact and portable.

"Forget that lousy ruby, Ed. Let's pry this Jensen cartridge loose."

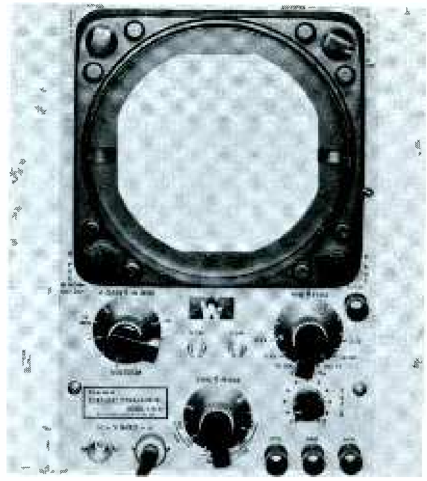


Fig. 8. Close-up view of the Craftscope showing the details of its front panel.

adjustments provided.

5. *Internal Calibration—neon relaxation oscillator provides reference signal; with calibration control preset, peak-to-peak values are indicated by vertical scan in cm times dial indication; 1 screen division= 1 cm.*
6. *Z-Axis Modulation — blanking input provided on front panel for control of beam blanking or intensification; positive signals required for blanking.*
7. *Other Features — phase reversal switch and vertical balance control on front panel; edge-lit graph screen with dimmer control; front mask designed for camera adapter; combination 1-to-1 and 10-to-1 probe supplied.*
8. *Size and Weight — 12½" x 7" x 10½"; 18½ lbs.*

The Model S-16-A is one of the most compact 5" scopes I have ever used. It features a short, flat faced CRT housed in an all-metal case only slightly over one-half cubic foot in total size. The mask assembly consists of a graticule with calibrated grid lines that can be illuminated to different intensities through use of a special dimmer adjustment. This assembly also accommodates conventional clamp-on camera equipment for taking pictures of waveforms displayed on the screen.

To familiarize you with the operation of the *Craftscope*, I have shown a close-up of its front panel in Fig. 8. One feature not too apparent when you first examine the instrument is the location of the phase-reversal switch. It is actuated by the same knob that controls vertical positioning of the CRT beam, which is found in the lower-left corner of the mask assembly. The switch serves to invert the pattern on the screen by reversing connections to the vertical deflection plates; thus, a response curve can be displayed to agree with the polarity shown in any manufacturer's alignment instructions.

The only other adjustment not plainly marked on the front is the dimmer adjustment for the illuminated graticule. This is a small lever protruding from the

Fig. 9. Probe for the *Craftscope* has reversible tip for 1:1 and 10:1 inputs.

right side of the mask, as can be seen in Fig. 8. With the lever down, no light is reflected from the etched calibration lines; however, as the lever is moved upward, illumination increases.

When working with this scope to view various TV waveforms, I found the calibration feature very interesting. The method used to determine peak-to-peak amplitudes is somewhat different from that employed in most general-purpose instruments. In the first place, the graticule or calibration screen is marked off in centimeters, with both intersecting center lines subdivided into smaller divisions of .2 of a centimeter each. You'll find it isn't necessary to convert from centimeters to inches or from millivolts to centimeters in order to determine an ordinary peak-to-peak value in volts. To calibrate the vertical input circuit for amplitude measurements, you merely flip the VOLTS/CM selector to the CAL position and adjust the small V. CAL control until the calibration signal occupies four vertical squares (4 cm) on the screen. When measuring the unknown peak-to-peak value of a wave, you then set the VOLTS/CM selector to one of its .1 to 5 attenuation positions so that the vertical scan covers from 2 to 6 squares on the screen. The peak-to-peak voltage is equal to the number of vertical squares times the dial setting (.1, .2, .5, 1, 2, or 5). Since the height of the calibrated graticule is 10 cm, a 50-volt input signal gives full-scale deflection with the attenuator set at maximum (5). For viewing signals of higher peak-to-peak amplitudes, additional attenuation must be introduced either by changing the setting of the V. CAL adjustment for less deflection sensitivity, or by using the 10-to-1 attenuation factor of the probe supplied with the instrument.

This probe is pictured in Fig. 9. Note that it has a removable tip which provides for either direct or attenuated signal transfer to the vertical input. With the longer tip out, however, a 9-megohm resistor is placed in series with the input, and the attenuation is 10 to 1. When using the probe in this position, remember that all peak-to-peak readings must be multiplied by 10. ▲

THE TROUBLESHOOTER

ANSWERS YOUR SERVICE PROBLEMS

The Roots of Boost

The schematics for many receivers carry a warning not to measure the boost voltage at the cathode of the damper tube. In such cases, how and where should boost be measured for best results?

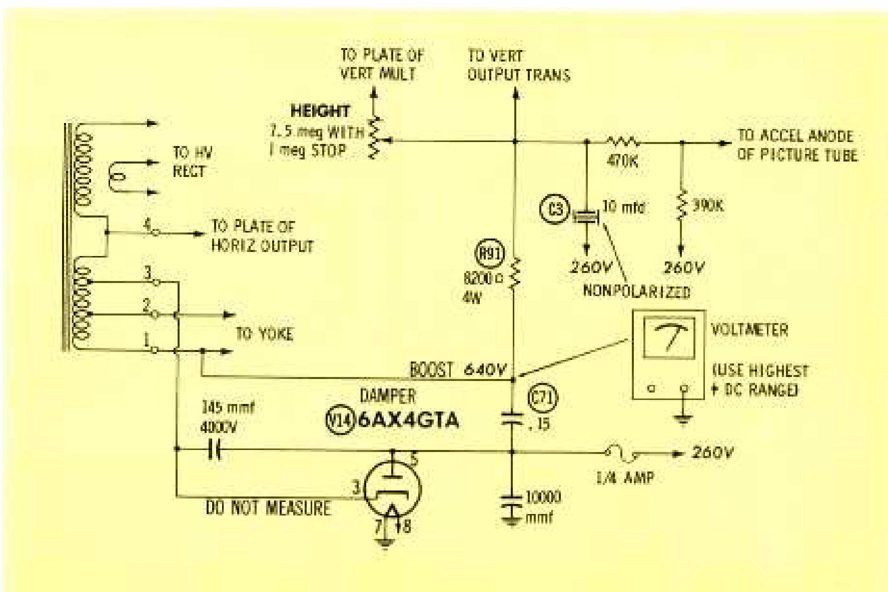
IGNATIUS TIZZANO
South Ozone Park, N. Y.

Begin at one of the load circuits which obtains voltage from the boost supply, and trace back until you find a connection going to the horizontal output transformer. At this point, you will usually find a capacitor corresponding to C71 in the attached diagram. (This is often a tubular unit of medium value, but it may be an electrolytic capacitor in some of the more recent models.) Boost voltage is developed across this component. In addition, C71 filters out high-amplitude flyback pulses; thus, the output-transformer terminal connected to C71 is established as the "bottom end" of the transformer. This means that DC voltage may safely be measured here. On the other hand, the damper cathode in many sets is connected to an intermediate tap on the horizontal output transformer—so it receives flyback pulses of sufficient amplitude to damage the input circuit of a voltmeter.

In practically all sets, the most convenient place to begin tracing the boost circuit is at the arm of the height control. Another handy spot is at the accelerating anode of the picture tube. Tracing back toward the horizontal sweep section, you will usually find that the boost line includes an RC filter network (R91 and C3 in the circuit shown). The arrangement of this filter follows a consistent pattern among various set designs, although a wide variation of resistor and capacitor values will be noted. Some receivers include two or more series resistors in the boost line, so check to make sure there are no resistors wired between your test point and the output transformer; otherwise, you will not be measuring the full value of boost voltage. In the occasional set which has the horizontal windings of the yoke in series with the boost line, measure boost on the load-circuit side of the yoke—not the flyback side.

Tongue-Tied

Please help us repair three identical TV sets (Hotpoint Model 17S301) which all have the same trouble symptom. The sound goes dead at irregular intervals, but it comes back as soon as the volume control is advanced. We have replaced



all audio tubes and coupling capacitors, as well as the volume control in each set; in addition, we've tried our shop speaker in place of the regular speaker. None of these efforts have produced any results.

A. G. HESHMATI

Carmel, Calif.

We've heard several reports of defective ratio-detector transformers in the General Electric and Hotpoint "U" chassis, which is of about the same vintage as the "MM" chassis employed in Model 17S301. Although not identical, the ratio-detector cans used in these two chassis appear to be very similar; so your trouble may be due to a defect in this component.

If the transformer isn't at fault, the next most probable trouble is a slight break (or a bad solder joint) in the printed wiring. Since it causes only an intermittent trouble, the defect is probably very small and hard to locate. So, instead of hunting all over the audio section for a bad spot, first try to localize it by means of a signal-tracing or signal-injection test.

Dimmit!

What would cause a Hallicrafters Chassis A1400D to have too much brightness, even with the control turned all the way down?

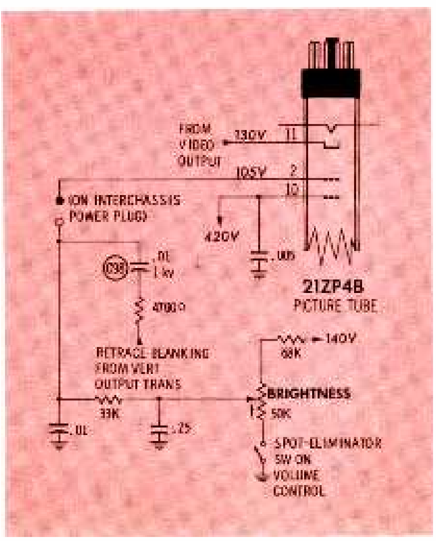
ROBERT L. WHEATON

Painted Post, N.Y.

Several troubles in the unusual CRT circuitry of this model could result in excessive and uncontrollable brightness. For one thing, the spot-eliminator switch (ganged with the receiver on-off switch and volume control) might have defective contacts. If it remained electrically open while the set was operating, there would be +140 volts on the picture-tube grid regardless of the brightness-control setting. Of course, this would result in a positive bias on the CRT.

Another very possible defect is leakage in the .01-mfd, 1000-volt capacitor C98, which couples a retrace-blanking signal from the vertical sweep section to the picture-tube grid.

Insufficient cathode voltage on the



CRT would have as serious an effect as excessive grid voltage. If you measure less than the normal 130 volts on the cathode, see if you have heater-to-cathode leakage in the picture tube or a partial short in the video-output plate circuit.

Hot Stuff

Every book says to use an isolation transformer when servicing "hot-chassis" receivers, but I still know many servicemen who don't use one. How do they get by?

ROBERT H. ARTHUR

York, Ala.

If you closely observe a technician working on a "hot" set without an isolation transformer, you may notice that he starts out by checking to see if the receiver chassis is connected to the earth-ground side of the AC line. (He can best do this by momentarily bridging a neon lamp or AC voltmeter from chassis to earth ground; if he gets an indication of voltage, this is a warning to reverse the line plug in its socket.) Modern polarized plugs and sockets are designed so that the receiver positively must be connected to the line with chassis going to ground.

Trouble with "hot-chassis" sets arises from the opposite situation, where the set chassis is connected to the ungrounded side of the line. Of course, this places 117 volts AC not only on the receiver chassis, but also on the ground bus or chassis of any test equipment being used. Most test instruments have their own built-in isolation from the line, so a direct short across the AC power circuit is unlikely (as long as no line-to-chassis short occurs in the test equipment). On the other hand, a serious short circuit may result from connecting an externally-grounded antenna system to a "hot" receiver when the line plug is incorrectly inserted. A house fuse will probably be blown, if the antenna coil in the tuner is not burned out first.

As for servicemen who just plug a "hot" receiver into a wall socket and proceed with the repairs, you'll probably notice that they avoid shocks simply by not touching any metal parts of the equipment on the bench. Depending on how their little game of "line-plug roulette" turned out, they may or may not have a considerable amount of AC voltage on the chassis to produce hum and other deceptive effects in their test measurements. And they are evidently willing to take the risk of accidentally causing a short across the line.

An isolation transformer provides a valuable extra measure of safety. By using this unit between receiver and wall socket, you are (1) relieved of worrying about the proper way to plug in the set's line cord; (2) given maximum protection against a "dead short" across the AC terminals; (3) insured against unpleasant (and possibly fatal) shocks when contacting metal portions of equipment; and (4) freed from the annoyance of high-amplitude AC hum on supposedly grounded connections.

Pale Pix

The picture on a Motorola Model 17T22 is barely visible. The 12BY7 video amplifier is in good condition, and voltages on this tube are normal. I have tried a new picture tube without good results.

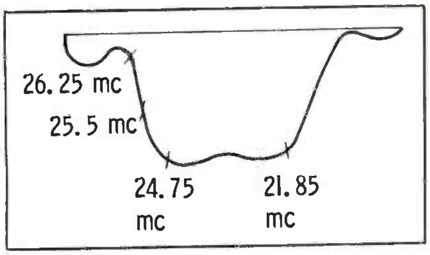
R. H. GIBSON

Punxsutawney, Pa.

Is screen brightness normal, and are the lines in the raster clearly focused? If so, check the peak-to-peak signal voltage on the grid of the 12BY7 with an oscilloscope or peak-reading VTVM. A feeble signal at this point—very much less than a volt—indicates trouble in the detector, IF, RF or AGC circuits. Check the setting of the local-distant switch, and make sure you do not have too much AGC voltage for existing conditions. Also check tubes and voltages in the RF and IF sections.

If the input signal to the video amplifier seems normal, you may have trouble in this circuit or in the cathode circuit of the picture tube. Make further component tests in this area.

Poor brightness and fuzzy focus indicate trouble in the circuits associated with the CRT. Check the voltages on the base pins for clues to possible defects; don't forget the filament voltage. Also see if the high-voltage rectifier circuit is working normally.



Alignment Ups and Downs

The over-all video IF response pattern for RCA Chassis KCS47B, given in PHOTOFACT Set 134, Folder 9, calls for a 21.85-mc marker up at the top of the curve. I have been unable to place it there; 21.85 mc always ends up at the foot of the curve.

CHARLES W. MCDONALD

Port Huron, Mich.

One of the traps which govern the "low end" of the curve is probably set at the wrong frequency. Double-check the following adjustments for minimum detector output at the indicated frequencies: 21-mc absorption trap A2 in the cathode circuit of the fourth IF; 21-mc sound take-off transformer secondary A1 in the third-IF grid circuit; and 19.5-mc absorption trap A5 in the first-IF grid circuit. In addition, make sure that the 21.75-mc adjustment A8 (also in the sound take-off transformer) is correctly peaked.

If these adjustments don't take care of your problem, look for circuit defects which might be causing weak output on the low-frequency side of the response curve. Low transconductance in one of the IF tubes might be to blame. Or, if the third video IF or first sound IF tube is drawing grid current for some reason, it will tend to load down the sound take-off circuit and prevent you from adjusting A8 for a satisfactory peak. A faulty AGC network is another possible cause of response-curve distortion.

Gremlins Again!

A nearly new Admiral portable (Chassis 15C1) stubbornly defied the efforts of four technicians to restore a lost raster and clear up garbled sound. At long last, it was discovered that the vertical and horizontal oscillator tubes (the bottom two in the series filament string) were not getting heater voltage because of a shorted RF bypass capacitor connected to the filament line where it entered the tuner. The horizontal oscillator tube is close enough to the fusible resistor to be warmed by it, so it felt "live" to probing fingers.

PATRICK J. MARTIN

Los Gatos, Calif.

Here's further proof (as if we needed it!) that the unlikeliest troubles are apt to occur. Bet you're now relying on an AC voltmeter instead of "feeling your way" around the filament circuit.

Dropout

I have been having trouble with the Neutrode tuners in several Zenith sets of the 17Z21 and similar chassis series. In each case, the picture fades out after the set has been on for awhile (anywhere from 10 minutes to three hours). Sometimes it can be brought back by switching off channel and then back again. I've been able to determine that the trouble is due to intermittent operation of the oscillator.

On the easy-to-fix ones, the filament of the 6CG8 goes out because of a bad connection between pin 4 of the tube socket and ground. Flowing solder over the connection doesn't repair it permanently, so I have been soldering a short wire jumper between the socket lug and the printed-wiring board.

In other sets, the heater of the 6CG8 remains lit, but the voltage at the oscillator grid (pin 1) drops to zero when the trouble appears. Even when a picture is present, the voltage at this point is only about half of the normal value. What do you think might be causing this symptom?

WEBSTER H. FOULON

(no address given)

Occasional reports have been received of defective ceramic capacitors in the oscillator grid circuit of early-production Neutrode tuners. These units can be replaced with conventional ceramic disc capacitors of correct value and temperature coefficient. Pay special attention to the 6.8-mmf, N330 unit wired between the oscillator grid and coil terminal 7, as well as the 3-mmf, NPO capacitor between terminal 7 and ground.

FM-Detector Circuits

(Continued from page 22)

Coupling capacitor C3 is relatively large in value—at least large enough to have very low reactance at 4.5 mc. Consequently, the signal voltage coupled through C3 undergoes little or no phase shift. Since it is in phase with the original signal voltage E1 in the primary of L1, this capacitively-coupled voltage is called a *reference* signal.

E1 also induces a voltage in the secondary winding of the transformer. This inductively-generated voltage is in phase with E1 (or 180° out of phase with it, depending on the way the secondary winding is connected to the external circuit). This induced voltage sets up a *circulating current* (Ic) in the tuned tank, which then develops a voltage across C2. Since it is developed across a capacitor, this voltage is 90° out of phase with Ic. In a discriminator transformer, the secondary winding is center-tapped, and two output signals of opposite polarity are taken from its two halves. Since the voltage across the secondary of L1 is the same as the voltage across C2, E2 and E3 respectively lead and lag Ic by 90° as shown in Fig. 2A.

If the incoming signal is unmodulated, or if the modulation momentarily has zero value, the signal frequency will be exactly 4.5 mc. This is not only the center frequency of the sound IF section, but also the resonant frequency of L1. In this case, the inductance and capacitance of the tuned secondary circuit will effectively cancel each other, and this circuit will appear to behave as a pure resistance. As a result, Ic will be in phase with the voltage induced in the secondary winding; therefore, this current will also be in phase with primary voltage E1. Since voltages E2 and E3 respectively lead and lag Ic by 90°, they will have a similar phase relationship with E1 (see Fig. 2A).

Remember, a "sample" of E1 has been injected into the secondary circuit through C3. In the upper half of the secondary winding, this reference voltage and E2 will add to produce an output signal. Since there is a phase difference between the voltages, we must use vectors to show how they add. The resultant voltage is indicated by the diag-

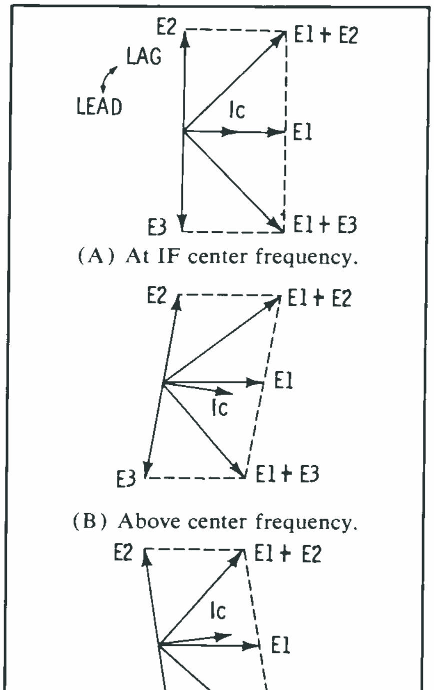
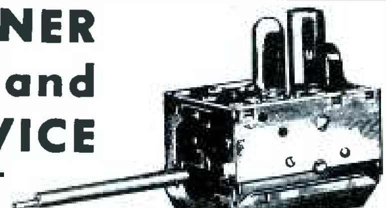


Fig. 2. Phase relationships between voltages in discriminator transformer.



onal arrow in Fig. 2A labeled "E1+E2." In a similar manner, two voltages add in the lower half of the secondary winding to produce the voltage labeled "E1+E3."

The length of these vector arrows is proportional to voltage amplitude, so you can see that E1+E2 will be equal to E1+E3 when the input signal frequency is exactly 4.5 mc. These equal voltages, applied to the plates of the two diodes, will cause them to conduct equally.

Before going on to consider what happens to the transformer output voltages at frequencies other than resonance, let's examine the results of diode conduction. Electron flow through the upper diode circuit proceeds down through the upper half of the transformer secondary to the center tap, up through R1, and from cathode (pin 3) to plate (pin 2) of the tube. Conduction in the lower circuit is up through the lower half of the secondary winding, down through R2 to ground, and from the cathode (pin 7) of the lower tube section to the plate (pin 1).

The audio output, obtained across the two resistors in series, is equal to the *difference* between the positive voltage developed across R1 and the negative voltage across R2. Note that the two resistors are equal in value; this means that equal diode currents will product equal voltages of opposite polarity across the load. Thus, at resonance, the two voltages will cancel and the resultant output will be zero.

Now suppose that the frequency of the sound IF signal rises because of a "positive swing" of modulation. Since the signal is above the resonant frequency of L1's secondary, it sees this circuit as being more inductive than capacitive. As a result, Ic will lag the primary voltage E1 by some angle less than 90°, as indicated in Fig. 2B. The degree of lag is proportional to the amount of "swing" away from the resonant frequency. Voltages E2 and E3 still maintain their 90° phase difference from Ic; so, as Fig 2B demonstrates, the phase difference between E2 and E1 will decrease while that between E1 and E3 will increase. The vectors show the results: The sum voltage E1+E2 applied to the upper diode will become greater than the voltage E1+E3 applied to the lower diode. The former tube section will then conduct more heavily than the latter; there will be more positive voltage across R1 than negative voltage across R2; and the net voltage will be positive.

A decrease in the IF signal frequency (below 4.5 mc) has just the opposite effect. The secondary circuit of L1 becomes more capacitive than inductive, so Ic leads E1 in phase. Output voltage E1+E3 then becomes greater than E1+E2, as diagrammed in Fig. 2C; the lower diode "outconducts" the upper one; and the output voltage changes in a negative direction.

Amplitude of the output voltage is directly proportional to the amount of frequency swing of the input signal away from resonance (within the ± 25-kc range of the detector circuit). This effect is illustrated in Fig. 3. Since the incoming signal frequency varies at an audio rate (less than 15,000 fluctuations per second), the output voltage is basically an audio signal. It is filtered to remove IF signal components, and then applied to the audio amplifier of the receiver — usually by way of the volume control.

The "S"-shaped response curve in Fig. 3—with zero output corresponding to center-frequency input, and with good linearity over the entire operating range—is typical of a properly-aligned FM detector circuit.

Ratio Detector

A typical modern ratio detector (Fig. 4) differs from a discrimiminator in a number of circuit details. One of the most noticeable differences is that the cathode (instead of the plate) of the upper diode is connected to the transformer. Effectively, then, both diodes are connected in series across the electrolytic capacitor C1. They both conduct on the same alternation of the input signal, thus charging to virtually the peak value of the signal voltage. Due to the large capacitance of C1, the combination of C1 and R2 has a very long time constant—equal to many cycles of the sound IF signal. Consequently, the charge on C1 remains at very nearly the established peak value, and the total voltage across both diodes remains nearly constant as long as the average strength of the input signal does not change. This is quite an important point, because it explains the ratio detector's ability to "ignore" amplitude modulation in the sound IF signal.

Even though the total voltage developed across the detector seldom varies, the voltage at the center tap of the transformer secondary *does* fluctuate according to the modulation in the sound IF signal. (This effect takes place because varia-

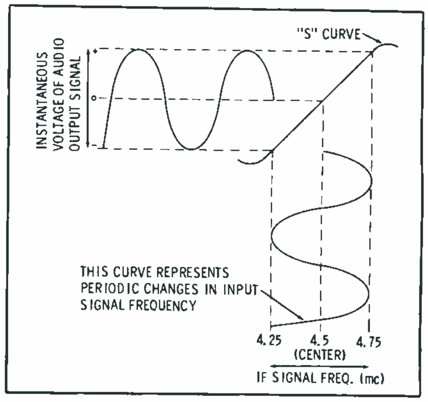


Fig. 3. Frequency shifts in input signal causes changes in audio amplitude.

tions in input-signal frequency produce unequal conduction of the two diodes—just as in the discriminator.) Therefore, an audio output signal can be obtained at the midpoint of the detector circuit.

The above paragraph explains ratio-detector operation in a nutshell, but there are several interesting circuit features which merit further explanation. First of all, most commercial-type ratio detectors differ from discriminators in the method used to couple a reference-phase signal from the primary to the secondary of the transformer. Instead of having a coupling capacitor such as C3 in Fig. 1, a typical ratio-detector transformer incorporates a small *tertiary* winding in series with the lead from the center tap of the secondary. Since this extra winding is untuned and very closely coupled to the primary, the voltage developed across it is in phase with the primary voltage.

Another "different" feature of the detector in Fig. 4 is its load circuit, which you may not immediately recognize because there are no matched load resistors correspond-

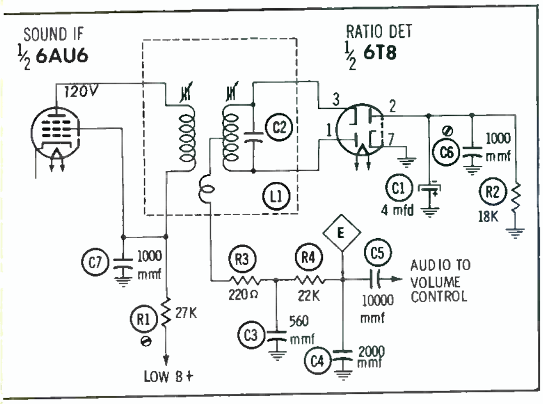


Fig. 4. Output of ratio detector circuit is developed across capacitor C3.

ing to those in a discriminator. Instead, both diode-output voltages are developed across a single capacitor (C3) between the center tap of L1 and ground. This component forms part of two distinct IF signal paths in addition to the previously-mentioned circuit (C1 and the two diodes in series). Plate current of the lower diode (high-frequency AC) travels upward through the bottom half of the transformer secondary to the center tap, through isolating resistor R3, down through C3 to ground, and back to the diode cathode. Conduction in the upper half of the circuit is *upward* from ground through C3, R3, the upper half of the secondary winding, and the upper diode; the return path to ground is through C1. In some circuits, small-value capacitor C6 is placed in parallel with C1 to compensate for the inductive reactance offered to high-frequency signals by C1.

When the incoming signal is on center frequency, the diodes conduct equally; so the signal voltages developed across C3 are equal in amplitude but opposite in polarity. This state of affairs results in no audio output. At frequencies other than resonance, the opposing signal voltages across C3 become unbalanced due to unequal conduction of the diodes; as a result, the output voltage changes in either a positive or a negative direction.

R4 and C4 form a standard FM deemphasis circuit. This combination also filters IF signal energy out of the output signal, leaving pure audio.

Troubleshooting

When servicing a discriminator or ratio detector, *always substitute*

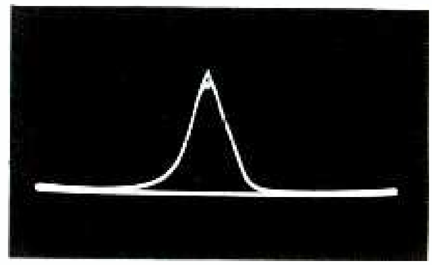


Fig. 5. Response curve of sound IF.

or check tubes first. In case there is a complete loss of audio, check the plate and screen voltages of the last sound IF amplifier or limiter tube to make sure that no breakdowns have occurred in the detector input circuit. Low voltages might indicate an open condition or excessive resistance in the plate decoupling resistor (R3 in Fig. 1), possibly because of a leaky or shorted decoupling capacitor. Then, again, there might be a primary-to-secondary short in the detector transformer. If the input side of the detector seems OK and the sound section is still dead, check for an open component in series with the detector output lead — or perhaps a shorted capacitor from this lead to ground.

In the ratio detector (Fig. 4), an open condition in C6 might not be noticed; but, if C1 should open, there would be a nontunable buzz in the sound, because the self-limiting feature of the detector would be disabled. If C1 became very leaky, the voltage across the entire detector would be greatly reduced, and the audio volume would follow suit.

Now, the biggest problem in either of these circuits is *not* a matter of minor components shorting or opening; after all, there is very little DC or pulse voltage in the sound detector proper. The real troubles are most often due to difficulties in the transformers themselves. Due to gradual changes in component values or in operational characteristics of tubes, the primary and secondary of the detector input transformer may become detuned—as may the preceding IF transformers. The first or second time this happens, you may be able to retune them by ear. But when the third or fourth time rolls around (and this is particularly true of old sets with 21.25-mc split-sound systems), the old sweep and marker generator must be hauled out and a calibrated signal at the

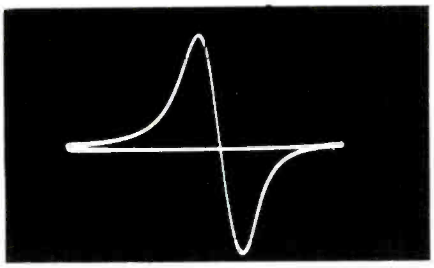


Fig. 6. Response of sound detector.

IF center frequency applied to the sound IF or detector input. Fortunately, the alignment procedures and response curves are very similar for both discriminators and ratio detectors. Look at Fig. 5, and you will see a normal response curve of a sound IF amplifier, with the center frequency indicated by a marker pip at the very top of the curve. Fig. 6 shows a typical "S"-curve response pattern obtained at the output of either type of detector. To obtain this curve, connect your oscilloscope to point E in either circuit—Fig. 1 or Fig. 4. Note that the middle portion of this pattern corresponds to the "S" curve in Fig. 3.

As you tune each transformer to resonance, watch the changes in shape and amplitude of the appropriate scope pattern. *This is how you spot a defective tank capacitor.* These are usually little mica capacitors that are "buried" in the transformer cans. They can either leak or become open, but mostly they leak. When this trouble occurs, the transformer is detuned from its correct operating frequency and the sound volume is greatly reduced. Nothing you can do will increase the volume to its original level.

If an IF transformer develops this fault, the response curve of the affected stage will probably appear something like Fig. 7. A similar trouble in the detector transformer will produce enough distortion in the response curve for you to recognize the fault. Replace the defective unit and realign the sound section. By all means, use an oscilloscope and a sweep generator plus a calibrated marker generator. The other alignment method, using a fixed-frequency signal generator and a VTVM, is only a fair approximation at best. The waveform on the scope screen is much more accurate because it lets you see the whole response curve at once—not just one point at a time. When you have finished performing an accurate alignment of the sound IF's and detector, and have made sure there are no defects in the video circuits preceding the sound-takeoff point, you should be able to rotate the set's fine tuning control throughout its range on all stations without noticeable buzz. And the sound from the speaker should be good and strong!

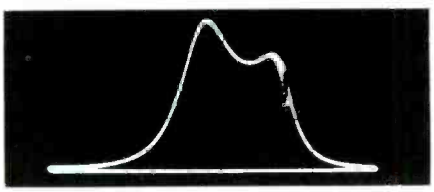


Fig. 7. Faulty sound IF response due to leaky capacitor across transformer.

If the audio output still doesn't sound right, there may be trouble between the volume control and the speaker. As the *Shop Talk* column in the November issue pointed out, the best means of troubleshooting the audio amplifier section is a signal-tracing method, using an ordinary audio signal generator. A voltmeter will also come in handy when you begin to get close to the source of the trouble. ▲

Large Current Tubes

(continued from page 27)

terminal A of the AC supply is negative and B is positive, the path of electron flow is from A through the transformer to the cathode of V1. Current does not pass through D, but flows from the mercury pool of V1 to the ignitor of this tube. From the ignitor, it goes through C, S2, the fuse, S1, and F, back to power-supply terminal B. This momentary current through the ignitor circuit starts an arc in V1, thus allowing heavy current to begin flowing through the welding transformer, from plate to cathode of V1, and back to B. During the next half-cycle of AC input, when B is negative with respect to A, the circuit action reverses and V2 is driven into conduction.

From this description, it can be seen that the circuit acts as a full-wave rectifier, with one tube conducting during each alternation of the AC supply voltage. By controlling the *portion* of each alternation over which the tube is actually in a conducting state, the operator can achieve control over the amount of output current delivered to the material being welded.

Initiating switch S2 furnishes the necessary current control by regulating the time at which conduction starts on each alternation. The circuit also contains a water-flow switch (S1) which automatically shuts off the equipment if water circulation ceases.

Fig. 9 shows the effect of S2, which is usually a thyratron instead of a mechanical switch. The applied AC voltage is indicated in Fig. 9A; in part B of the figure, the voltage across the ignitrons is plotted as it would appear on an oscilloscope (assuming that the load is not reactive). At point 1, the switch is closed and the ignitrons fire. Note that the tube voltage falls to a very low value when the switch is closed. This is due to the low IR drop across the ignitron during conduction. Because of the ignitor voltage drop at

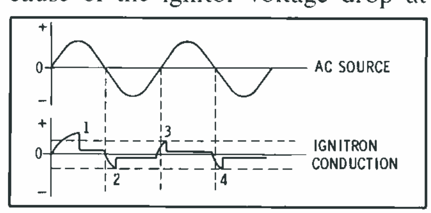


Fig. 9. Waveshape of the voltage across ignitrons in the circuit of Fig. 8.

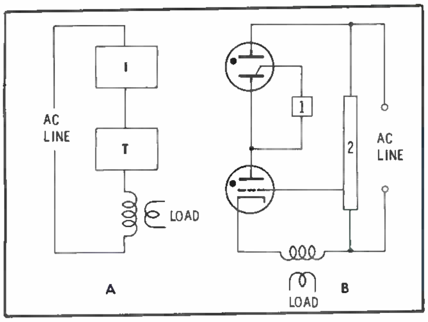


Fig. 10. Ignitron controlled by a thyratron in series with the ignitor circuit.

the start of each conduction period, there are sharp pulses at 2, 3, and 4.

Another commercial circuit is shown in Fig. 10. Note that the load, the thyratrons, and the ignitrons are in series. The thyratron firing cycle is adjusted by controlling the thyratron grid with a small signal. This, in turn, controls the ignitron firing time—which determines the average current per cycle through the load. In Fig. 10B, block 1 represents the ignitor circuit, and block 2 represents the control circuit for the thyratron (a phase-shifting network).

There are three main applications for which ignitrons are particularly suited: resistance welding, power rectification, and power conversion or transmission.

In welding applications, ignitron tubes are used to control the primary current supplied to resistance welding transformers from supply circuits of 220, 440, 550, 1100, and 2300 volts (rms). These circuits provide the most exact means of weld control ever developed. The tubes operate as switches and, through suitable electronic control, may be arranged to provide one, two, or a dozen cycles of current at given weld settings which may be repeated indefinitely without change in the number of cycles. As a result, very great uniformity in the welds is obtained, and losses from poor welds are reduced.

Ignitrons for power rectification are available in sizes which permit DC power outputs of 40 to 1000 kilowatts (depending on the operating voltage) to be obtained from single units. Usual DC voltages are 125, 250, 600, and 900 volts. Such rectifiers are used to provide power for machine shops, elevators, mines, electrolytic reduction plants, arc welding, and similar types of service. Suitable voltage-regulating equipment may be provided to give practically constant output voltage from zero to full load.

The third class of application is high-voltage DC power transmission, or conversion of power at one frequency to power at another. In such applications the tubes are primarily for power conversion and are grouped to form units of 2000- to 20,000-kilowatt capacity. Higher capacity may be obtained with additional units. These electronic power converters provide a nonsynchronous tie between two power systems and are able to transmit a constant amount of power regardless of the usual frequency and voltage variations in either the supply or receiving system.

Stored-Energy Welding

An example of the combined use

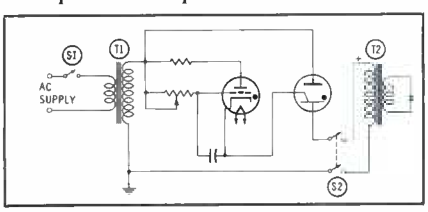


Fig. 11. Thyratron-ignitron circuit used in reactor-storage welding control unit.

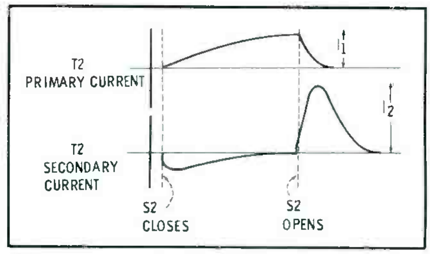


Fig. 12. Current waveforms for Fig. 11.

of thyratrons and ignitrons is in the *Sciaky* or reactor-storage welding control process shown in Fig. 11. Only one phase of a three-phase AC supply is illustrated. The AC is stepped up through T1, and the secondary voltage is shifted in phase and applied to the thyratron grid to control this tube's conduction. When the thyratron is activated, it fires the ignitor circuit and starts the ignitron, whose plate is connected to the high side of T1. The ignitron controls the current in transformer T2.

In operation, the work to be welded is clamped in place at X (secondary of T2), and S1 is closed. S2 is then closed, but this does not immediately activate the welding current. As Fig. 12 demonstrates, the primary current of T2 slowly increases at an exponential rate because of the large inductance of the primary. There is a secondary current flow (in the opposite direction) which decreases as the primary current stops charging.

When S2 is opened, primary current decreases rapidly. Since this produces a large magnetic field, there is a large surge of secondary current which does the welding. The peak current of the output (I2) is four or five times the peak rectified current (I1).

A modification of this storage principle, using a capacitor, is shown in Fig. 13. Here the rectifier charges C (a bank of capacitors) while S is open. When switch S is closed, the energy stored in C discharges through the transformer to the load to make the weld. Actually, of course, the total output energy is equal to the total input energy (except for losses). But the output is delivered for a short period, whereas the capacitor bank is charged over a long period. Thus, a much smaller rectifier can be used than if all the energy were supplied directly to the load through a conventional output transformer.

The *Weldmatic* Model 1015

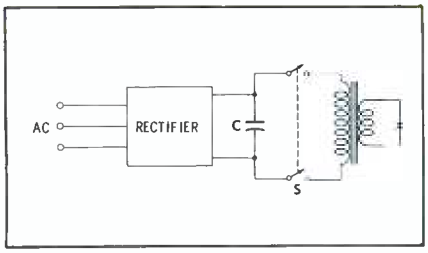


Fig. 13. Capacitor-storage weld circuit.

shown in Fig. 14 is a bench-mounted self-contained precision resistance welder used to join small metal assemblies in electronics, instrument and ordnance work. With this type of unit, it is practical to obtain such welding advantages as better mechanical performance of joints, higher tensile strength, better fatigue resistance, lower electrical resistance, less electrical noise, and freedom from flux or other contaminants.

The stored-energy principle used in the Model 1015 permits easy welding of high-carbon steel, copper, silver, tungsten, molybdenum and other "difficult" materials. Millisecond weld time prevents discoloration, excessive deformation or metallurgical change. Dissimilar metals and parts of widely varying thicknesses are joined with ease.

Operation requires a minimum of operator skill. Because the weld is made within milliseconds, production speed is governed entirely by operator response. Using the capacitor-discharge principle, the unit welds with a single, short pulse of heavy current. Energy is accurately regulated by an electronic power supply having a single, stepless control. Applied electrode pressure, set by a knob on the head, is directly

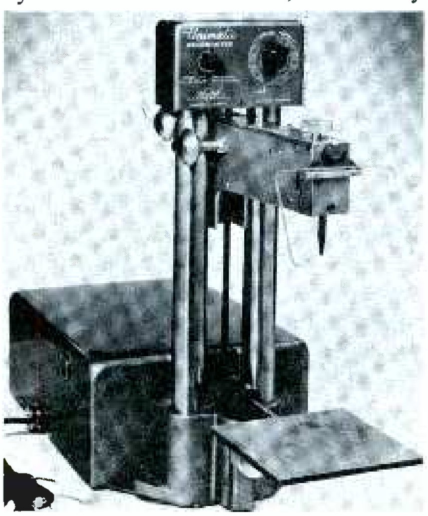


Fig. 14. *Weldmatic* Model 1015 operates from 117-volt, 60-cps AC supply.

indicated on a force scale, and is adjustable over a wide range. Welds are uniform because output remains constant despite line-voltage fluctuations.

Maintenance

Very little maintenance, in the usual sense of the word, is required for either ignitron or thyratron tubes; however, the tubes should be kept clean, and accumulations of waste should not be allowed to collect around the anode insulation bushing. If water jackets of an ignitron become clogged with silt, they can be cleaned out. Operational failures of ignitron tubes, due to the tubes themselves, are usually the result of air leakage, gas, or ignitor failure. Gas and air leakage most frequently result in arc-back, usually accompanied by severe flashing or red-hot sparks in the anode seal. In general, such failures can be spotted by a visual inspection of the equipment while it is operating.

Spare ignitron tubes may be checked for vacuum by means of a spark coil of the make-and-break type. Ignitor failure (where the tip has been burned off) results in misfiring. This fault can be detected by connecting an ohmmeter between the ignitor lead and cathode terminal and slightly tipping the tube to lower the mercury level on the ignitor. The normal tube may be tipped approximately 20° from vertical before the ignitor-mercury contact breaks.

Ignitor wetting sometimes occurs in tubes which have carried excessive current. In this case, cathode spots form on the side walls of the tube, and metal vaporized from these spots finds its way into the mercury pool. This metal is in turn re-evaporated by the arc around the ignitor, and this element tends to become coated with a layer of vaporized metal. The ignitor usually has no protective oxide coating, and amalgamation with the mercury (wetting) takes place. A simple check for this type of failure is again to connect an ohmmeter between the ignitor and cathode terminals. As the tube is tipped slightly to withdraw the ignitor from the mercury, there should be a gradual increase in resistance. If the ignitor is wet, the resistance will remain constant and then suddenly jump to a new and higher value.

Operation with excessive water temperatures usually results in arc-back in the case of the rectifier tubes, and extra conduction cycles in the case of the welder tube.

The ignitron tube forms the closing switch in the circuit where it is used, whether this be a welder or rectifier. Most faults, therefore, are noticed only when this switch is closed, and trouble in other parts of the equipment may frequently be considered as tube trouble. The simplest check is to replace the seemingly faulty tube with a spare tube. Failure may also be caused by the thyratron firing tube.

A cathode-ray oscilloscope is a valuable test instrument for further troubleshooting because it permits a visual observation of the voltage waveshapes across the tube and other components in the circuit. A knowledge of the waveshapes to be expected under both normal and abnormal conditions can often lead to a direct solution to the trouble. In addition to a cathode-ray oscilloscope, the serviceman will find a VOM useful in checking circuit values. ▲

Satisfaction from Hi-Fi

(Continued from page 31)

trol used with many radio receivers. It is usually a two-position switch marked "bass" and "treble." Circuitwise, the control merely switches a capacitor in or out of the circuit. When the capacitor is connected, the high-frequency signals are reduced in amplitude—so this is the "bass" position. In other words, we effectively boost the bass response by reducing the treble. Of course, the same effect would appear to be obtained by boosting the bass; equipment users should be aware of this in seeking proper adjustments of the tone controls.

Tone controls can be used in a number of ways:

1. By turning down the treble, record noise can be reduced. Some of the higher signal frequencies may be lost, but normally this is not nearly as objectionable as the noise.

2. Reducing both the bass and treble settings will decrease noise. Decreasing the amplitude at both ends of the frequency range (but not at medium frequencies) sacrifices response somewhat, but only at frequencies to which the ear is least sensitive. The great reduction of noise may be well worth the sacrifice.

3. Reducing the bass response also reduces the amplitude of any hum which may be present. Hum is usually at 60 or 120 cps, so the bass control has considerable effect on its elimination.

4. Even when noise and hum are not a problem, tone controls are useful in varying the response to suit individual listeners' tastes.

5. When the exact equalizer setting is not available, the tone controls can alter the response curve to produce the desired equalization. If an equalizer is not used, the tone controls may be adjusted to give some degree of equalization.

Different listeners vary widely in their choice of tone-control settings. A few hi-fi owners have the strange idea that hi-fi means maximum bass and maximum treble. A person with poor high-frequency perception may find it necessary to turn up the treble to a level which may seem too high for others. Then there are those who buy the best equipment available, only to turn the bass all the way up, and the treble all the way down! "Right" or "wrong," each individual has the privilege of adjusting the tone controls to his own level; however, customers should be encouraged to experiment with the controls and learn how to use them to best advantage.

Loudness Controls

A number of cartoons have appeared in which the hi-fi owner was depicted playing his set with tremendous volume. Most of these are exaggerations, but there is a valid reason for playing a hi-fi set good and loud. The frequency response generally sounds better at high volume levels than at low levels, because our ears respond differently to the various audio frequencies at different sound intensities.

Some years ago, a set of curves (Fig. 3) was drawn up representing the response of the "average ear" at various volume levels. These are popularly known as Fletcher-Munson curves, after the men who compiled the information. Frequency is plotted along the horizontal axis, and intensity levels along the vertical axis. Intensity is plotted in decibels, with zero db representing the sound level at the threshold of hearing for a signal frequency of 1000 cps. Each line is an "equal loudness contour," and by reference to the bottom curve we can see that about +64 db of a 30-cycle signal is required to give the same sensation of loudness as a 1000 cps signal at the zero-db level. It is evident from the curves that the human ear is most responsive to sounds having frequencies of 3000 to 4000 cps.

As volume level increases, the Fletcher-Munson curves tend to become more nearly flat, meaning that the requirements for a certain loudness level are more nearly the same for all frequencies. Summarized, all of this means that the frequency response (as we hear it) is improved as the output sound level is increased. And all of this occurs with no change in the response of the audio-reproducing equipment.

This peculiar imperfection in our hearing mechanism shows up mostly at low volume levels. We can compensate for it to some extent by turning up both the bass and the treble, but this has its disadvantages. Besides being bothersome, it is difficult to advance the controls by just the proper amounts. However, if the volume control is replaced with a loudness control, automatic compensation can be made for the above-described effect at all volume levels. There are a number of different types of loudness controls, but the one shown in Fig. 4 is fairly typical.

This control circuit employs three ganged potentiometers, two fixed resistors, and two capacitors. R1, the volume control proper, determines the signal amplitude. Isolating resistor R2 prevents interaction between the controls. At maximum volume level, all three potentiometer arms are at the top ends of the respective controls. C1 and R3 are then effectively cut out of the circuit and do not affect response. The series circuit consisting of R4, R5, and C2 has maximum impedance so that the reactance of C2 has minimum effect on response. With the controls at the other extreme (minimum loudness), R3 and C1 are in series with the signal path. The reactance of C1 varies inversely with frequency so that less voltage drop occurs across it at high frequencies; therefore, the response to "highs" is improved.

With R4 set for minimum resistance, C2 has its maximum effect. It is in shunt with the signal and thus gives increased low-frequency response. At intermediate settings of the controls, the capacitors have varying effects—depending on the exact level chosen. It would be difficult to design a network which would exactly compensate for the loudness response, especially since each individual varies somewhat from everyone else with regard to hearing ability.

Stereo Balance Controls

Dual-channel amplifiers in stereo systems often include ganged volume, loudness, tone and other controls to permit simultaneous adjustment of both amplifier sections. In addition, many of these amplifiers incorporate *balance* controls for equalizing the levels in both stereo channels. It can be pointed out to the user that this balance

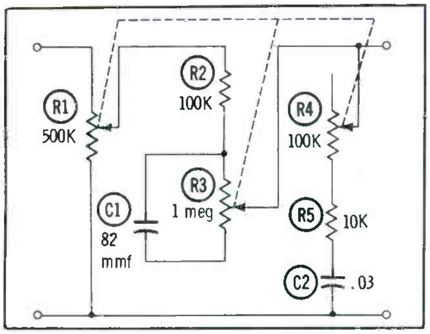


Fig. 4. Typical loudness-control hookup.

control does not necessarily have to be adjusted for perfectly equal volume from the two sets of speakers. Actually, the system can be purposely *unbalanced* so that listeners can sit "off to one side" — not directly across the room from the stereo system—and still obtain an acceptable stereophonic effect. (To achieve this, volume is reduced in the "near" speakers and increased in the "far" ones.) With a little experimentation, the stereo listener can determine the most pleasing balance setting for his purpose.

Record Care

A large portion of hi-fi program material originates on records, and the owner of hi-fi equipment often has a sizable investment in records alone. Proper care of these records will protect this investment and add years to the playing life of each disc, so hints along that line are in order. Here is a listing of the most important items in record care.

1. Store each record in its own cardboard jacket, preferably also using an inner covering of plastic or paper.

2. Never stack records unless they are in their jackets. Store them so that the records are vertical, not horizontal.

3. Prevent dust pickup by keeping records properly stored except when playing them.

4. Spraying the record with anti-static fluid or wiping them with a properly treated cloth gets rid of the static charge which attracts and holds dust. Once treated, the records can be cleaned with any soft, clean rag.

5. Touch the records only in the label area and at the edge. An oily residue from the fingers causes the disc to hold dust and dirt.

6. Be careful not to drop the

disc or allow it to be scraped or scratched in any way.

7. Store records in a closed cabinet in a dry location where heat is not excessive. This keeps them cleaner and minimizes warping.

Stylus Wear

Regardless of some claims to the contrary, there is no such thing as a permanent stylus. After too much wear, the stylus begins to flatten and actually chisels out the record grooves, eventually ruining the disc. But even before this occurs, a worn stylus increases noise and gives poor frequency response. There are three popular types of stylus material; metal (usually osmium), sapphire, and diamond. As a general rule, a metal stylus should not be used for more than 20 hours of playing time, nor should a sapphire be used more than 100 hours. These are the maximum figures under ideal playing conditions; styli may not last that long if tone arms are not adjusted for correct stylus pressure and tracking force. (This should be checked by the serviceman who installs the equipment.)

A good diamond stylus has the longest life of all, and can usually be used for up to about 1000 hours. However, even diamonds wear out eventually and should be replaced.

Some hi-fi owners may need a gentle reminder that the price of a new stylus is very low when compared with the replacement cost of an entire record collection.

MORE ABOUT MICROPHONES

For lack of space, the October column, "How to Choose and Use Microphones," glossed over a few points on which some elaboration is called for. This short addendum, therefore, is for those who would like a few more specific details.

In comparing the difference in response of ceramic and crystal mikes, the difference in the generator elements themselves has little if any effect on response range. Other design parameters, such as the diaphragm and drive mechanism, do affect frequency response. Temperature and humidity, which limit the use of crystals, has little effect on ceramic elements.

Speaking of diaphragms used in dynamic units, it should be pointed out that while in years past most of them were metallic, most modern dynamic microphones, particularly those of higher quality, use nonmetallic diaphragms. This, and other improvements, have permitted dynamic microphones to be designed for practically any application.

Because the internal impedance of a dynamic microphone is inherently very low (voice-coil impedances average between 3 and 12 ohms), an internal matching transformer is, of necessity, included in the over-all unit design. Thus, the output impedance depends entirely on the transformer specifications, and may be low, high, or variable. Directional characteristics of dynamic units vary with case design and frequency. Very small microphones, such as modern lavalier types, are essentially nondirectional regardless of position at low and midrange frequencies. Pressure - activated units utilizing fairly large case diameters become somewhat directional at higher frequencies. However, with the use of phase-shifting devices, which in part involves case design, a cardioid response pattern can be obtained.

Crystal mikes are high-impedance units, and on occasion their response characteristics are used to complement those of the amplifier. The fact that replacement of a crystal mike with a dynamic unit results in a loss of "highs" or "lows" is not likely to be caused by a fault of the microphone. Substituting a dynamic mike for a crystal type on modern equipment almost invariably results in improved response — providing a high-impedance model is selected, or a low-impedance type is used with an external high-impedance matching transformer.

Well-designed ribbon microphones have very good response characteristics, a factor which has made them popular in broadcasting and recording activities; however, they are quite fragile and not suitable for out-of-door use. Rapid movement, such as when quickly moved from one position to another on a TV boom, activate the ribbon and thus produce unwanted noise output.

These factors, as well as others, may well contribute to the reasons why dynamic mikes—which have been improved to the point where they are designed for even the most discriminating uses—have achieved a high degree of popularity. ▲

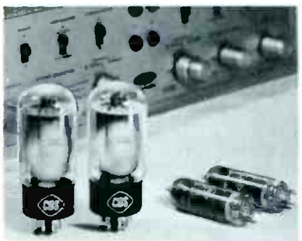
PRODUCT report

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

Stereo Amplifier (46K)

The Webster Electric Model GL20-20 includes preamp and power amplifier circuits for both channels of a stereo system. Audio output is 20 watts per channel. The amplifier will accept input signals from radio tuners, tape decks, and all types of phonograph pickups. A master volume control is supplemented by separate-channel volume, bass and treble controls.

Matched Pairs of Tubes (47K)

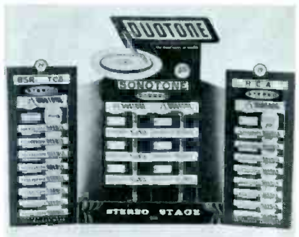


A half-dozen different types of audio output tubes are now being supplied by CBS in matched pairs to help minimize harmonic distortion in push-pull audio amplifiers. Types 7189 and 6L6GC have just been added to the list of paired tubes available, joining the previously-announced 6BQ5, 6V6GT, 5881, and 6550.

Transistor Test Equipment (48K)

A set of three Sencore instruments for servicing transistorized circuits is now available in a single package called the *Transistor Radio Service Lab*. Units included are the TRC4 transistor tester, the PS-103 *Transipak* power supply (which also measures receiver current drain), and the HG104 harmonic generator for signal tracing. Price of the complete set is $45.85.

Styli Counter Display (49K)



A self-service counter display unit, the Duotone *666 Stereo Stage*, holds an assortment of 18 sapphire styli for use in several popular brands of stereo record players. Six of the styli are designed to fit Ronette cartridges; there are also six each for Sonotone and RCA replacement applications. Retail price of the assortment is $51.00.

Tape Maintenance Kit (50K)

Three chemicals for tape recorder maintenance, all in plastic "squeeze" bottles, are furnished with suitable applicators in the Electrical and Chemical Specialty Co. *Master Kit*. The fluids supplied are a cleaner for drive surfaces in the tape transport mechanism; a lubricant for tape heads and guides; and a tape conditioner with antistatic, placticizing, lubricating, and cleaning properties. The conditioner is dispensed by a special *Tower Applicator* which mounts on top of the recorder and applies a measured amount of fluid continuously to the tape. The complete kit is priced at $3.98; extra bottles of fluid are 98c each.

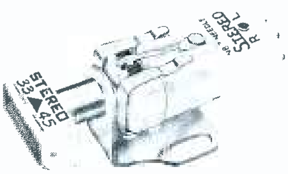
Silicon Rectifier Display (51K)

A Baker's Dozen No. 500 display card, holding 13 Pyramid Type S1-500 silicon rectifiers for TV and radio power supply applications, is being offered at the regular price of a dozen single units. The rectifiers, which are of a "top-hat" design with axial pigtail leads, come complete with conversion fittings for "snap-in" installations.

FM Radio (52K)

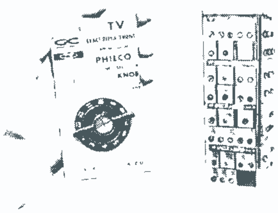
The Blonder-Tongue Model R120 FM radio, featuring temperature-compensating circuitry said to provide drift-free tuning, uses six tubes and a rear-mounted speaker to create the effect of wide sound dispersion. Available in plastic cabinets of grey and white, sandalwood and white, or solid white. Suggested list price is $39.95.

Crystal Stereo Cartridges (53K)



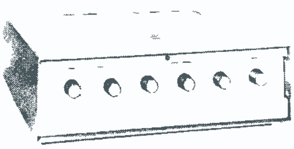
Astatic *80 Series* crystal stereo cartridges are made in two different designs (both of the turnover type) to meet different mounting requirements. Specifications are as follows: Output from stereo LP record at 1000 cps, 0.8 volts; frequency range, 30 to 15,000 cps; compliance, 1.3 x 10^{-6} dyne; and stylus force, 6-8 gm.

Control Knobs (54K)



Replacement knobs for all "customer controls" on eight widely-sold makes of TV sets (RCA, Zenith, Motorola, Philco, Admiral, General Electric, Westinghouse, and Emerson) are being marketed by G-C Electronics. The line comprises a total of 97 knobs, all packaged on cards and hung on a display rack for quick identification.

Stereo Amplifier Kit (55K)



A stereo version of the Grommes *Little Jewel* hi-fi amplifier kit has dual-channel preamplifiers and 10-watt power amplifiers which can be paralleled to provide 20-watt monophonic output. Model 20-LJK has 4 pairs of inputs: crystal phono, RIAA magnetic phono, NARTB tape, and auxiliary.

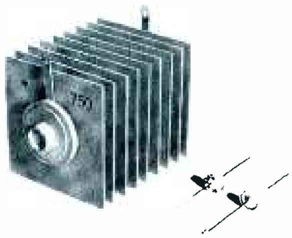
Phonograph Accessories (56K)

A stock of the nine "most-often-wanted" items in the Audiotex phono-accessory line is offered to dealers, complete with a 24" x 13" easel-type counter-display rack. Items included are a record brush, static-eliminating device, stylus brush, antistatic liquid cleaner, silicone-treated record-cleaning cloth, two types of 45-rpm disc inserts, a tone-arm lifting device, and a stylus microscope.

New Type Indoor Antenna (57K)

In many areas, usable TV and FM broadcast signals are induced on AC powerline and house wiring. The Jerrold *TV-Receptor* antenna taps off these signals by inductive coupling and feeds them to the receiver antenna terminals. No direct-wire connection is made from line to antenna; the device is just slipped over the line cord of the set and moved back and forth to locate the point of maximum signal pickup. List price is $5.95.

Silicon Rectifiers (58K)



Audio Devices No. 40E5 silicon diodes have a PIV rating of 400 volts and maximum DC output current of 750 ma (with resistive load) or 500 ma (with capacitive load). Other types are also available with PIV ratings from 100 to 500 volts. These rectifiers appear somewhat similar to military-type "top-hat" units except for being encapsulated within an outer ceramic shell.

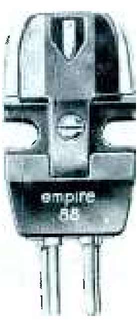
Stereo Signal Mixer (59K)

Sound from external sources (such as microphones) can be intermixed with stereo programs in the Switchcraft No. 306TR Stereo-Monaural Mixer. To prevent signal attenuation, the unit contains battery-powered, transistorized amplifiers. Each channel has two input circuits (with independent volume controls) and one phono-jack output. List price is $37.50.

Stereo Record Changer (60K)

A nonmagnetic, 6½ lb. turntable, a dynamically-balanced four-pole motor, and an automatic-intermix type of changer mechanism are featured in the Collaro *Constellation* Model TC-99 record changer. Tracking pressure of the tone arm varies less than one gram as the machine plays through a stack of records. Price of the unit is $59.50 (slightly higher out West).

Moving-Magnet Cartridge (61K)

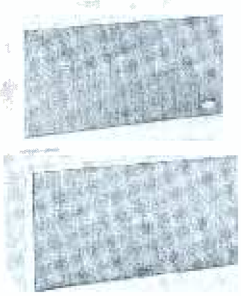


The stylus of Audio Empire's new *Empire 88 Stereo/Balance* cartridge moves a magnet within a stationary coil assembly that incorporates a hum-balancing feature. The moving element is said to have extremely small dynamic mass so as to maintain smooth performance at high frequencies up to 20,000 cps. Outputs (5 mv per channel) are matched within ± 1 db. Price is $24.50 with diamond stylus, or $18.50 with sapphire.

Ganged "L" Pads (62K)

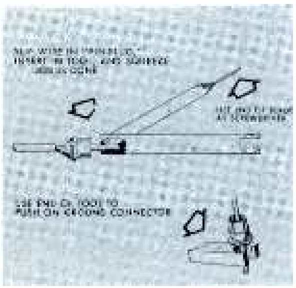
Consisting of twin "L" pads operated by a common shaft, the Mallory "LL" can serve as a constant-impedance, tandem-style volume control in speaker circuits of stereo amplifiers. The "LA," single "L" pad for monophonic circuits, is also obtainable. Both these controls have bushings 1" long to permit installation in thick walls of speaker cabinets. The "LL" is furnished in 8-, 16-, and 50-ohm versions; the "LA" in 8 and 16 ohms only.

Finish-It-Yourself Cabinets (63K)



Optional versions of the Jensen *Tri-ette* and *Duette* bookshelf-size speaker systems have unfinished cabinet surfaces which the buyer can stain, varnish or paint as he chooses. Provisions are made for custom installation of grille fabric. The *Tri-ette* ($89.50) is a 3-way system with 12" woofer, 8" midrange unit, and compression-driver tweeter; the *Duette* ($59.95) has an 8" low-frequency speaker (new type P8-QF) and a direct-radiator tweeter.

Easier Phono Plug Wiring (64K)



The Berns Audio Pin Crimper (Model AU-2) can be used to attach a shielded cable to a phono plug without making soldered connections. Besides crimping the center conductor tightly within the pin plug, the tool also assists the user in pressing a "C" ring over the shell of the plug to clamp the braided shield firmly in place. The AU-2 is also useful for repairing defective tube-pin connections.

Rack for Tube Stock (65K)

To help TV shops maintain an orderly tube stock, General Electric (through its tube distributors) is making available a wrought-iron display rack called a PROFIT unit. Approximately 5' high and 3½' wide, the rack holds up to 665 tubes in "eggcrate" cases which allow easy removal of any tube. Type numbers are printed on the bottom of empty spaces as a reminder to restock the indicated types.

AM-FM Tuner Kit (66K)

A choice of AM and FM monophonic reception, provisions for attaching an FM multiplex stereo adapter, a prewired FM "front end," and fully prealigned RF-IF circuits are featured in the EICO Model HFT-92 tuner. The dial pointer is a DM70 "exclamation-point" tuning eye. Price is $59.95 in kit form, or $94.95 preassembled.

INDEX TO ADVERTISERS

DECEMBER, 1959

Latest Jackson Tube Test Data

TUBE TYPE	MODEL 648 FIL.	MODEL 648 CIRCUIT D.	MODEL 648 CIRCUIT E.	PLATE TEST	MODEL 49 SEC.	A.	B.	C.	D. SHORTS	CATH.	E.
5GH8	5.0	A129	AB358	48V	P	5.0	4	X	236	7	28
	5.0	A127	A46	45V	T	5.0	4	X	19	8	28
6EA7	6.3	238	AC56	75YZ	T	6.3	7	X	45	6	35
	6.3	234	A17	13WZ	T	6.3	7	-	12	3	4
6EY6	6.3	123	456	26W	P	6.3	2	-	345	8	5
6GH8	6.3	A129	AB358	48V	P	6.3	4	X	236	7	28
	6.3	A127	A46	45V	T	6.3	4	X	19	8	28

TUBE TYPE	MODEL 658 SEC.	HEATER	CIRCUIT H-K	P-G	PLATE	GRID TEST	HEATER CURRENT
5GH8	P	5.0J	129	ab358	60S	10WY.	
	T	5.0J	127	a46	42S	10WY.	A10. GL Z600
6EA7	T	6.4L	233	ac56	60Q	10WY.	
	T	6.4L	234	a17	18R	80VY.	
6EY6	P	6.4K	123	456	25Q	70VY.	
6GH8	P	6.4K	129	ab358	60S	10WY.	
	T	6.4K	127	a46	42S	10WY.	A10. 6M Z450

Latest Chart Form 648-22, 49-5, 658-2

CATALOG AND LITERATURE SERVICE

1K. *AMPHENOL*—New edition of company's dealer catalog of service products, including twin lead, antennas, accessories and radio-TV parts. *See ad page 38.*

2K. *JFD* — New 24-page catalog of UHF, VHF, FM and indoor TV antennas and accessories, plus hi-fi speakers and TV accessories. *See ad page 12.*

3K. *MOSLEY* — Form CB-2A, describing citizen's-band antennas in both deluxe and standard lines. Form TV-1, describing TV outlets and accessories. *See ad page 58.*

4K. *TACO*—Promotional material for TV & FM antenna installers, including sample copy of "A Guide to Proper Selection of TV Antennas," available for distribution to customers. *See ad page 58.*

5K. *WINEGARD*—Brochures on new *Trans-coupler* and "K" series yagis. Also dealer broadside on super *Color 'Cepter. See ad pages 24-25.*

AUDIO & HI-FI

6K. *ASTATIC*—Catalog 33-3 containing complete listing and descriptions of cartridges, microphones, pickups, and needles. *See ad page 9.*

7K. *CBS — Harmony* phonograph "Dealer Helps Booklet," RPF-290. *See ads pages 15, 16-17.*

8K. *JENSEN MFG.*—20-page, 2-color catalog describing complete line of loudspeakers for stereo and monophonic high fidelity applications. *See ad page 49.*

9K. *PRECISION ELECTRONICS* — Flyer describing the *Grommes* "Premiere Line" of high-fidelity sound equipment for quality industrial and commercial installations. Includes data on 20, 30, and 50-watt amplifiers, as well as deluxe preamps and booster amplifiers. *See ad page 74.*

CAPACITORS

10K. *AEROVOX* — 32-page 1960 edition of servicemen's Catalog, listing electrolytic, paper, mica, and ceramic capacitors, as well as filters, test equipment and accessories. *See ad page 46.*

11K. *SPRAGUE*—Large, 2-color *Ceramichart*, with circuit diagrams showing typical ceramic capacitor applications in radio and TV, plus color-code specifications for ceramic and molded mica capacitors. *See ad page 10.*

CARTRIDGES & NEEDLES

12K. *ELECTRO-VOICE*—Data on 1960 *Power Point* cartridges and needles. Also, a cartridge to needle guide, a cross-reference guide, and a stereo phono needle guide. *See ad page 33.*

13K. *SHURE* — Phono cartridge replacement guide. *See ad page 76.*

14K. *ZENITH* — Retail price schedule on single- and dual-needle replacement cartridges, four types of 45-rpm spindles, and center-hole adapters for 45-rpm records.

CHEMICALS

15K. *PORTER & DIETSCH*—Folder describing the use of *Flexicone* to improve speaker response. *See ad page 64.*

COMPONENTS (MISC.)

16K. *ADMIRAL* — 74-page 1960 sectionalized parts and accessories catalog on tubes, transistors and diodes, batteries, speakers, TV and radio components, TV tuners, record changers and components, indoor and outdoor TV antennas, and TV receiver stands and bases. Also, large cross-reference wall chart for phono needles.

17K. *CENTRALAB* — 24-page general catalog lists complete line of controls, ceramic capacitors, switches and "PEC" packaged electronic circuits. *See ad page 44.*

18K. *CHICAGO MINIATURE*—New pocket-sized cross-reference catalog listing all lamps and manufacturers, in addition to helpful technical data. *See ad page 82.*

19K. *IRC*—Catalog DC9 describes 35 *Handy-Pak* resistor assortments for dealers. *See ads pages 23, 66.*

20K. *MILLER*—Spec sheet on IF transformers for FM-transistor circuits. *See ad page 47.*

FUSES

21K. *BUSSMANN*—Completely new television fuse chart describing proper fuses to use, how they are mounted, and which circuits they protect. *See ad page 45.*

SEMICONDUCTORS

22K. *TUNG-SOL* — "The Lattice," a semiconductor technical brochure written for design engineers. *See ad page 21.*

SERVICE AIDS

23K. *ANTRONIC CORP.* — Literature on Anchor *NEV-A-BREAK SOC-KIT*, the replacement socket for CRT testers. *See ad page 58.*

24K. *E-Z-HOOK*—Convenient reference sheet titled, "How to Build the Five Most Useful Scope Probes," with schematics, mechanical component layouts, etc. *See ad page 74.*

25K. *JW ELECTRONICS*—Dealer leaflet outlining complete tuner repair and alignment service for all makes and models of UHF and VHF tuners. *See ad page 64.*

26K. *MUELLER*—New catalog illustrates and describes complete line of electric clips, from miniature alligator types to heavy-duty test clamps.

SPECIAL EQUIPMENT

27K. *AKRO-MILS*—16-page, 2-color illustrated booklet describing complete line of storage cabinets for component parts, hardware, etc.

28K. *ATR* — Descriptive catalog sheet on 5-tube superhet hand-wired table-model home radios available with or without synchronous electric clocks. *See ad page 14.*

TECHNICAL PUBLICATIONS

29K. *HOWARD W. SAMS*—Literature describing all Howard W. Sams publications covering servicing of radio, TV, hi-fi, etc. Includes data on "Tube Location Guide," "Printed Circuit Diagnosis Made Easy," "Servicing Transistor Radios, Volume 4," "101 Ways to Use Your Audio Test Equipment," and the revised edition of "Radio Receiver Servicing." *See ads pages 60, 61, 66, 82.*

30K. *UNITED CATALOG PUBLISHERS*—24-page "Foreign Tube Interchangeability Guide." *See ad page 62.*

TEST EQUIPMENT

31K. *B & K*—Bulletin ST24-R gives helpful information on how to save time and work and make money with point-to-point signal-injection, direct-viewing Model 1075 Television Analyst, Models 550 and 650 dynamic mutual-conductance tube testers, Model 675 automatic tube tester, and Model 440 CRT cathode-rejuvenator tester. *See ad page 41.*

32K. *DOSS*—Information on the latest in test equipment, including the Pioneer 250 Horizontal Systems *Quantalyst. See ads pages 56, 64, 65.*

33K. *EICO*—20-page 1959 2-color catalog describes 65 models of professional test instruments, hi-fi, and "ham" gear in both kit and factory-wired form. Shows how to save 50%. Also, 4-page 2-color stereo hi-fi guide. *See ads page 79.*

34K. *JACKSON* — Flyer describing complete line of "Service-Engineered" electronic test equipment. *See ads pages 39, 84.*

35K. *PRECISION APPARATUS* — Catalog describing electronic test equipment for service or engineering shop, lab and field requirements. Also explains principles of *Electronomic* tube testing. *See ad page 42.*

36K. *RCA*—Data sheet on complete line of electronic instruments for home instrument and industrial servicing. *See ads page 59, 3rd cover.*

37K. *SECO*—12-page booklet on using Model 100 dynamic transistor tester to troubleshoot transistorized equipment. Also, 12-page folder describing complete line of Seco test equipment and service aids. *See ad page 67.*

38K. *SENCORE*—4-page brochure on complete line of time-saver instruments. *See ads pages 69, 71, 73, 75.*

39K. *SIMPSON*—Radio, television and industrial test-equipment library featuring VOM's, DC VTVM's, tube testers, etc. *See ad page 53.*

40K. *VIS-U-ALL* — Catalog #59A contains complete description of business-building test equipment. *See ad page 50.*

41K. *WINSTON*—Flyers describing complete line of instruments, including an AGC circuit analyzer, intermittent condition analyzer, induced waveform analyzer, rainbow generator, dot generator, sweep circuit analyzer, and audio system analyzer. *See ad page 81.*

TOOLS

42K. *BERNS*—Data on the 3-in-1 picture tube repair tool and the new "Audio Pin-Plug" crimper that lets you make pin-plug and ground connections for shielded cables. *See ads pages 68, 74.*

43K. *ESICO* — Information on the *GUN-CHOKE*, a simple and inexpensive device that reduces tip temperature for soldering on printed-circuit or laminated boards. *See ad page 70.*

TUBES

44K. *AMPEREX* — Literature on premium quality *frame-grid* tubes. *See ad page 40.*

45K. *RAYTHEON*—Handy 8½" x 11" industrial tube interchangeability guide lists direct substitutions for 262 types.

Have you checked the big dealer profits on RCA Monogram Picture Tubes?

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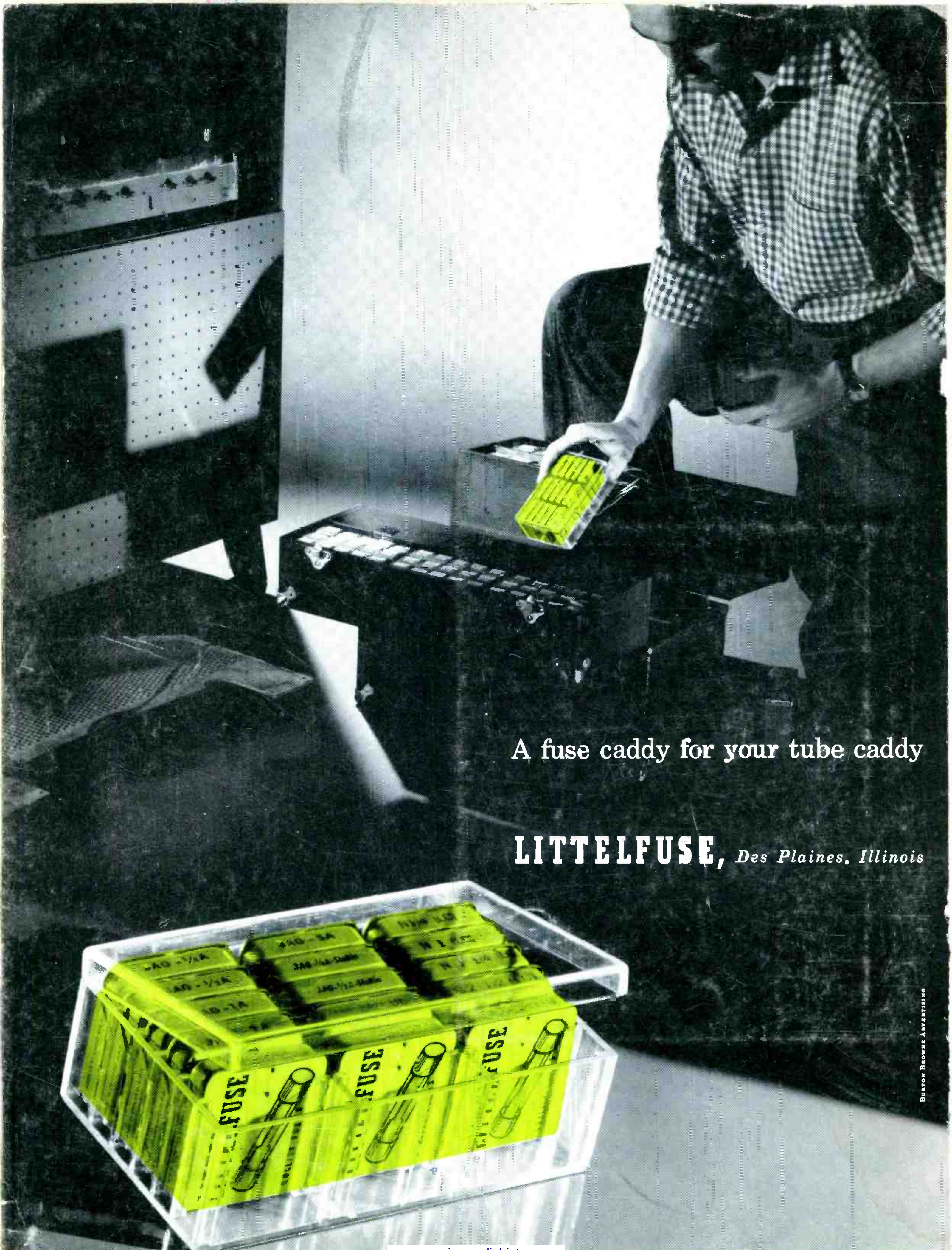
RADIO CORPORATION OF AMERICA

Electron Tube Division ***Harrison, N. J.***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