MAY 1953

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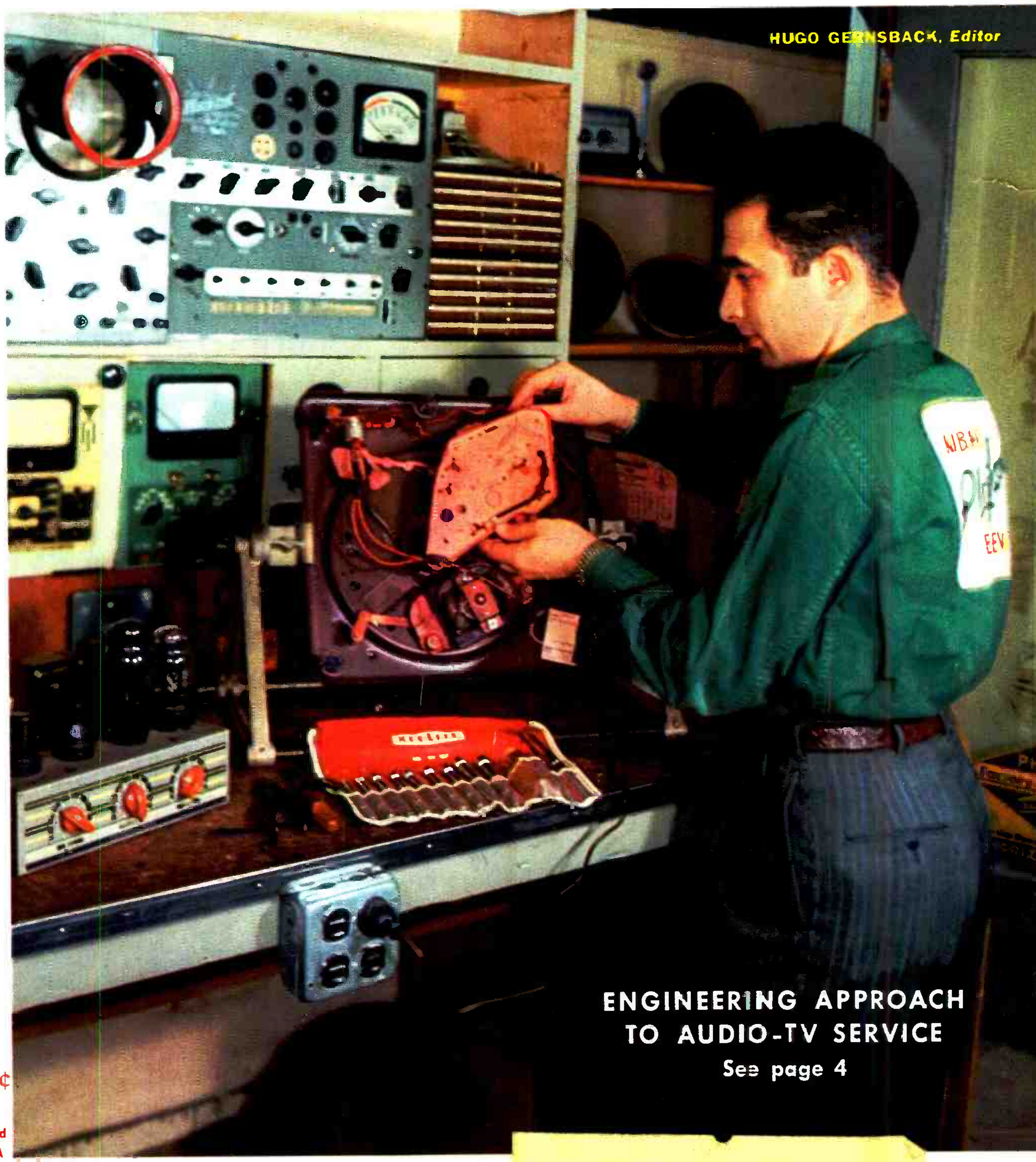

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In this issue: **Two New U.H.**

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Adjusting a record player on the audio service bench of Playhouse Radio & TV, Rye, N. Y.
Color Original by Avery Slack

MEMBER Audit Bureau of Circulations

Vol. XXIV, No. 5

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RADIO-ELECTRONICS DIGEST

. . . In lieu of the single editorial theme, we will from time to time alternate it with various interesting odds and ends of the Industry . . .

By HUGO GERNSBACK

SOUTH AFRICAN TELEVISION. Two American firms, the North American Philips Export Co. and the Atlas Television Corp., are anxious to bring television to South Africa. One of the corporations is prepared to invest $13,000,000 to establish television service there. Admirable as the idea is, the South African Broadcasting Corp., which knows conditions of the country intimately, is somewhat unenthusiastic about the proposal. It feels that the time is not ripe to bring television to the country on account of the language block. According to Gideon Roos, director-general of the S.A.B.C., the country will not be served unless the television service is in two languages, both English and Afrikaans. Says Mr. Roos, "In effect, we will have to operate two television services. All our experience has proved that a service in one language only, or a service in which the two languages are mixed, is not acceptable." He thinks that the cost of broadcasting in two languages would be prohibitive. Programs would probably have to be given in one language, then repeated in the second language later. This makes the whole proposition unwieldly.

Perhaps a way out would be the new Armstrong system, whereby it is now possible, at least on FM, to carry as many as three programs on a single channel simultaneously (see page 12). This means that special television sets would have to be used. Then, while the program is on, simply by throwing a switch on the set the listener could get either English or Afrikaans sound. The picture part, of course, would remain the same, but sound tracks would be broadcast simultaneously in two languages.

South Africa is not the only bilingual country. Switzerland, for instance, has three languages: French, German and Italian; Luxembourg, two languages: French and German; Puerto Rico, English and Spanish. There are many other similar multiple language countries. If the multiple broadcast can be adapted for television, such countries could be served better in the future.

★ ★ ★

QUO VADIS COLOR? Early in March, Senator Edward C. Johnson came up with the statement that "powerful interests are holding back color TV from the public because they are more interested in selling black and white sets." This statement came as somewhat of a surprise to the industry. As a matter of fact, people within the industry know that huge sums are being spent to perfect compatible electronic color television and iron out the few remaining technical bugs. This should make it possible to give us color television within a few years. Says General David Sarnoff, Chairman of the Board of the Radio Corporation of America, "I do not know to whom Senator Johnson refers. It surely cannot be to the Radio Corporation of America. We are doing everything we know how to advance color television for the home. RCA has everything to gain by bringing color TV to the American public at the earliest possible date." Sarnoff furthermore pointed out that his company has spent over $20,000,000 in research work on the development of a commercial system of compatible color television—$5,000,000 of it during 1952.

Other television companies also have spent large amounts on color, as the industry rightfully believes that color is the next great advance in television. Moreover, color is not going to kill black and white sales any more than television killed radio broadcasting. There will always be those who will prefer black and white programs to those in full color.

★ ★ ★

RADIO STREET LAMPS. If the Federal Communications Commission gives its permission, New York City will soon have radio controlled street lights at an estimated annual savings of $500,000.

Today the city street lamps are controlled by astronomical time clocks. They are complicated and expensive gadgets, synchronized to the seasons of the year. Thus the lights are switched on within 15 minutes after sunset and blink out 15 minutes before sunrise.

If everything goes well, the lights work according to plan; but all too often we have seen whole banks of them burning up electricity at noon because some of the relays stuck; and during storms or heavy fogs when it is dark in the middle of the day, the lights, of course, do not go on.

The city asked the FCC's permission that the power of WNYC, the city-owned broadcast station, be "momentarily" increased twice a day for purposes of sending out a control signal. The signal would be picked up by 12-inch antennas on top of each lamp post and fed to a one-tube miniature receiver placed inside the stanchion. The incoming signal sets off a relay turning the light switch on or off. The radio receivers cost only $9 and have a life expectancy of from five to six years. Maintenance for the radio sets attached to each lamp would be less than the annual $5 per lamp which is the cost of the clock system. WNYC would send out a simultaneous aural "beep" signal similar to a time signal so citizens would know that the street lights had gone on simultaneously all over the city. If sudden storms, or thick fogs, that often darken the city during the day occur, the lights can be turned on quickly by an extra signal from WNYC.

★ ★ ★

"PUFF" TELEVISION CONTROL. For the lazy man the Lion Manufacturing Corp. of Chicago has developed a new method of control for television sets. Instead of fiddling around with the station selector, we now have "breath control." It enables the viewer to change stations or turn the volume off or on by puffing into the appropriate opening of the control. The set was developed specifically to aid bed-ridden or immobilized set-owners.

★ ★ ★

THE UNSEEN AUDIENCE. Mr. and Mrs. John McCullough, of Louisville, Kentucky, had been radio listening fans for many years. Recently they ordered a 21-inch Raytheon single-knob control TV receiver—not that they particularly needed it. Indeed, after they had the set installed, they went right back to their radio listening. They explained that they bought the television set so that their friends who called would be entertained by television.

You see, both Mr. and Mrs. McCullough are blind!

THE SCOPE and your POWER SUPPLY

Eliminate guesswork and save time—use a scope to service and design power supplies.

By HAROLD ENNES

WITH the arrival of the television age the popularity of the oscilloscope is growing rapidly in all branches of electronics. Alert service technicians and radio personnel in general, even in areas not yet concerned with TV, are preparing themselves in the fundamentals of scope operation.

The oscilloscope can be a very helpful instrument in testing power supplies. The fact that their behavior can be studied accurately with even the most inexpensive scope is highly valuable in preventive maintenance and trouble-shooting on receiver or transmitter power supplies, as well as in design work and improving old supplies.

Let's look at the fundamentals of a single-phase full-wave rectifier. Fig. 1-a illustrates the basic action. Curve A is the voltage across a resistive load *without* a filter. When a filter capacitor is shunted across the resistance load, the capacitor charges to the peak voltage at the output of the rectifier and starts to discharge as soon as the voltage drops (Curve B). On subsequent half-cycles the rectifier will pass current only when the rectified voltage is greater in amplitude than the capacitor voltage (Fig. 1-b). This is the interval between x and y on curve A. The capacitor is charged to its maximum voltage value (curve B) at the time corresponding to the positive peak of each rectified current pulse, then discharges through the load in the interval between pulses. Thus the rectifier supplies current in sharply rising pulses represented by curve C. For a given transformer voltage and load resistance the peak current through the rectifier increases with the size of the input capacitor. Note the quick build-up of the capacitor charge when the tube conducts, and the relatively slow discharge through the resistive load when the tube current ceases. After the initial charge, *before* point X and *after* Y on curve A, the diodes' plates are below the capacitor voltage and conduction cannot occur.

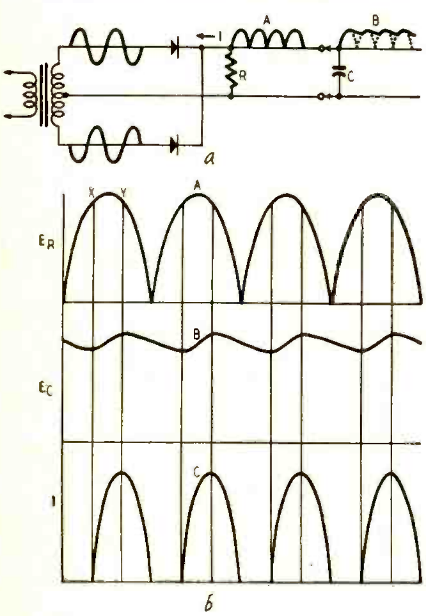


Fig. 1—(a) Voltage waveforms in full-wave rectifier circuit, showing how capacitor raises *average* voltage. (b) Current I flows through rectifier only in short pulses over interval marked X-Y.

Before connecting up any scope to observe power-supply conditions, make sure the voltages in the circuit do not exceed the maximum-signal-input rating of the scope itself. Also consider whether to use a direct connection to the deflecting plates or to use the vertical amplifiers in the scope. These factors are pointed out in each application to be described.

Checking filter operation

A number of conditions may be observed with the connection shown in Fig. 2. The vertical input terminals of the scope are connected directly across the filter choke. The amplitude of the trace at this point is usually great enough to allow the signal to be fed directly to the vertical deflecting plates, although the vertical amplifier may be used if desired. (**Caution:** Practically every general-purpose scope has one terminal of each input circuit grounded to the case. The hookup shown in Fig. 2 puts the full output voltage of the power supply directly on the scope case. **This is a highly dangerous situation. Do not attempt to make measurements of this type without taking every possible precaution to avoid a fatal shock from contact with any part of the oscilloscope—*Editor*.**)

The scope sweep should be adjusted to show two or three alternations on

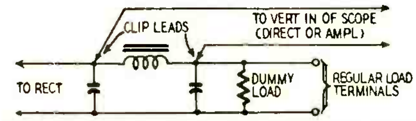


Fig. 2—Connections for checking filter waveforms. See warning note in text.

the screen. The normal power-supply load may be removed and a suitable dummy-load resistor substituted across the filter output.

A normal pattern obtained from this connection with good input and output capacitors and normal load current is shown in Fig. 3-a. The slope of the discharge trace depends on the resistance of the load. The higher the resistance, the slower the rate of discharge will be. If the power supply is in good operating condition, the discharge trace will be straight and smooth.

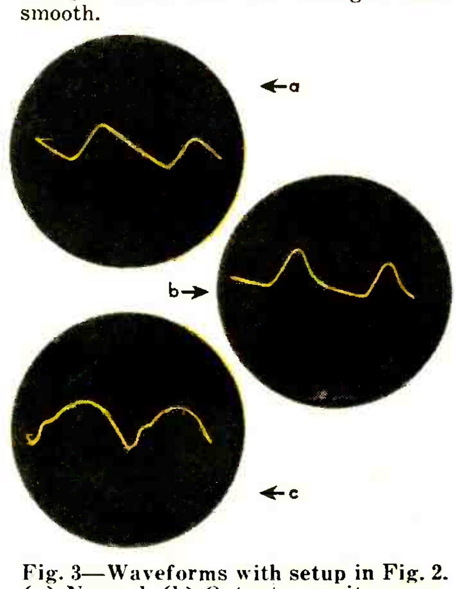


Fig. 3—Waveforms with setup in Fig. 2. (a) Normal. (b) Output capacitor open. (c) Input capacitor open or inadequate.

If the output capacitor is open or partially open, the waveform will look like Fig. 3-b. The effect of the choke inductance is readily apparent and the rate of discharge is no longer linear. A completely open output filter capacitor can usually be recognized by excessive hum or motorboating, but a partially open capacitor may go undetected until a customer has used his set a few days after a service job Thus any test that will anticipate possible future trouble is well worth the time consumed.

A completely open *input* filter capacitor shows up in low-voltage output and may also introduce excessive hum. Again, however, this condition can sometimes be anticipated with the scope, as illustrated by Fig. 3-c. This pattern across the choke reveals an open or partially open input capacitor. The height of the hump will depend on the amount of input capacitance left in the circuit. (The same is generally true of Fig. 3-b, where the steepness of the discharge curve just after the charge peak will depend on the effective output capacitance for a normal load current.)

In general the input filter capacitance affects voltage output and ripple (hum) content, and the output filter capacitance controls the amount of ripple in the d.c. delivered to the load. Another factor relating to adequate output filter capacitance should be borne

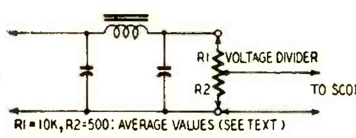


Fig. 4—Voltage divider for reducing d.c. output voltage to safe value for connection to scope deflecting plates.

in mind by the reader concerned with high-fidelity audio amplifiers or transmitters. The reactance of the output filter capacitor must be negligible at the lowest audio frequency to be amplified efficiently.

Measuring ripple

The simplest way to determine the amount of ripple in the output of the power supply is to compare the a.c. component of the output with the output of a voltage calibrator. (Before proceeding with these ripple measurements check whether the d.c. output of the power supply is higher than the maximum-signal-input rating of the scope. If it is, you will have to make up a simple resistance voltage divider as shown in Fig. 4.)

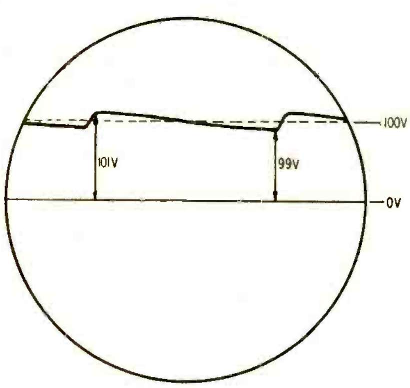


Fig. 5—Typical scope trace with d.c. output of power supply applied to deflecting plates. See text for method of computing the percentage of ripple.

Feed the output of the calibrator to the scope vertical input (through the voltage divider, if required) and adjust the over-all height of the trace with the scope vertical gain control to fill the required number of calibration lines. For example, if the calibrator output is 50 volts peak-to-peak, it should fill 25 or 50 horizontal lines. It

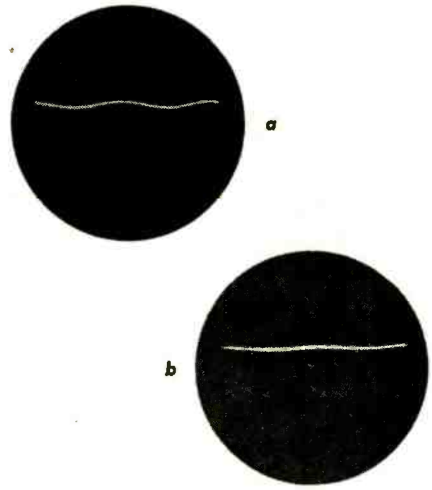


Fig. 6—(a) Power-supply output waveform with open output filter capacitor. (b) Waveform with open input capacitor.

is not necessary to balance the trace uniformly on either side of the center line.

Then—*without changing any of the scope adjustments*—disconnect the calibrator and hook the vertical input leads of the scope (or the voltage-divider leads) across the power-supply output terminals. The blocking capacitor in the scope input circuit will pass only the a.c. component of the power-supply output voltage. The peak-to-peak ripple voltage can then be read simply by counting the total number of horizontal calibration lines occupied by the trace.

To find the ripple percentage, measure the d.c. voltage at the scope input terminals and apply the following formula:

$$\text{Ripple } \% = \frac{35 \times E_{pp}}{E_{dc}}$$

where E_{pp} is the peak-to-peak ripple voltage and E_{dc} is the measured d.c. voltage.

If no voltage calibrator is available, the ripple can be computed by observing the actual variation in d.c. output voltage on the scope. To do this, first lock the scope sweep at the *line frequency*, so that *two complete ripple cycles* will appear on the screen with a full-wave rectifier. Short out the vertical input terminals and adjust the position of the sweep trace so that it coincides perfectly with one of the horizontal calibration lines near the bottom of the calibrating screen.

Next, apply an accurately known d.c. voltage (a 100-volt B battery, for example) directly across the vertical deflecting plates of the scope. This will shift the trace vertically, but it should still remain perfectly horizontal. Now switch the scope input to the voltage divider across the power supply. Adjust the divider output for the same vertical displacement obtained with the battery, and center *one* of the ripple cycles exactly on the horizontal calibration line.

The peak-to-peak a.c. component (ripple) can now be found by counting the number of horizontal lines between the left and right ends of the cycle.

This method of measurement is illustrated in Fig. 5. The test is most accurate when a screen containing a sufficient number of fine lines is used. Assume, for example, that the trace is as shown in Fig. 5, with the left end of the trace showing 101 volts and the right end showing 99 volts. In the above example, the actual ripple is 1 volt (varies 1 volt above and below d.c. level), and the percentage ripple is therefore 100 x 1/100, or 1%. This amount may be considered satisfactory for many receivers and PA systems, but the maximum allowable for high-fidelity equipment is 0.5%. This amount is hardly calculable on the scope and will appear as a perfectly straight line.

Figs 6-a and 6-b illustrate filter output traces under two typical conditions for a typical full-wave rectifier system. 6-a illustrates the trace *without* an output capacitor, and 6-b shows the same system without an *input* capacitor. Note that hum is greater without the output capacitor than without the input capacitor. The voltage output is lower, and the performance of the amplifier might be poorer.

Selenium rectifiers

The condition of a selenium rectifier also may be checked with the oscillo-

TABLE I

Rectifier Rating (ma)	Load Resistor (ohms)
75	2,000–3,000
100	1,200–1,800
125	960–1,200
150	800–950
200	600–800
300	400–600

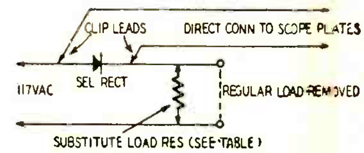


Fig. 7—Scope connections for checking condition of selenium rectifiers. See Table I for suitable values load-resistor.

scope, and impending troubles anticipated. Remove the normal load and substitute a load resistor as indicated in Fig. 7. The selenium unit should be loaded just under its maximum rating with suitable resistors as indicated in Table I. Connect the vertical deflection plates of the cathode-ray tube directly across the unit as shown.

The selenium rectifier is composed of a number of metal plates which have one side coated with selenium and a low-temperature alloy. As the selenium unit begins to "show its age," or, when minute arcs develop from excessive moisture on the plates, the conduction in the *undesired* direction increases and rectifier action is impaired. Typical traces on the scope with the setup of Fig. 7 are illustrated in Figs. 8-a, 8-b, and 8-c. A good unit will give the pattern shown in *a*. A deteriorating selenium unit will produce a trace like the one in *b* when operated near its maximum load. (It should be noted that some hump will appear normally if the rectifier is not loaded properly.) Fig. 8-c is the trace produced by an unsatisfactory unit.

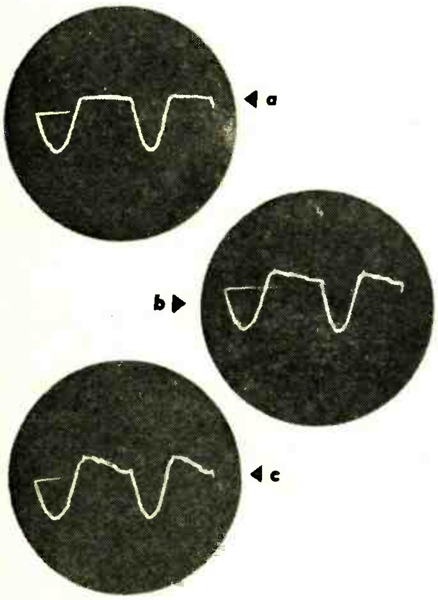


Fig. 8—Selenium-rectifier waveforms obtained with setup shown in Fig. 7. (a) Good unit. (b) Rectifier beginning to show back conduction. (c) Faulty unit.

Another use for the scope in power-supply testing is checking for r.f. in transmitter power supplies. Use well shielded test leads to avoid picking up r.f. in the leads themselves, and connect a suitable r.f. bypass capacitor across the vertical input terminals of the scope. The setup is shown in Fig. 9. The idea is to examine the effect of any r.f. energy on the power-supply waveshape. The scope amplifiers are connected to one side of the line at the power tranformer, and the ground lead is simply clipped to chassis.

If there is no r.f. feedback, the pattern will be a pure sine wave. A large amount of r.f. in the supply will produce the pattern shown in Fig. 10.

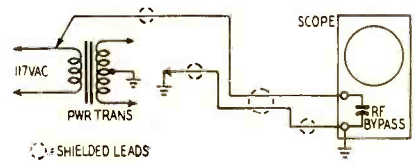


Fig. 9—Scope connections for checking r.f. feedback in transmitter power supply.

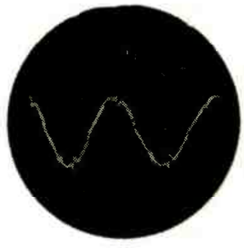


Fig. 10 — Scope trace showing considerable r.f. in transmitter power-supply.

Mercury-vapor rectifiers

The oscilloscope method of checking the operating characteristics of mercury-vapor rectifiers is invaluable in preventive maintenance on such supplies. The mercury-vapor tube is widely used in high-power PA systems, class B modulators, and transmitter supplies, yet methods of testing such tubes are perhaps the most unreliable of any type of tube check. In previous years the technician could anticipate a mercury-vapor tube reaching the end of its useful life by the appearance of an unhealthy yellowish glow in the normal blue color under conduction. In recent years—perhaps due to some change in method of manufacture—gaseous rectifiers will expire or arc-back when still appearing perfect by visual inspection under conduction.

Mercury-vapor-tube operation may be observed by leaving the tube in its socket with the filament voltage on and removing the plate cap. (For tubes without a plate cap such as the 82 and 83, a separate socket should be used with filament voltage only.) It is advisable to use an isolation transformer (1:1 ratio) for applying the a.c. To load the tube properly, place a 50-ohm, 200-watt resistor in series with the a.c. to the plate terminal as shown in Fig. 11. Connect the vertical deflecting plates of the cathode-ray tube directly across the rectifier tube as shown.

A typical scope trace is illustrated in Fig. 11. With the internal sweep adjusted to display one cycle of the wave, the user may study the nonconducting negative alternation; the arc-drop at the firing point of each cycle at the start of the positive alternation; and the shape and amount of the d.c.-conduction drop. The face of the tube should have a ruled mask so that beam deflection may be calibrated with a battery or voltage calibrator.

The only 100% perfect test for mercury-vapor rectifiers in high-voltage supplies operating very near the tubes' peak-inverse voltage rating, is to substitute new tubes *one at a time* and note meter readings or any defects such as arc-across or arc-back within the tube. In commercial transmitters such occurrences operate the associated overload relays. However, a number of defects and signs of pending trouble may be detected by scope analysis, and this procedure is highly recommended for communications and broadcast-service personnel.

Fig. 12-a illustrates the trace with a good tube. The arc-peak is about 12 volts, the d.c.-conduction curve almost flat with a drop of around 8 volts. The height of the arc-peak is a very important characteristic of a mercury-vapor rectifier. Fig. 12-b illustrates a tube beginning to develop a high arc-drop, in this particular case about 22 volts. When this peak approaches 30 volts, the tube should be checked on the scope about every 5 days when in continuous service. When a value of 40 volts is indicated, the tube should be discarded.

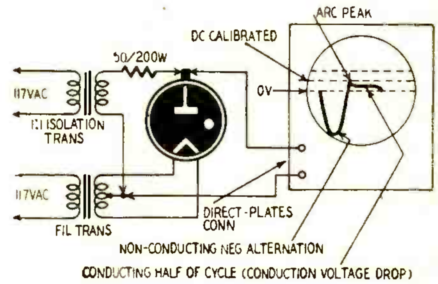
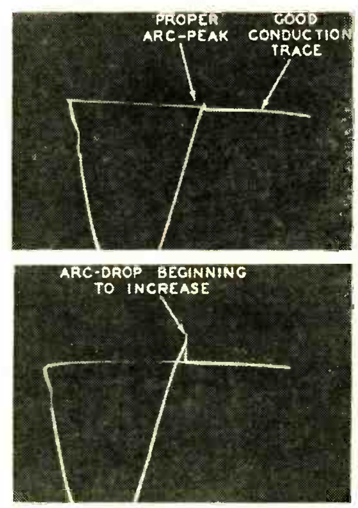


Fig. 11—Arrangement for checking performance of mercury-vapor rectifiers. Note that rectifier *is not* tested under normal high-voltage working conditions.

Another important factor is the shape and magnitude of the conduction trace. Aging of a tube is revealed by the trace in Fig. 13, showing a hump in the conduction curve. The advantage of scope analysis over the usual method of measuring the d.c. voltage at which the tube breaks into conduction should be apparent. When the voltage drop across a mercury-vapor rectifier exceeds approximately 22 volts, positive-ion bombardment leads to rapid disintegration of the filament. Scope tests show that this may occur over a



a

b

Fig. 12—Mercury-vapor rectifier waveforms. (a) Trace produced by good rectifier. Note small arc peak at beginning of horizontal trace. (b) Aging tube shows a higher arc peak at conduction.

considerable portion of the conduction interval *without* occurring at the beginning of conduction immediately after the arc-strike. When this hump reaches about 18 volts, the tube should be retired.

Still another defect of mercury-vapor rectifier tubes is observable by this

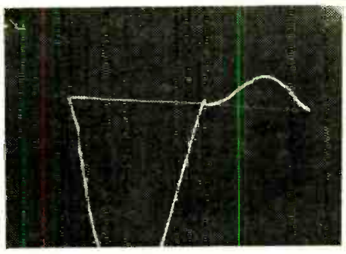


Fig. 13—Hump during conduction interval indicates rapidly-weakening mercury-vapor rectifier. Tube should be discarded when hump peak is over 18 volts.

scope test. Fig. 14-a illustrates the beginning of a transient "pip" immediately after the arc-peak. Fig. 14-b shows a tube in which this condition has passed into a decided series of transients. A tube showing this characteristic will invariably arc-back

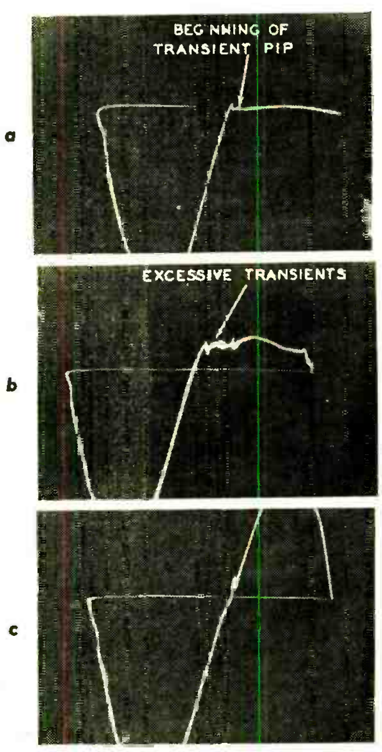


Fig. 14—(a) Tiny transient following arc peak shows breakdown at full peak-inverse voltage. (b) Series of transients indicates tube must be operated at reduced peak-inverse-voltage ratings. (c) Worn-out mercury-vapor rectifier shows almost pure a.c. output on test.

when operating near its peak-inverse voltage rating. Such a tube, however, may be operated satisfactorily for some time longer in a circuit supplying less than half the peak-inverse rating. Fig. 14-c illustrates what happens when the tube has reached the end of its useful life. This tube glowed blue only around the base. END

POWERING AUDIO PREAMPS

By J. P. C. McMATH

THE popularity of the G-E and other similar low-level magnetic pickups has resulted in many preamplifier installations on commercial radio receiver combinations and PA amplifiers. In most cases the heater and plate power are obtained from the receiver or amplifier. Unless precautions are taken, this often results in an unsatisfactory installation.

First, consider the plate supply. Many commercial preamplifiers do not provide any plate decoupling network. If such a preamplifier is fed directly from the plate supply of an average receiver, the hum level will be high, and low-frequency oscillations are very likely to occur. The remedy is to provide suitable decoupling and filtering, such as the circuit shown in Fig. 1. If available, a suitable audio choke can be used in place of the input filter resistor, with even better results. However, orient the choke for minimum coupling with the stray field from the power transformer, to avoid risk of hum pickup from this source.

Second, consider the heater supply. Almost all commercial receivers, and many PA amplifiers, have one side of the heater supply grounded, and most use the chassis as the ground conductor. This causes excessive hum in low-level audio circuits. Good audio construction requires a center-tapped or balanced heater supply, preferably using twisted-pair wiring. And hum can often be reduced greatly by biasing the heaters about 10 to 20 volts positive with respect to the cathodes, to prevent emission from heater to cathode. This is mentioned in most tube manuals, but is not employed nearly as often as in the writer's opinion it deserves. Another way to reduce hum is to cancel it out by introducing an out-of-phase hum signal at some suitable point. The difficulty here is that in general the waveform of the hum voltage is considerably different from that of the canceling voltage, so that complete cancellation is impossible. A circuit which combines all three of the above hum-reduction methods, and which is very easy to install and adjust, is shown in Fig. 2.

The adjustment procedure is as follows:

1. With the 100-ohm "hum-dinger" across the filament winding of T1 set at approximately half position, and the amplifier at full gain (with preamplifier connected and energized, and preferably with turntable motor running) gradually increase the voltage with the 10,000-ohm potentiometer. At a certain position, depending on the type of preamplifier tube and circuit used, the hum will drop markedly. If the bias is increased very much beyond this point the hum may again increase slightly due to heater-cathode capacitance.

2. Now vary the 100-ohm "hum-dinger." Unless the main amplifier has an extremely low hum level the optimum setting will generally be toward one end, rather than at the center; the hum being increased on one side of center and reduced on the other side.

Using a common commercially available preamplifier which uses a 6SL7-GT tube (not too good a choice for low-noise applications) and the circuits of Figs. 1 and 2, on an average PA amplifier the hum was reduced from an intolerable level to near zero, and the results on several large radio-phono combinations have been equally good.

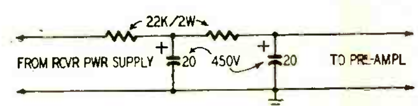


Fig. 1—Decoupling filter for preamp.

The parts values shown are not particularly critical. In Fig. 1, the filter resistors should be chosen with regard to current requirements of the preamplifier, and the supply voltage. The values shown are typical. In Fig. 2, the series-dropping resistor should be chosen to suit the supply voltage, to give about 20 volts at the high end of the 10,000-ohm resistor. The capacitor may be as large as desired—the bigger the better. The "hum-dinger" should be about 100 to 300 ohms, the lower values being preferable. The biasing potentiometer may be from 2,000 to 10,000 ohms, provided it receives approximately 20 volts at its high end.

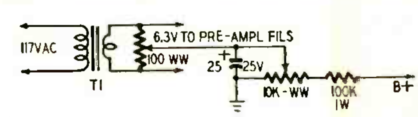


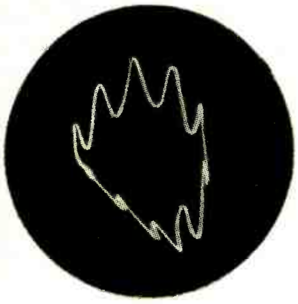
Fig. 2—A hum-bucking bias circuit.

In some cases, it may be necessary to reverse the supply leads to T1 to obtain the optimum adjustment. It is an ordinary filament transformer, 6.3 volts at 1 amp, and should be fed from the receiver or amplifier a.c. supply rather than from a separate plug, so that adjustments, once made, will be permanent and not dependent on correct insertion of power plugs. Mount it far enough from the preamplifier tube so that its stray field and lead wiring will not become a source of hum. Very often this and the other components can be mounted on the main chassis near the existing power-supply components. END

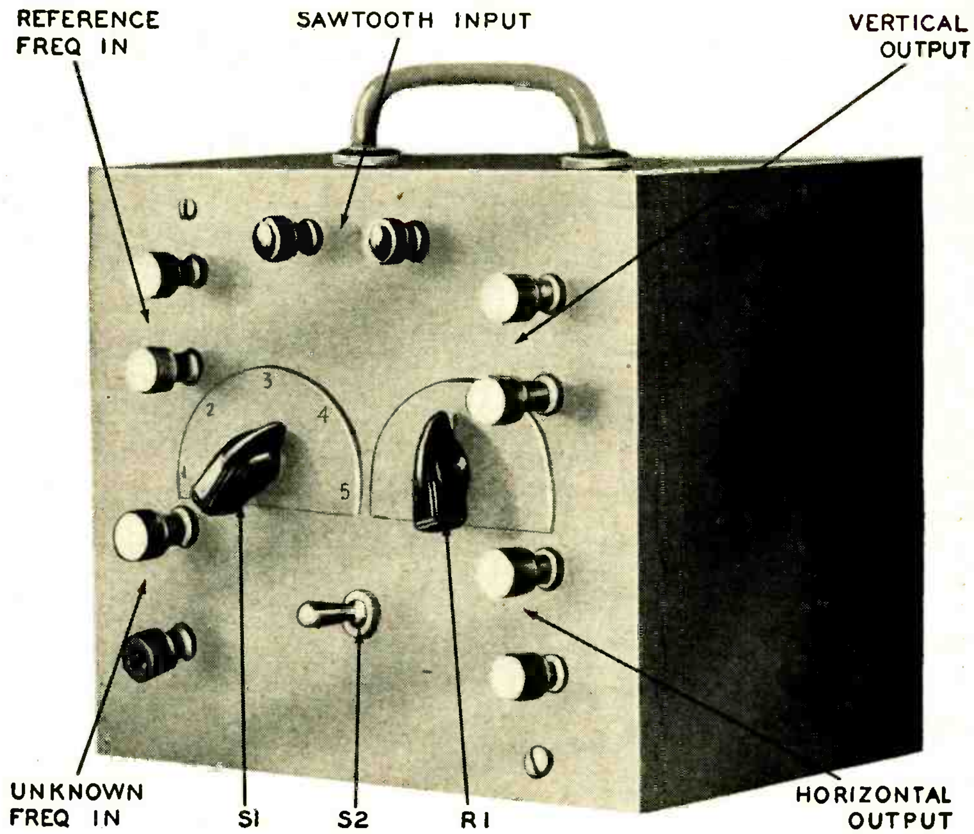
*Assistant Professor in Electrical Engineering, The University of Manitoba, Winnipeg, Man.

SIMPLIFY FREQUENCY RATIO CHECKING!

By CARL L. HENRY



This ratio pattern is not perfectly circular but cycles can be counted easily.



The frequency-ratio checker is a handy portable case. Labels refer to Fig. 4. Terminal arrangement and layout can be varied to suit individual requirements.

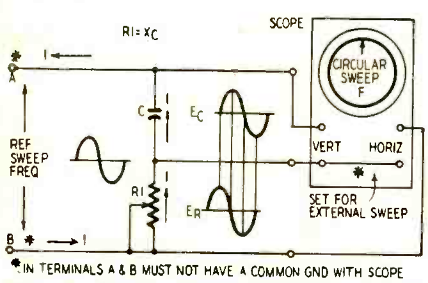


Fig. 1—Basic phase-splitting circuit.

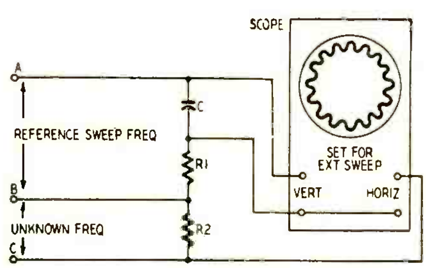


Fig. 2—Typical display of 16:1 ratio.

When checking frequency ratios with an oscilloscope, I have frequently been forced to waste valuable time switching from a scope with sinusoidal sweep to one with polar or circular sweep in order to get a better check on high-frequency ratios. I solved the problem with this simple gadget. It provides five different basic patterns and greatly extends the range of ratios that can be checked on an ordinary oscilloscope. With this instrument and a basic knowledge of patterns one will have no trouble checking any oscilloscopic frequency pattern.

The instrument is simply a device for displaying the frequency to be measured on a *circular* time base. This is equivalent to stretching the usual straight-line oscilloscope sweep to as much as three times its normal length, and allows up to three times as many cycles of the unknown frequency to be seen and counted. The basic phase-splitting circuit is given in Fig. 1. C and R1 form a series circuit. The same current I flows through both, and develops voltages across each of them. By Ohm's law, the voltage across R1 will be $E_{R1} = IR1$, and the voltage across C will be $E_c = IX_c$. If $X_c = R1$, the voltages E_{R1} and E_c will be equal;

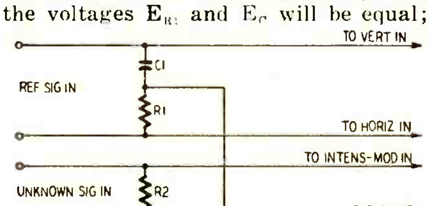


Fig. 3—With this method of feed the unknown frequency produces a dotted circular trace on the 'scope screen.

the voltage across R1 will be *in phase* with the current, but the voltage across C will *lag* the current by 90°. If the signals at the ends of the network are fed to the vertical and horizontal inputs of the oscilloscope, they produce a *circular* sweep trace. The circumference of the circle represents the time of one

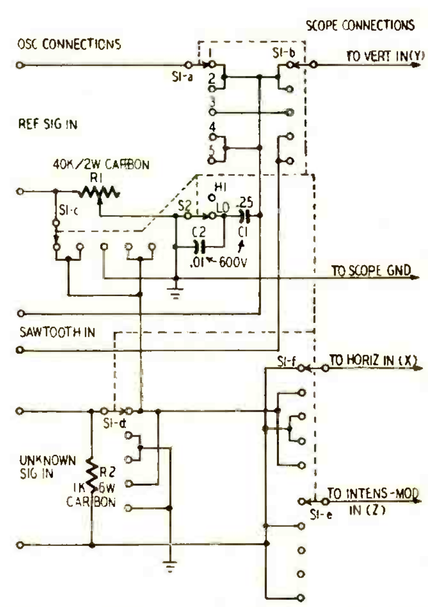


Fig. 4—Schematic of the ratio checker.

ENGINEERING APPROACH TO AUDIO-TV SERVICE

By KAY KIBLING

MY husband, Charles Kibling, and I established Playhouse Radio in 1946, on the sole conviction that there was a dire need for the professional approach to both audio and video servicing. Though both of us are long experienced in the field of radio, we were advised against that approach, on the ground that "specialists are gamblers." It has been gratifying to note that—even though people are skeptics—they will buy service if they are *given service*. And they will travel far to purchase their audio or TV instruments if the purchase is backed up by confidence in a sound engineering laboratory and competent personnel.

Playhouse Radio-TV has from the beginning specialized in high-fidelity sound, with the firm recognition that the music lover is too often led astray with so-called "custom installations" of sound equipment instead of true high-fidelity. Too many dealers have abused the trend toward better sound reproduction with "Custom" high-pressure. They even refer to the installation of a 5-inch speaker as a custom job, simply because the unit is concealed in the customer's cabinet or bookshelf. Over-the-counter sales of component units are also often influenced by sales rather than technical considerations, so the customer gets a tuner-amplifier-speaker package which gives him the acme of mismatch from input to output.

For proper demonstration, Playhouse has a relaxing acoustically treated high-fidelity sound room, carpeted, draped, and with four layers of acoustic plaster suspended in the center portion of the ceiling, surrounded by deep air-modules for the purpose of keeping the bass tones alive. The room is furnished like a living room, and offers the customer an opportunity to hear different combinations of high-fidelity equipment, to satisfy his ear response before having the equipment molded into his walls or chosen cabinet. This type of customer —properly served and satisfied—makes the best type of mobile advertisement.

The same principles bring success in television service. Each of the vehicles used by our technicians and installation crews is completely fitted out with all necessary equipment and parts to expedite servicing. Each car is equipped with a portable TV set, into which has been installed a microammeter for antenna signal strength readings. The proven theory behind this practice: *A meter will make a liar out of the eyes every time*. All antennas are oriented with these microammeter measurements, not with a mariner's compass or by the neighbor's antenna!

Our motto, "Engineering first, sales second," does not mean that handling sales has not been of primary importance in its own turn. We find that most TV shoppers are confused and fearful of their own ability to reach the final decision as to the proper unit for their investment. We—and each of our sales representatives—spend much time with each customer, screening the needs of the family, the particular room where the unit is to be placed, the type of furnishings in the room, and last—but of extreme importance—where, within the budget, would the interested persons wish to confine this expenditure. On this basis, recommendations are made. We can fit any person's pocketbook and any person's living room. The salesman at Playhouse recommends that the customer not buy from the sales floor, but that he live with the TV set of his assumed choice for an evening's performance in the home. Only under these conditions can our customers determine what sets will be theirs for relaxation and acceptance.

Playhouse has never ever believed the paid-in-advance contract to be either fair or necessary. From our first television sale, we have employed a pay-as-you-go contract, with a limited expenditure assurance, beyond which the service is rendered free of charge till the termination of the contract. This policy dispenses with the usual "nuisance calls" of the contract holder who has paid for a year's service, and, periodically and unnecessarily, decides to demand attention. These calls are dangerously demoralizing to the valued technicians and costly to the management. With the pay-as-you-go plan, it is certain that the customer is having trouble when he calls, for he knows he is going to pay for the service. END

(*Continued from page 34*)
complete cycle at the input reference frequency.

By adding a second resistor R2, as shown in Fig. 2, the frequency to be measured can be fed to the scope in series with the horizontal input. If the unknown frequency is higher than the frequency of the circular sweep, the pattern will have the gear-tooth form shown in Fig. 2. The unknown frequency can be found by simply counting *either* the external or internal teeth (not both) and multiplying by the sweep frequency.

We can expand the base line and increase the frequency range of the instrument still further by using a *spiral* sweep. If we feed a very low frequency *sawtooth* wave into the scope in series with the vertical-input lead, the linear change in sawtooth voltage will produce a spiral trace.

If the scope is equipped with an INTENSITY MODULATION (Z-axis input) terminal, the unknown frequency can be fed in as shown in Fig. 3. This will produce a dotted trace instead of a gear-tooth pattern as each negative peak of the unknown frequency blanks out the sweep trace. (If the unknown-frequency signal is not strong enough to blank the beam completely, try reducing the scope's INTENSITY control.)

A wide range of sweep frequencies can be covered by making R1 adjustable, and by changing the value of C. The values used in the final circuit (Fig. 4) will handle sweep frequencies from as low as 10 cycles to over 200 kc. **One important precaution:** The ground sides of all the various input circuits must be isolated from each other and from the scope ground terminals.

The 6-pole, 5-position switch S1 in Fig. 4 provides 5 different combinations of sweep and modulation for frequency checking. S2 gives a change of approximately 25 to 1 in the capacitance arm, and the 40,000-ohm range of R1 allows the input resistance to be balanced exactly against the reactance of the capacitor selected.

In position 1, the circuit is connected for gear-tooth modulation of the circular sweep by the unknown frequency. Position 2 switches the unknown frequency to the INTENSITY MODULATION (Z-axis) input of the scope for dot modulation. Position 3 feeds the unknown frequency to the HORIZONTAL (X-axis) INPUT terminals of the scope for checking with standard Lissajous' patterns. (See "Calibrating Audio Oscillators," by Norman H. Crowhurst, in RADIO-ELECTRONICS for November, 1952.) This position is for checking very low frequency ratios.

Position 4 gives a *spiral* sweep (with a low-frequency sawtooth applied to the SAWTOOTH INPUT terminals) which is useful in checking very large ratios, such as 50:1, 100:1. The basic circuit is similar to position 1, except for the addition of the sawtooth in series with the scope's vertical (Y-axis) input.

Position 5 gives a spiral sweep intensity-modulated by the unknown signal. With this type pattern it is possible to check ratios as high as 200:1.

The small photo is a pattern photographed directly from the screen of an inexpensive scope. While the reference sweep is far from a perfect circle, the number of teeth can be counted accurately to show the frequency ratio.

The unit was built in a 7 x 5 x 3-inch wooden case. The sawtooth signal for the spiral sweep was taken from the Du Mont model 208 oscilloscope used to read the ratios. The spiral sweep will not work properly unless the sawtooth frequency is *lower* than the sweep frequency. END

NARROW GAUGE MOTION PICTURES

Part II—More on servicing 16-mm sound-film projectors—handling optical systems and mechanical elements—sources of business and film libraries

By RONALD A. LANE

THE first installment of this article described the general features of narrow-gauge motion picture apparatus, with the idea of giving the service technician a certain feeling of familiarity with it. This installment describes details and service methods.

The audio amplifier and some of the magneto-optical switching arrangements of the equipment of Fig. 1 (Figs. 1 and 2 appear in the first part, in the April 1953 issue) are concealed behind the left panel. The microphone (for magnetic recording) is mounted on a desk stand, and the loudspeaker is in a separate carrying case.

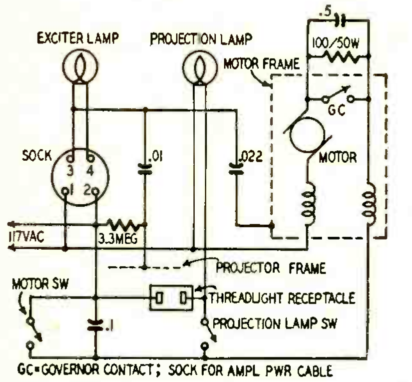


Fig. 3—Wiring of control switches and unit interconnections in Eastman Kodak 16-mm sound-film home projector.

Physical arrangements naturally vary as between different makes and models. In the projector shown in the photo the audio amplifier is underneath and not behind the mechanical and optical equipment. The projection lamp is inside the ribbed turret; the takeup reel is at the rear instead of at the front of the assembly. (In still other projectors the takeup or "lower" reel is actually at the *top* rear.)

A variation not pictured here is use of an arc lamp for projection light where the screen is large and an incandescent lamp may not provide enough illumination. Arc lamp powers range upward from 1 kw minimum, as a rule. Since the arc must be supplied with high-amperage, low-voltage d.c., a suitable rectifier is commonly added. This will use either Tungar tubes or selenium stacks, and a tapped transformer or other means of regulating the voltage fed to the arc, but no ripple filter.

Figs. 3 and 4 show the electrical wiring of two different 16-mm projectors —both by Eastman Kodak, but not the same model. Fig. 3 is typical of standard practice. Fig. 4 is the most complex and elaborate 16-mm unit produced in this country, having no less than 5 interlocked driving motors (instead of the customary one motor).

In Figs. 3 and 4 exciter lamp supply is d.c.—obtained through a rectifier—but more recent practice is to use high-frequency a.c. obtained through an oscillator tube. Fig. 5 shows this type of arrangement. V7 is the oscillator. The same high frequency (super-audible but hardly r.f.) is used also, by switching, for the erase head of the magnetic recorder. Fig. 5 is the electronic circuitry of the equipment of Fig. 1.

Servicing 16-mm projectors

Servicing 16-mm equipment involves four kinds of requirements, two of which are highly familiar to radio repairmen, the other two perhaps slightly strange. Electrical and electronic servicing will involve no particular difficulty. Circuits are conventional and familiar. Most components are standard items on the open market. However, motors, some optical elements, and magnetic erase and record heads are likely to be special items. Policies of different manufacturers with respect to supplying these will be stated in a moment—as soon as the requirements of optical and mechanical servicing have been reviewed.

Optical servicing usually involves nothing more than cleanliness. Dirt in the light path means a duller picture or lower volume sound (from an optical soundtrack); or dirty picture and noisy sound. The projection lamp, its associated mirror or condenser lens or both, the projection lens, the exciter lamp, the exciter light lens or mirror or optical tube as the case may be, and the surface of the photoelectric cell facing the exciter light, all must be kept clean. Lubricating oil is the principal form of soil.

In general, optical surfaces are cleaned with *dry* lens tissue. This is a special tissue paper that leaves no lint. Camera supply firms and motion picture theater supply firms have it; so do dealers in optical goods. The glass

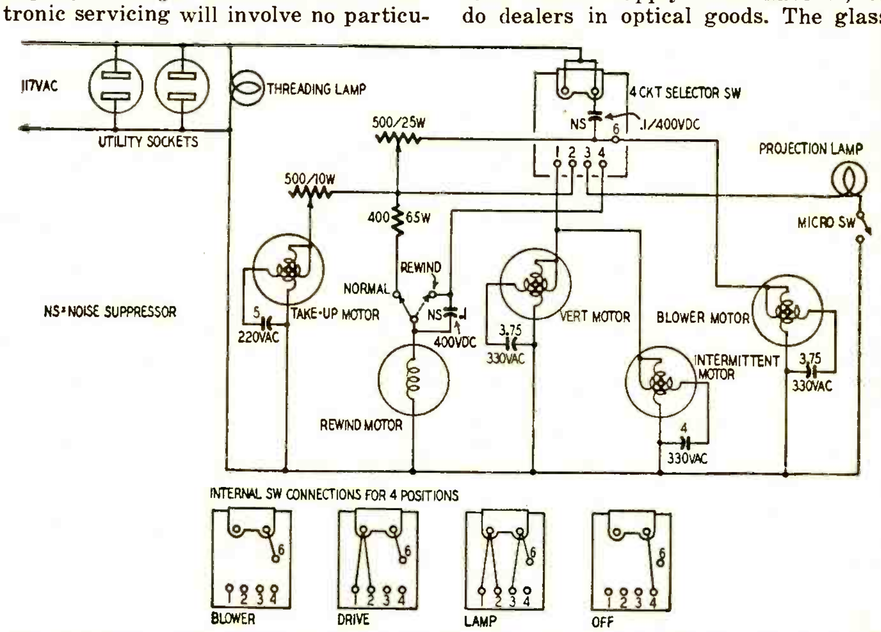
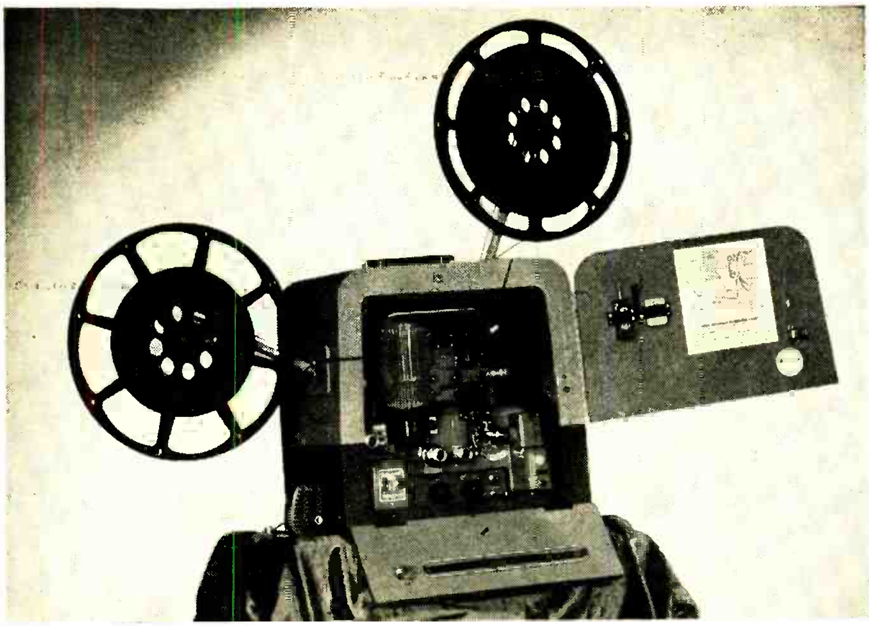


Fig. 4—Operating circuits and switching of Eastman Kodak professional model 16-mm sound-film projector. Individual motors are provided for every function.



Bell & Howell *Filmosound 202* optical-magnetic sound-film recorder-projector.

surface to be cleaned is simply wiped off carefully with dry lens tissue.

In the case of the projection lens, however, the manufacturer's instruction book should be consulted, since most lenses used for projection nowadays have been given special surface coatings to a depth of only a few molecules to reduce surface reflection and improve light efficiency. Some of these coatings are impaired by cleaning. Check the instruction book.

Projection lenses always, and exciter lamp optics often, are compound—made of several lens elements suitably assembled. Avoid taking these apart for cleaning or any other purpose (at least, unless a spare is at hand). Many optical assemblies in common use cannot be reassembled accurately without factory jigs and fittings. In some, lens elements are cemented together with Canada balsam. Recementing these if they come apart involves special skill. Unless the radio repairman has had considerable skill and experience in optical work, it will be best to treat any optical assembly as a unit, replacing it as a unit if necessary. Optical elements, however, do not wear out; and unless dirt gets into them or lubricating oil seeps in, they should need no servicing except cleaning and repositioning.

Optical elements must be correctly positioned for efficiency and focus. Whenever a new projection lamp is installed, it must be so positioned and focused that the image of the filament does not show on the picture screen. Trial and error and the manufacturer's instruction book will soon teach this simple skill. The projection lens must be adjusted to bring the picture into the sharpest possible focus. If the picture does not fill the screen, or overlaps it, move projector and screen toward or away from each other until the picture fits, or substitute a projection lens of different focal length.

Positioning and focusing of optical elements associated with the optical soundtrack vary in details in different makes of equipment. Details in each case will be found in the manufacturer's instruction book. In all cases, adjustment can be checked with test reels and a decibel meter. Suitable test reels are sold by the Society of Motion Picture and Television Engineers.

Mechanical servicing

Mechanical troubles are of two general kinds. Misadjustments need to be corrected and worn parts need to be replaced. Manufacturers' instruction books are a useful guide, although they differ in the thoroughness of the instructions.

A common example of wear is represented by undercut teeth in sprockets or driving claw. This results from frictional contact with the film despite the fact that the teeth are harder than the film—some are even jeweled. They wear eventually, and when undercut or hooked will tear film. Replacement is the remedy. Gear teeth also wear, and drive belts stretch.

A common example of misadjustment is in the tension of the friction clutch or other device that drives the take-up reel. At the start of a reel, the diameter of the film on the take-up hub is very small; as film keeps coming down and is taken up it forms a "hub" of ever-increasing diameter. Since the speed of the film is constant, the take-up reel must revolve at continually decreasing speed. A clutch-type drive of some sort is therefore needed at this point.

Misadjustments also are common in the pressure exerted on the film by the gate. Or a loose screw may permit a shutter or other rotating part to shift on its shaft.

A few of the commoner types of mechanical troubles, their causes and remedies, are discussed below.

Travel ghost is a *vertical* blurring of the picture. It is best observed in title scenes—the letters appear to have tails either above or below. Cause is loss of synchronism between shutter and intermittent sprocket or claw. If the tail, or "ghost," is under the letter, the shutter is ahead of time; if above it, behind time. Remedy is to reset the shutter. Usually it can be rotated on its shaft.

Vertical unsteadiness—*picture jump*—may be caused by inadequate gate pressure, which needs readjusting; or by extensive wear throughout the mechanism for which the only good remedy is overhauling throughout; or by some specific mechanical mislinkage or slippage resulting in excessive vibration.

Horizontal unsteadiness—known as *picture weave*—may be the result of worn lateral guides in the gate. Replacement is the remedy.

A blurred picture can be caused by buckled film, for which there is no remedy except to get other film; by slippage in the focus of the projection lens; by projector or screen or both having been moved out of position; or by extreme vibration of a very badly worn-out projector. Remedies in each case are obvious.

Dim or unclear picture may result from blackening of the projector incandescent lamp with passage of time and use. Replacement is the remedy.

Mottled picture may be the result of over-lubrication or oil leakage, permitting oil to get on film.

Streaked picture may result from dirt in gate or elsewhere along film path, scratching film; or from film so scratched on a previous run. Cleanliness is essential in projection.

Weak sound may result from exciter lamp that has darkened with time; from misadjustment of exciting lamp optics; from oil on optics or exciting lamp or photoelectric cell; weakening of photoelectric cell; electronic faults in its circuit; or from mispositioning or misadjustment of magnetic track pickup magnet. Noisy sound is created by dirt with either optical or magnetic track. Magnet pickup heads show frictional wear in time, calling for readjustment or replacement.

Exceptionally noisy operation (mechanically) may result from neglect of lubrication, stretched chain or belt, excessively worn gears, loose part. Remedies are obvious.

Manufacturers' service policies

Manufacturers' policies with respect to supplying service information and replacement parts vary.

Ampro Corporation will supply service parts to anyone but recommend that they be bought through authorized Ampro dealers and service stations. All other buyers must pay full list price.

Bell & Howell assert that any servicing done by anyone other than their factory-trained representatives will void their lifetime guarantee.

De Vry Corporation, to the contrary, "will supply parts and service information to anyone." Equipment owners pay full list price for parts; a "recognized repair man, whether he be one of our competitors or not," is granted a courtesy discount. De Vry's own dealers enjoy a regular dealer discount.

Eastman Kodak sells service parts only to a "few of the larger and better camera stores with photographic repair departments and Kodak audio-visual dealers who are specially qualified to render this service," and to Altec Service Corporation.

RCA sells repair parts through two channels: "RCA Tube Department distributors which sell all types of RCA renewal products, including tubes, batteries, and service parts for all RCA Victor Division products," and "RCA Visual Products Distributors."

Victor Animatograph, according to their service manager, William Kellogg, would not co-operate with radio technicians in servicing Victor equipment.

It does *not* follow, however, that the radio techinican cannot service Victor or other non-co-operative products. For most electronic repairs he needs no co-operation. Moreover, there is nothing to prevent his entering into arrangement with the authorized local repair station. This is apt to be a photographic products dealer who never has any business dealings with electronic equipment except when called on to repair 16-mm and 8-mm projectors, and who may be very glad to contract with a competent radio repairman to take that headache off his hands.

Business opportunities

Servicing 16-mm equipment, however, is not the only way the radio repairman can benefit from this fast-growing field of activity. Schools, business firms, churches, do not always own projectors, or at least may not own enough of them to meet peak demands. Families often wish to rent a projector for an evening, to entertain guests, or perhaps for a children's party. Thus a rather substantial rental market exists, to serve which profitably nothing more is needed than to buy and own one or more projectors.

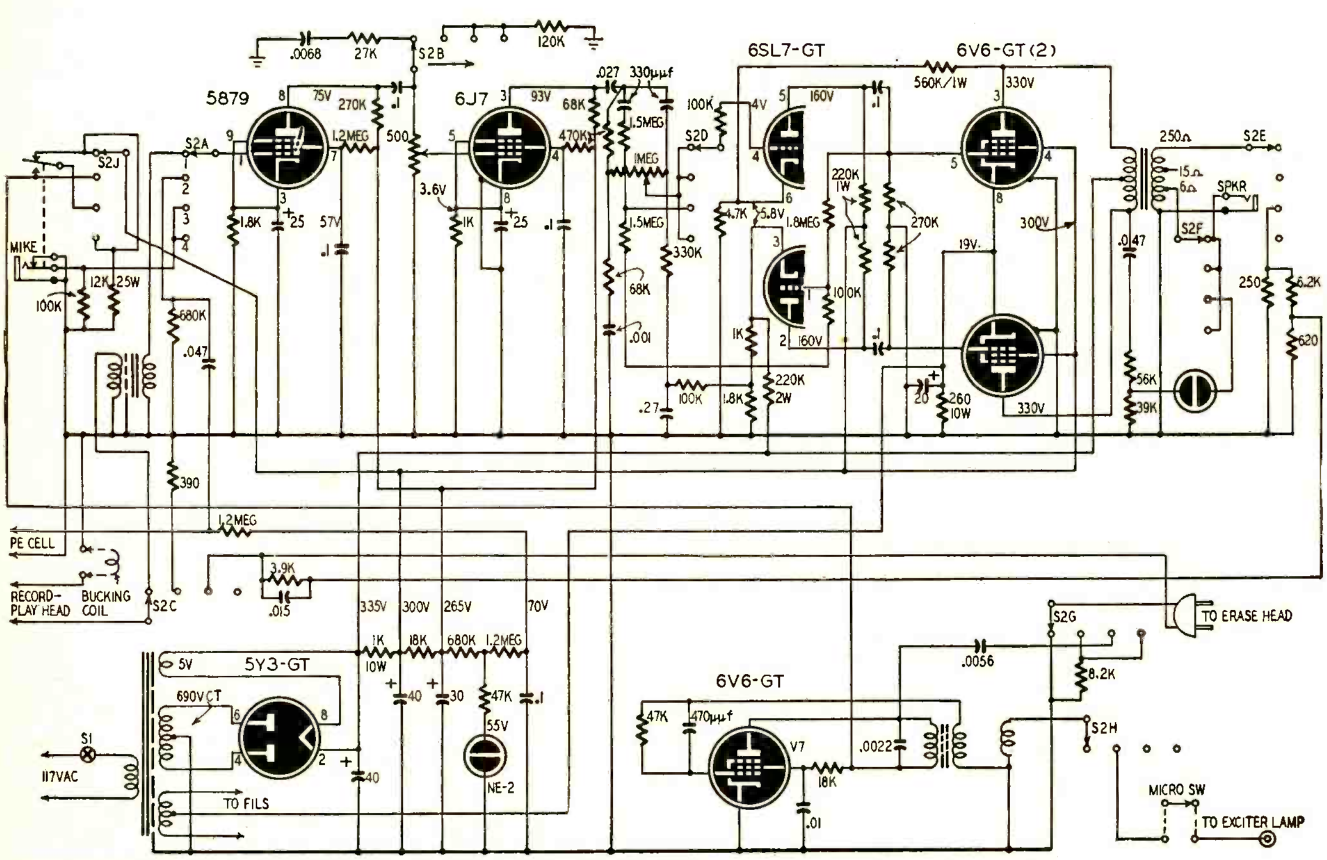
Allied to this form of business is that of rental agent for 16-mm film. An enormous stock-pile of such films exists. Surprisingly, vast numbers of films can be borrowed *free*. These include service films made by government or educational or social agencies, and "institutional" advertising films that show how a product is made or an industry functions, but carry no direct sales message. And some public libraries now circulate films as they do books. Other prints, however, must be rented, leased, or bought, and the prices and terms vary greatly. For sources, see below.

The leading 16-mm sound projector manufacturers are: Ampro Corporation, 2835 N. Western Ave., Chicago 18. Bell & Howell Company, 7100 McCormick Road, Chicago 45. De Vry Corporation, 1111 Armitage Ave., Chicago 14. Eastman Kodak Company, Rochester 4, N. Y. General Precision Laboratory, Pleasantville, N. Y. Radio Corporation of America, Engineering Products Department, Camden, N. J. Victor Animatograph Corporation, Davenport, Iowa.

Sources of 16-mm sound film offered free, for rent, for lease, or for sale, include the following:

British Information Services, 30 Rockefeller Plaza, New York 20. Encyclopedia Britannica Films, Inc., 150 Willmette Ave., Willmette, Ill. Government Printing Office, Washington 25, D. C. McGraw-Hill Book Company, Text-Film Department, 330 W. 42nd St., New York 36. National Association of Manufacturers, 14 W. 49 St., New York 20. Religious Film Association, 220 Fifth Ave., New York 1. UAW-American Federation of Labor, 492 W. Michigan Ave., Milwaukee, Wis. United Nations Film and Visual Information Division, United Nations, New York. U.S. Air Force, Public Information Officer, nearest Air Materiel Area Headquarters. U.S. Army Pictorial Service Division, Washington, D. C. U.S. Bureau of Mines, 4800 Forbes St., Pittsburgh 13, Pa. U.S. Forest Service, Washington 25, D. C. U.S. Navy Motion Picture Section, Washington 25, D. C.

This list is far from complete. Additional sources can be found in Educational Film Guide, published by H. W. Wilson Company and available at your public library, or at $5.00 from the Wilson Company at 950 University Ave., New York 52. END



SWITCH S2 SECTIONS GANGED & SHOWN IN POS 1: 1-MAGNETIC SOUND, 2-OPTICAL SOUND, 3-RECORD-ERASE, 4-PUBLIC ADDRESS

Fig. 5—Magnetic-recording and optical-magnetic playback circuits of the RCA model 400 home-type 16-mm projector.

UHF master antenna systems

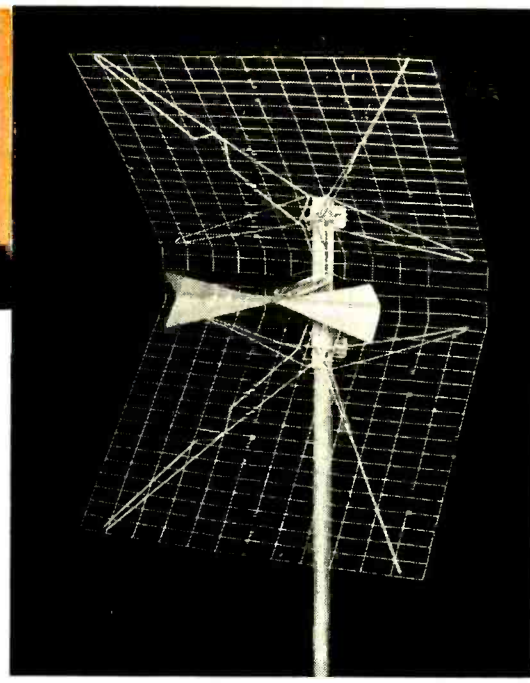


Fig. 1—Corner reflector antenna. A wise selection for u.h.f. TV reception, easy to install.

The higher frequencies require new techniques, new methods of thinking.

By IRA KAMEN*

PROBLEMS in u.h.f. master-antenna systems will resolve themselves much the same as they did for v.h.f. The basic difference is that the service technician will have to change his thinking from lumped components to distributed components. He will have to understand that a straight piece of wire has inductance, capacitance, and resistance.

The system described in this article is now operating successfully in numerous dealer stores in Portland, Oregon, and has been demonstrated with equal success in Chicago and New York, on experimental transmissions of the Zenith and Du Mont transmitters.

There is no single most important element in a master antenna system. Just as in the proverbial chain, there can be no weak links if the system is to be 100% dependable. First we must make certain that the antenna itself picks up the greatest possible amount of u.h.f. signal with respect to noise and interference. The antenna selected at this time as having the highest gain (9 to 12 db) over the entire u.h.f. band is the bow-tie with corner reflector. See Fig. 1. It has an average front-to-back ratio of 4 to 1, and negligible side-lobe pickup (Fig. 2). The antenna impedance is approximately 300 ohms, and is an excellent match for the recently developed AT270 u.h.f. cable shown in Fig. 3. While there are other lead-ins which meet the requirements of u.h.f. reception, this type was selected for its stability in providing a constant signal regardless of weather conditions. AT270 cable has a maximum loss of slightly over 5 db per 100 feet at 900 megacycles. Therefore we can see that in a 100-foot installation where the antenna itself has a gain of approximately 12 db, if the cable loss is approximately 5 db and there is an anticipated connection loss of approximately 1 db, we can expect a net gain of at least 6 db. This represents a 2-to-1 voltage gain. If the antenna is in a 5-millivolt area we should have approximately 10 millivolts of signal available at the end of the cable.

Where local regulations require lightning arresters, the unit shown in Fig. 3 has performed successfully at u.h.f. This lightning arrester is easy to connect to the transmission line, and has no loading effect on the line at ultra-high frequencies. The heart of this arrester is a rare-gas tube with three contacts, which provide a balanced discharge circuit to ground. In addition to this lightning-arrester protection there is of course the usual recommendation that the antenna mast itself be grounded.

*Vice-President, Brach Manufacturing Corp., Division of General Bronze Corp.

Distribution system

We now have the antenna signal available for connection to the distribution unit. The distribution unit shown in Fig. 4 has a 300-ohm input and four 72-ohm outputs designed for connection to coaxial cable. The unit is enclosed in an aluminum shield can to preclude interference pickup. The principle on which this unit operates is shown in Fig. 5. Two 150-ohm transmission lines are series-connected to provide a 300-ohm balance with respect to ground. At

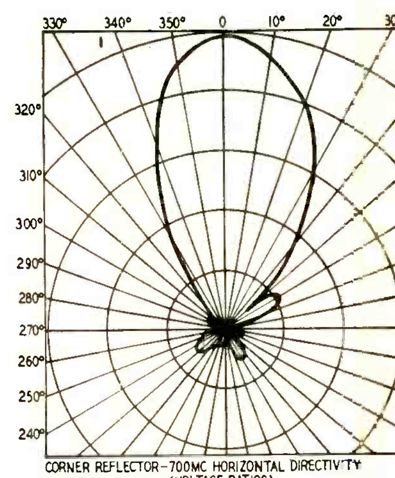


Fig. 2—Corner reflector 700-mc pattern.

the other end (for coaxial output) each 150-ohm line is balanced with respect to ground so there are four 75-ohm outputs.

Fig. 6-a shows the circuit of a unit which has a 75-ohm input and four 75-ohm outputs. The 75-ohm input is obtained by paralleling the 150-ohm transmission lines and grounding one side to provide the proper unbalanced coaxial ground connection. The unit shown in Fig. 7-a works on the same principle as the distribution units in Figs. 5-a and 6-a except that its function is that of a matching transformer. This function is realized by paralleling the 150-ohm transmission lines, unbalancing them to ground at one end for connection to coaxial cable and series-connecting them at the other end for a proper match for 300-ohm

balanced input. All the units shown in Figs. 5, 6, and 7 have their ground connections made to the aluminum container. The matching transformer shown in Fig. 4-c and diagrammed in Fig. 7-a is required in the master antenna system installation, as many of the tuners and converters are designed for 300-ohm input. This unit, however, will not be required with RCA-type tuners since they are designed for direct connection to coaxial cable.

The diagrams at *b* in Figs. 5, 6, and 7 are equivalent circuits with lumped inductances. Fig. 7-b is the same as the familiar elevator transformer used in the antenna input circuits of some TV sets.

The distribution unit shown in Fig. 4-a and 4-b affords a maximum isolation of approximately 16 db between sets connected to its coaxial outputs. In making a dealer installation the distribution unit should be centrally located so that the lengths of cable between any of the coaxial outputs and the four receivers give approximately equal signals at the set antenna terminals. Since these distribution units have no amplification, the best they can do efficiently is to divide the antenna signal into four equal parts, which means an insertion loss of at least 6 db.

There are several rules which must be followed in making u.h.f. master antenna installations, whether they be for the dealer, the multiple dwelling, or the community.

1. Do not pare back or spread the 300-ohm transmission line to make the antenna connection. The 300-ohm impedance of the cable must be maintained out to 900 megacycles to avoid serious signal losses due to transmission line mismatch.

Tests have shown that mismatch at either end of the transmission line manifests itself as signal loss rather than as multiple images due to line reflections. The high attenuation of the cable dissipates the reflections to a point where they are of insufficient strength to show up as noticeable multiple images.

2. All 75-ohm coaxial-cable connections must be made with low-loss coaxial fittings which have a minimum loss at u.h.f. Paring back 75-ohm cable to make lug connections nearly always results in the loss of several db due to impedance mismatch and series impedance loss.

3. Before attempting to install a u.h.f. master antenna, test the signal from the antenna through 100 feet of transmission line and a 12-db pad to simulate the losses of the distribution units, the RG-59/U coaxial cable, and the receiver. Where a long run must be made to a TV set from the output of the distribution unit, RG-11/U may be substituted to reduce the line attenuation. END

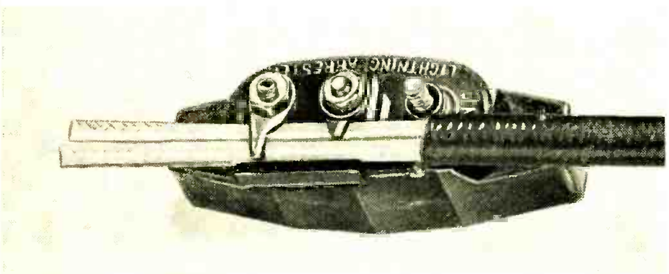


Fig. 3—A rare-gas type u.h.f. lightning arrester connected to ATV270 cable.

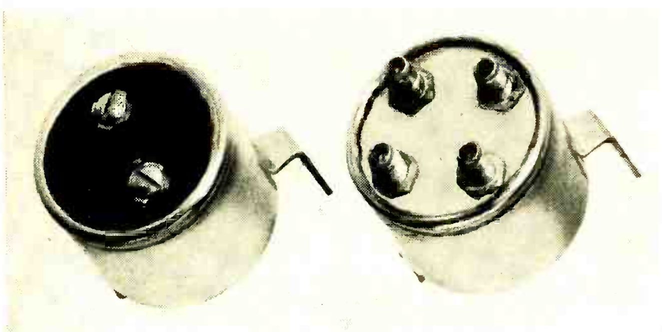


Fig. 4-a—A u.h.f. distribution unit for 300-ohm input and four 72-ohm outputs.

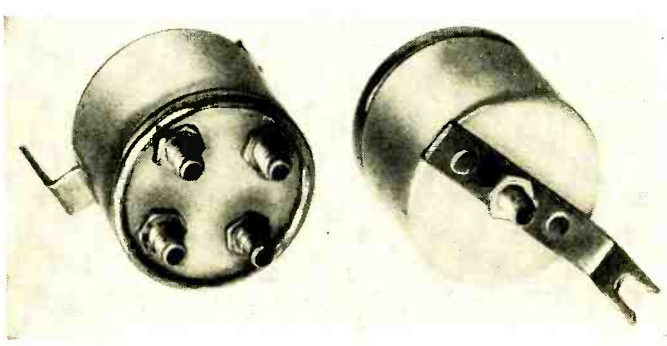


Fig. 4-b—A u.h.f. distribution unit with 72-ohm input and four 72-ohm outputs.

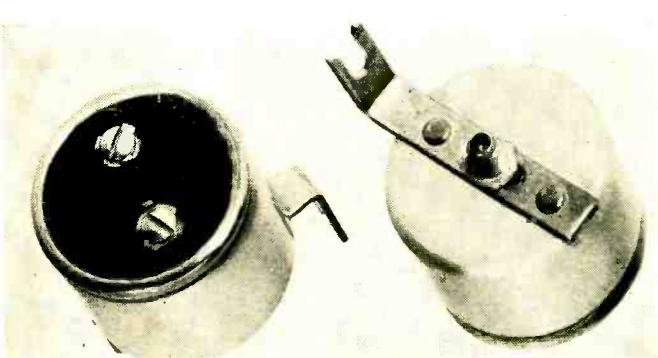


Fig. 4-c—A 72-ohm to 300-ohm transformer.

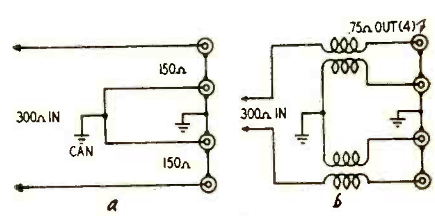


Fig. 5—Schematics of unit in Fig. 4-a. Transmission-line circuit at *a*, equivalent lumped-inductance circuit is at *b*.

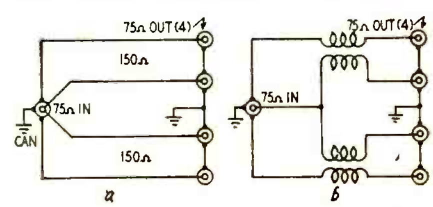


Fig. 6—Diagrams of unit in Fig. 4-b.

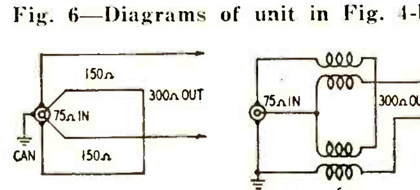


Fig. 7—Diagrams of unit in Fig. 4-c.

Some real backbreakers —plus a few tricks for keeping your customers happy—and keeping them

TV Oddities

By JOHN D. BURKE

TV REPAIR is a crazy business. I pity the students in trade schools who, like one promising young man I know, have only the faintest conception of what lies ahead.

I. Just yesterday the owner of a good-sized and successful shop asked me to take a set off his hands. The problem: They had installed a high-voltage doubling circuit in the set, and now they couldn't get enough width.

What was wrong? I chanced to look at the yoke, while carrying the set to my car. It was a 50-degree yoke!

No cause for boasting on my part—no cause for embarrassment on his. It happens to the best of mechanics.

II. Some people in high places in our trade, or in proximity to it, speak boastfully of being able to find what's wrong with any set, in a matter of minutes.

I will contest that with anyone. Now and then a set will stand you on your head. Just finished one like that last night.

A case of not enough high voltage. Got about 3,000. A Motorola TS 118A. Take a look at that set's diagram. Note all the possibilities for high-voltage trouble.

Note also the fact that they use an *odd value*, and *odd voltage* capacitor (180 μμf at 3,000 volts) across the damper tube.

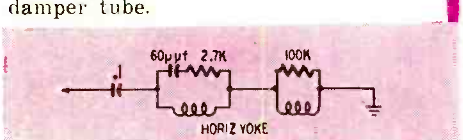


Fig. 1—A shorted 100,000-ohm resistor across one section of the horizontal yoke winding was responsible for loss of high voltage in a Motorola TS 118A.

Convinced that the capacitor was at fault (got some voltage rise with other values of capacitance) I wasted several hours going to Motorola N.Y. to get one. (Nothing like it to be had at local distributors.)

Still—I was not too surprised when the new capacitor failed to help. Sweat—test—sweat—test. (And curse!)

Now—for those of you who do not earn your living in this trade—I want to emphasize that the trouble in that set—when I finally found it—was something that *no instrument* could have revealed.

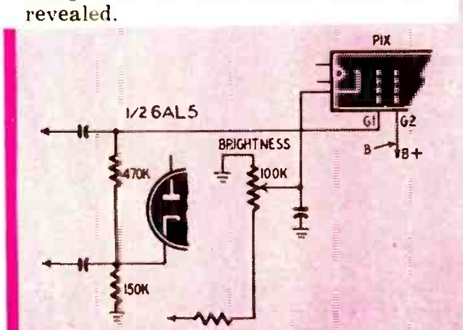


Fig. 2—This works despite a high-resistance short between G1 and G2.

I'll give you a diagram (Fig. 1) to look at. (The editor will like that!)

That 100,000-ohm resistor was the culprit. When I took the focus coil off, and tested with the scope at the junction of the two coils, the pattern looked normal. Long afterward I came back again—after getting an apparently correct resistance reading across the yoke, and hunting all over the place for the cause of the trouble, including the substitution of another high-voltage transformer. This time I started to open up one end of that resistor. The resistor broke! It had heated, fused, and dropped down to some value low enough to spoil the circuit's normal impedance; yet not low enough to show on the ohmmeter on a test across the coil.

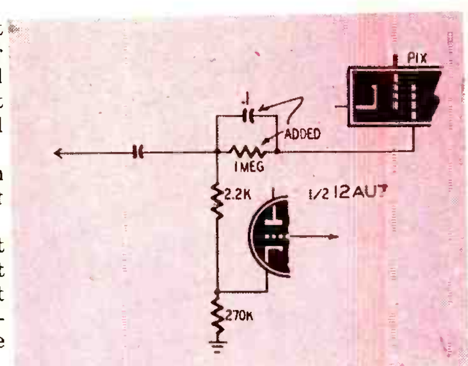


Fig. 3—A temporary remedy for heater-cathode leakage in a TV picture tube.

Trouble in high-voltage (and in B-voltage, too) often arises in the yoke. But, the yoke is often one of the most inaccessible parts of a TV set.

III. One of my customers now operates his set in the following manner, according to instructions I gave him:

He turns the set on, lets it warm up. Then he gently taps on the base of his picture tube. After a few minutes of tapping, he chances to strike the tube just right. The cathode tab circuit fuses, and the picture tube lights up normally.

Next time he lets the set cool off, he goes through the same procedure to get it going again. Thus he is getting use out of a 14-month-old 16-inch tube.

IV. Three of my other customers are getting use out of defective picture tubes which have high-resistance internal shorts.

Such shorts spoil the normal biasing arrangement—but by revising the circuits I was able in each case to extend the useful life of the tubes. Well over a year already in two cases.

One of the sets had a high-resistance short between grids 1 and 2 of the picture tube. Result—picture much too bright. The set is a Crosley 9-419M. Fig. 2 shows the changes made. The resistor at *A* was 220,000 ohms. I reduced it to 100,000 to raise the cathode potential. Reduced the B-voltage to grid 2 (point *B*) to bring brightness down further. Result—good contrast!

The other two sets were both high-resistance grid-cathode shorts in Meck MM614C's. The shorts spoiled sync take-off by cutting out the d.c. restorer tube. The solution in Fig. 3 leaves some effect of d.c. restoration. That in Fig. 4 eliminates d.c. restorer action, but customer is satisfied.

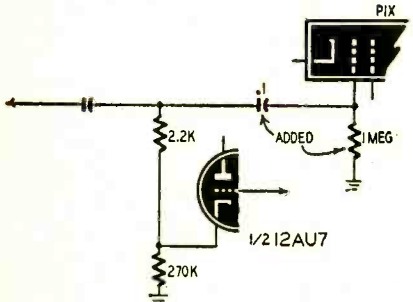


Fig. 4—Another method of overcoming the effects of a high-resistance short between heater and cathode in the picture tube by eliminating d.c. restoration.

V. Saw an article in another magazine for a rather elaborate tester one could build to test high-voltage transformers.

Here (Fig. 5) is my rough-and-ready method, which works well.

First familiarize yourself with the length and snap of the normal arc which can be drawn from various types, and voltage ratings of flyback transformers. Not the d.c. only, but the a.c. (I use the arc to a well-insulated-handle socket wrench or screwdriver, held in my hand.)

Now connect the transformer to be tested to a TV set in such a way that only the *essential* connections are made. That is, to B plus or to B plus plus, and to the plate of the horizontal output tube. Make sure your damper tube is going to receive its voltage.

Disregard width and linearity connections. In some transformers you can leave off the sweep coil connections—in others they are necessary. Study the situation. In any case, it's *not necessary* to convert the a.c. to d.c.—You need not connect it up to a rectifier tube.

Nice thing about this, I find, is *also* that you can tack in a new transformer *without* having to do any soldering. If the new transformer is not needed—it can be returned for credit!

(Double-ended clips are very handy for such jobs and many others.)

VI. A job which stood me on my head:

A service call. No d.c. high voltage, and at the same time plenty of a.c. arc on the cap of the 1B3. Naturally, I replaced the 1B3. Got a faint picture, similar to low-emission picture tube. However, I checked for high-voltage d.c. again.

It was still very low! So I tried another 1B3. No luck. Took the set to my shop.

Some hours, and many curses later, I finally realized what was wrong. Apparently, when the set was built they were fresh out of proper sockets for their 1B3's.

So they used one of those rectifier tube sockets which have pin connections only for pins 2, 4, 6 and 8.

Need I tell you that the 1B3 uses 2 and 7 for filament?

Knowing what they had done, they must have put a jumper on the tube they used, between pins 7 and 8.

That set was a booby trap, waiting for some unsuspecting repairman. Can you top that?

VII. It is about time for someone to say, "No!" to the indiscriminate use of plastics.

One such is the generally adopted new type of i.f. transformer, with fixed parallel trimmers molded in the base.

They short-circuit! And are devils to repair.

One of my customers now operates his TV set with a shield missing from a sound i.f. transformer. I took it off, the only way I could clear a short through the plastic base to ground.

True, one can always replace defective transformers (if and when the substitute is available). But it is not good to be left wondering whether—and when—the replacement, or some other similarly constructed transformer in the set, is also going to short.

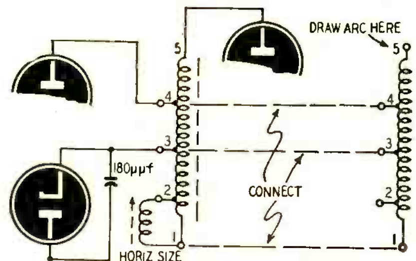


Fig. 5—Flyback substitution test setup.

VIII. My own set is a Philco 48-1000 which I converted to 14 inches.

When I bought the set second-hand, I found that the tuner was defective. Several contact springs were broken. The repair? I soldered in new springs made out of a certain type of women's hair curlers of good spring steel.

The resultant circuits had more inductance and capacitance than the original, creating greatest difficulty in the oscillator. So I moved oscillator segments—used channel 13's for channel 11, 11's for 9, etc. The set works well, except that I don't get 13. However, 13 is weak in my neighborhood anyway.

I also eliminated the automatic frequency control circuit—put in manual fine tuning based on a 1-meg control which varies oscillator grid bias. It works well. END

tv dx IN MAY

THE month of May, marking as it does the real beginning of the summer dx season, is always awaited eagerly by TV dx enthusiasts and hams who operate on the v.h.f. and u.h.f. bands. May, 1953, has a special significance for both. Careful observation of propagation phenomena on the frequencies above 50 mc should bring out some interesting facts that have not been available to us heretofore.

Sporadic-E dx (responsible for reception of signals on frequencies up to 150 mc or so at distances up to about 1,400 miles) will bear close watching this spring and summer. For several years we've been in the descending portion of the 11-year sunspot cycle. Does solar activity have any direct relation to the amount and intensity of E-layer ionization? This summer may provide evidence one way or another. The last solar minimum came during the war period, so no detailed v.h.f. dx observation was possible. Two cycles ago use of frequencies above 30 mc was just getting under way, and little was known of propagation phenomena on these frequencies.

The summer of 1952 was one of the poorest on record for the v.h.f. ham and the TV dx-er, but will 1953 follow the same pattern? Your observations will tell the story.

How will the u.h.f. TV channels react to summer's changing weather patterns? With u.h.f. stations blossoming out in many parts of the country a new field of interest is opening up for the TV viewer who is interested in something more than entertainment. Amateur experience in the 420-mc band indicates that some rather tremendous signal levels may be expected from our u.h.f. stations when weather conditions are right. Most of our u.h.f. converters and receivers are none too good, and some of the stations are operating on temporary low power, but it still should be possible for the fringe-area viewers of u.h.f. to turn up some mighty interesting information. If you see signs of life on channels 7 to 13, be sure to watch the u.h.f. channels, too. We'll be interested in the details of any unusual u.h.f. reception you can report, as well as dx on the lower-frequency television channels.

Sporadic-E dx may begin to show on channels 2 to 6 in late April, mostly in the southern portion of the country. It will be spreading more to the north in May, and in the latter part of the month viewers in all sections should be getting in on the fun. Detailed observations and comparisons with previous seasons (where these can be made) are welcomed. END

circuit shorts

Two new uhf tuners

BY ROBERT F. SCOTT
Technical Editor

As WAS indicated in the "Directory of TV Receiver Characteristics" in the January issue, almost every TV manufacturer has adapted his new sets for u.h.f. TV reception. Some have provided for external converters, others have installed turret-type v.h.f. tuners with plug-in u.h.f. strips, while still others have incorporated separate u.h.f. and v.h.f. tuners ganged to a single tuning control shaft.

The RCA u.h.f.-v.h.f. tuner

RCA has developed a new turret-type 16-channel v.h.f.-u.h.f. tuner known as the KRK-12 and KRK-25. It is the KRK-12 when it is factory-installed as standard equipment in the receiver, and is called the KRK-25 when used to replace the original tuner in 45-mc i.f. sets using the KCS66, -66A, -66D, -68C, -68E, -68F, -68H, and KCS74 chassis. This tuner receives any desired combination of 16 channels in the 54–88- and 174–216-mc v.h.f. and 470–890-mc u.h.f. TV bands. It is shipped from the factory with 12 pretuned v.h.f. channel inserts for channels 2 through 13. Snap-in channel strips for u.h.f. channels can be obtained as desired from RCA distributors. The tuner (Fig. 1) includes four tubes and a crystal diode.

When tuning the v.h.f. channels the 300-ohm v.h.f.-u.h.f. antenna is coupled through L1 and L2 to the antenna transformer feeding the input section of the 6BQ7A cascode r.f. amplifier. The output of the cascode feeds into a 1N82 germanium diode mixer where it heterodynes with the signal from the 6AF4 local oscillator. The 45-mc i.f. signal thus produced is coupled into the 6BQ7A cascode i.f. amplifier through T1. The amplified i.f. signal appears in the primary of the i.f. plate transformer T2 which is link-coupled (through its secondary) to the primary of the first picture i.f. transformer in the receiver.

When the receiver is switched to a u.h.f. channel, the r.f. amplifier is cut out of the circuit and the 300-ohm antenna terminals are connected to L10, the primary of the antenna coil. L3, the tuned secondary of the antenna coil, is tapped for connecting a 72-ohm lead-in from a u.h.f. antenna. The link L4 couples the antenna coil L3 to mixer coil L5. The oscillator signal, 45 mc above the picture carrier, is picked up on the adjustable pickup loop and applied to the 1N82 mixer diode. The 45-mc intermediate frequency signal is fed from the mixer through T1 to the 6BQ7A i.f. amplifier. From here on out the i.f. signal follows the same path as for v.h.f. reception.

An electronic voltage control is used in the B plus circuit to the 6AF4. The plate-to-cathode resistance of the 6S4 acts as a variable resistance in the B plus lead to the oscillator. The effective value of the resistance is determined by the bias on the 6S4. When the bias is adjusted to the correct value, the internal resistance of the tube reduces the oscillator plate voltage to the proper value. If the supply voltage or the oscillator current changes, the 6S4 cathode bias changes in a direction which causes the oscillator load voltage to remain substantially constant.

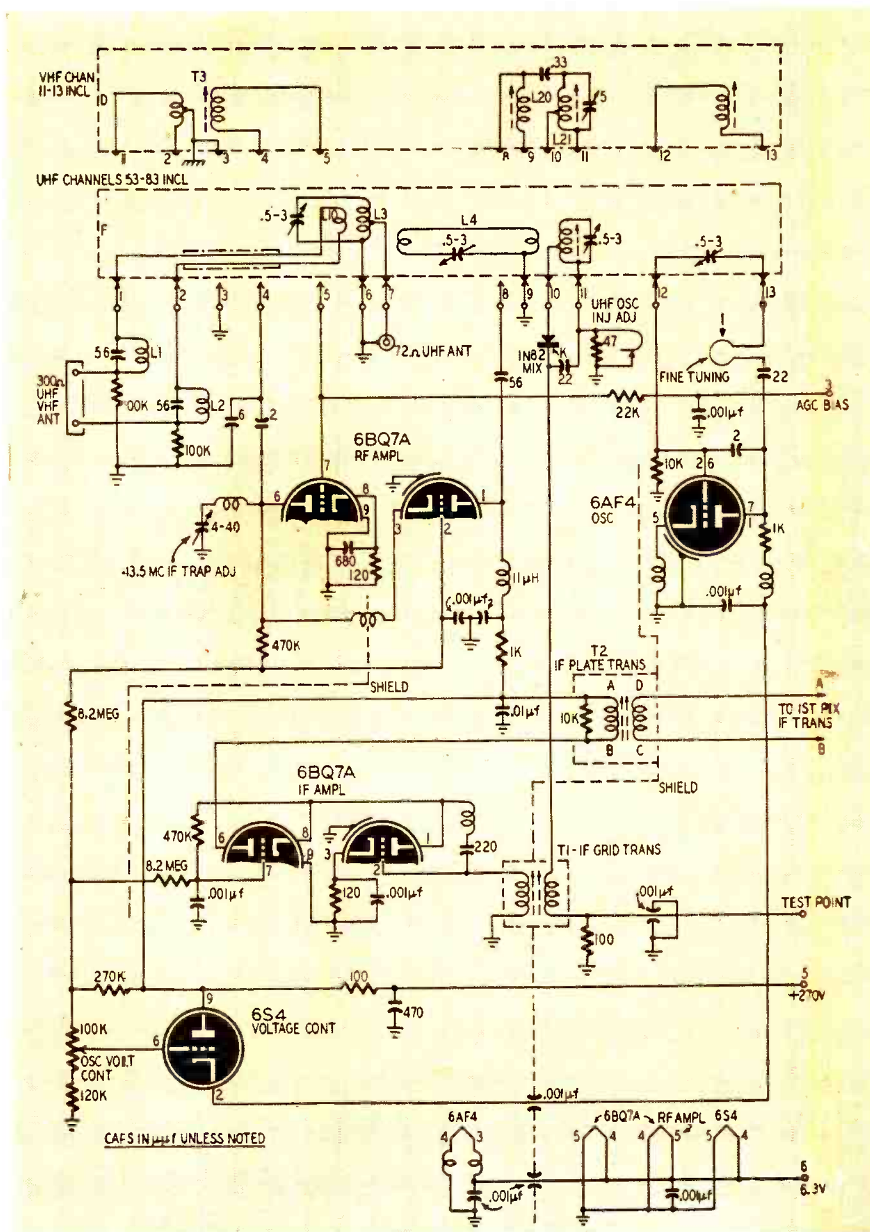


Fig. 1—Schematic diagram of the RCA KRK-12 and KRK-25 turret-type tuner which can receive any desired 16 channels in the v.h.f. or u.h.f. bands.

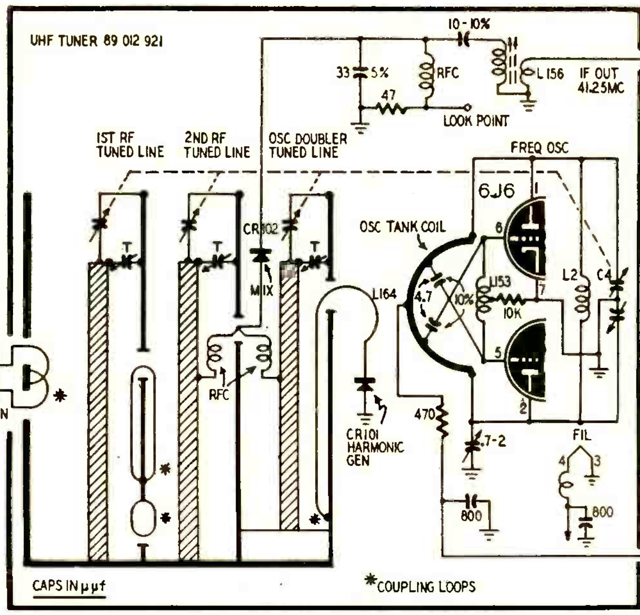


Fig. 2—Du Mont's 70-channel u.h.f. continuous tuner used in the RA-171.

u.h.f. tuner section is shown in Fig. 4. The inner conductors are U-shaped channels which also serve as stators of the straight-line frequency tuning capacitors. The trimmers shown in the schematic are actually flexible metal tabs fastened to the outer conductor so they can be bent closer to or farther from the inner conductors to set the high end of the tuning range.

The oscillator is a push-pull tuned-grid tuned-plate type tunable from 258.5 to 465.5 mc (one-half the required heterodyning frequency). The plate-circuit tuning capacitor C4 is ganged to the transmission line tuning capacitors. L2 is shunted across the oscillator tank coil to adjust the oscillator plate-circuit inductance precisely. The grid coil (L153) is self-resonant at the low end of the tuning range and maintains the oscillator signal amplitude at the required level throughout the range.

The oscillator's output is coupled to crystal CR101 through the loop L164. The crystal's nonlinear characteristic distorts the r.f. signal, producing harmonics, which are coupled into the oscillator doubler tuned line. This line is similar to the r.f. lines, but is made shorter to reach the higher frequencies. It is tunable from 517 to 931 mc. The shorter length of the oscillator doubler

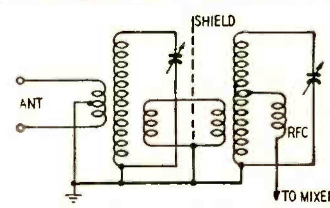


Fig. 3—Simplified circuit of the L-C constants in Fig. 2's continuous tuner.

Du Mont all-channel tuner

The new Du Mont RA-171 45-mc i.f. chassis uses a turret-type cascode v.h.f. tuner and a continuous-tuning 470–890-mc tuner for receiving all 82 v.h.f. and u.h.f. TV channels. The two are ganged to a single control to make tuning easier. The v.h.f. tuner uses a 6BQ7 cascode r.f. amplifier and a 6J6 mixer-oscillator. Its circuit is about the same as the Standard Coil cascode tuner used in many modern TV sets. The only difference is that the tuner in the RA-171 has 13 positions instead of 12. The thirteenth position is for u.h.f. reception. When the channel selector is set to the u.h.f. position, the v.h.f. oscillator is disabled and the r.f. amplifier and mixer circuits are converted to 45-mc amplifiers.

The u.h.f. tuner uses tuned-line type preselector circuits, a crystal mixer, and a 6J6 oscillator. Its circuit is shown in Fig. 2.

Many u.h.f. tuners and converters use quarter-wavelength lines with movable shorting bars as variable tuning elements[1]. The Du Mont tuner uses shorted-line tuning elements in a different manner. A transmission line shorter than one-quarter wavelength acts as an inductance and can be tuned over a band of frequencies by a variable capacitor connected across the open ends of the conductors. This is the principle used in the Du Mont tuner. In Fig. 2, the heavy shaded bars represent the inner conductors of a coaxial line. The heavy solid lines represent the outer conductor.

Fig. 3 is a low-frequency representation of the first and second r.f. lines shown in Fig. 2. The inductors represent the inner conductors and the capacitors are the capacitance (stray and lumped) between the coaxial conductors. The shield between the r.f. tuned lines also serves as one side of the outer conductor common to both lines.

The coupling coils between the inductors (center conductors) are actually two closed loops of wire extending through the shield partition. The larger loop is effective at the low-frequency end of the band and the smaller one is effective at the high end. A similar coupling arrangement is used between the antenna and first r.f. line and between the oscillator doubler tuned line and the harmonic generator crystal.

The physical construction of the

[1] "Converters for U.H.F. TV," October, 1952, "More U.H.F. Converters," December, 1952, and "Two More U.H.F. Converters" and "U.H.F. Circuitry," January, 1953.

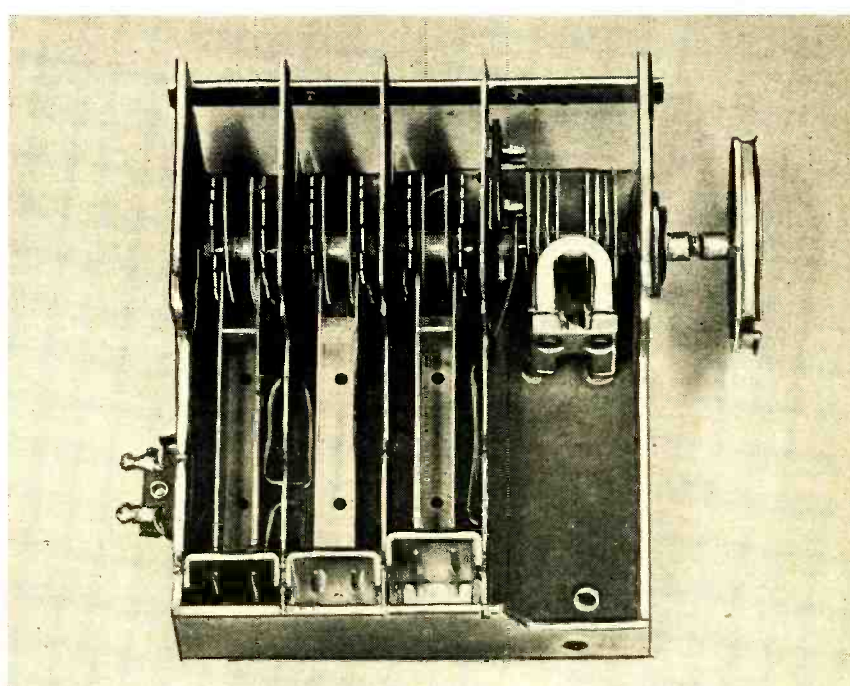
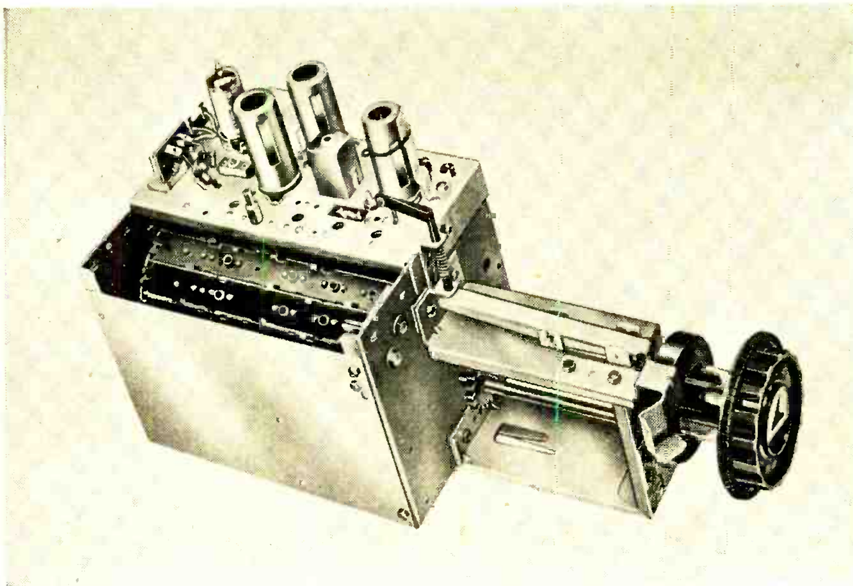


Fig. 4—Tuning elements in the Du Mont u.h.f. tuner. The U-shaped channels are inner conductors of a coax line and stators of the tuning capacitors.



The RCA KRK-12 tuner with a part of the top cover removed to show the turret.

line is indicated in the schematic and is shown in the photograph in Fig. 4.

The signal frequency and the oscillator signals are heterodyned in the crystal mixer. The output of the mixer (41.25 to 45.75 mc) is coupled into the v.h.f. tuner by the i.f. coil secondary, L156, and a length of 72-ohm coax.

I.f. screen circuit decoupling

In the Du Mont RA-160 chassis, the screen grids of the first, second, and third video i.f. amplifiers are fed from a 230-volt line through series dropping resistors which reduce the voltage to about 135. The series resistors and the screen bypass capacitors also serve as decoupling networks which prevent the 45-mc intermediate-frequency signal voltage from finding its way into other circuits through the impedance of the power supply. The bypass capacitor provides a low-impedance path to ground while the series resistor presents a high impedance in series with the B plus lead.

In this application, each screen draws about 3.5 ma, so a 1-watt resistor would be specified normally to provide an adequate safety factor.

A standard 1-watt resistor has a capacitance of approximately 3 μμf between its end terminals. At 45 mc the reactance of this built-in capacitance parallels the resistance to reduce the series impedance of the screen lead to about 1,200 ohms. This reduction in series impedance greatly reduces the effectiveness of the decoupling network and is likely to cause regeneration and circuit instability.

In designing the RA-160, Du Mont engineers came up with a novel solution to the problem of shunt capacitance in decoupling resistors. Instead of using a 27,000-ohm, 1-watt resistor with its high inherent capacitance, they used 12,000- and 15,000-ohm, ½-watt resistors in series in each screen lead as shown in Fig. 5. The shunting capacitance of a standard ½-watt resistor is only about 1 μμf. With two resistors in series the effective shunting capacitance is only one-sixth that of a single 1-watt unit. The decrease in shunt capacitance causes a corresponding rise in shunt reactance which will provide adequate decoupling.

Series-connected resistors are used for decoupling and reducing the voltage for the plate of the third video i.f. amplifier. In this instance, the two resistors serve a dual purpose. Aside from providing more efficient plate-circuit decoupling, this arrangement also makes it possible to locate the 2-watt, 6,800-ohm resistor in a spot where the heat from it will not affect the performance of the i.f. transformer.

When replacing the decoupling resistors in the video i.f. strip of this receiver, it is important that the original parts be replaced with identical units. Do not use a single resistor to replace the two series-connected units, and do not replace ½-watt resistors with 1-watt or larger types.

Unusual output stage

Service technicians who have specialized in TV and have had little or no practical experience on modern audio circuits are likely to be puzzled by the phase-inverter output stage of the HS-316 AM-FM chassis used in some Motorola TV combinations. Instead of using a push-pull interstage transformer or one of several vacuum-tube phase inverters, the out-of-phase voltage for the grid of one of the push-pull output tubes is obtained through resistance-capacitance coupling to the plate of the other half of the circuit, as shown in Fig. 6. This circuit has been used in a number of public address amplifiers and in a few AM sets, but it is unusual to find it in a TV set.

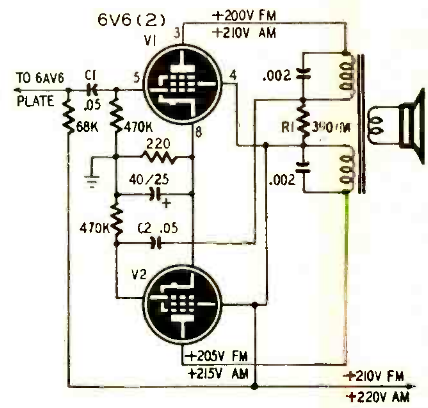


Fig. 6—An unusual phase inverter circuit.

The grid of V1 is resistance-capacitance coupled to the plate of the 6AV6 first a.f. amplifier through C1, a .05-μf capacitor. The output transformer has a split primary. The half of the primary connected to the plate of V1 is connected to the B plus line through a 390-ohm resistor R1. The plate of V2 goes directly to B plus through the other half of the primary. When an audio signal is fed to the grid of V1, it causes an a.c. signal voltage to appear across R1. The voltage at the junction of R1 and the B plus side of the upper half of the primary is 180 degrees out of phase with the voltage on the grid of V1. This voltage is fed to the grid of V2 through capacitor C2. END

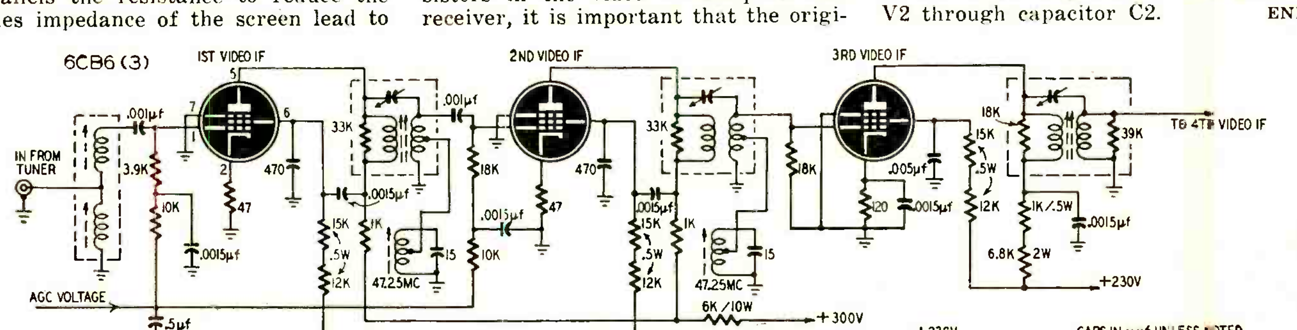


Fig. 5—Video i.f. screen decoupling circuit uses small series-connected resistors to minimize shunt capacitance.

TV SERVICE CLINIC

Conducted by MATTHEW MANDL*

The result of intermittent defocusing in a Fada projection-type TV receiver.

A TELEVISION service technician must always be careful when installing new components to make sure that circuit performance is not upset. Often exact replacements are essential and original lead dress must be maintained. This is particularly true with the 40-mc video i.f. circuits. They operate at higher frequencies than the older 25-mc circuits, therefore stray capacitance between adjacent wires and parts

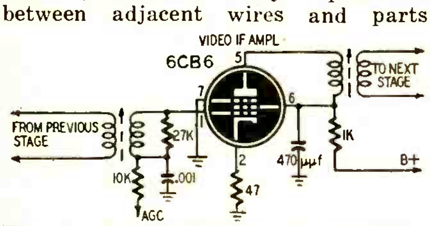


Fig. 1—A typical 40-mc i.f. amplifier.

affects performance much more.

At high frequencies capacitive effects are greater, and so more energy is lost through unintentional bypassing. Undesired coupling may occur to cause regeneration and oscillation. Remember that the shunting effect of capacitances increases as the frequency increases.

The interelectrode capacitances of the tubes are also of increasing importance in receivers using 40-mc i.f.'s. These could cause the video i.f. amplifier stage to oscillate, even though a pentode is used. Thus, neutralization is usually necessary to prevent feedback.

Fig. 1 shows a typical 40-mc video i.f. amplifier. Usually the video i.f. is 45.75 and the sound i.f. is 41.25 mc. The amplifier is neutralized by using a screen bypass capacitor which is too small to bypass the circuit completely. Inadequate bypassing causes screen-circuit degeneration which neutralizes the signal energy that is coupled to the grid circuit via the interelectrode capacitance. This prevents the stage from oscillating. Thus, when replacing the screen-bypass capacitor in video i.f. circuits, make sure that the replacement is the same type and value as specified by the receiver manufacturer. Cut the leads of the new capacitor to the same length as the original and place it in exactly the same position as the defective one.

Note that the cathode resistor in Fig. 1 is not bypassed. This is usually the case in video i.f. amplifiers connected to the a.g.c. line. Variations in a.g.c. cause the input impedance to change. This is minimized by cathode-circuit degeneration which results when the cathode bypass capacitor is omitted. For this reason the technician should never assume that the manufacturer accidentally omitted the bypass or left it out for reasons of economy. Never insert a cathode bypass to increase gain, since this upsets alignment and may cause the stage to oscillate. If the gain is too low, try a new tube and check components as well as voltages.

Intermittent sync

I am having trouble with intermittent horizontal sync in an Emerson 700-D and an RCA KCS49-A. Sync is lost after three hours of operation. Hold control is ineffective and I have checked all tubes and components in the horizontal oscillator and control circuits. I have also tried readjusting the frequency controls and find everything is normal.

Can overheating within the cabinet cause component values to change until synchronization is lost? Do you recommend removing the back panels of the cabinet to provide more ventilation? —D. W., Great Barrington, Mass.

The complete loss of synchronization after warmup indicates a change in characteristics of a component as you suspected. Inasmuch as you have changed the a.f.c. and oscillator tubes you should also check the sync-separator circuits. It is quite possible that the coupling capacitor from the sync separator to the horizontal a.f.c. input is intermittent. The cooling process after the receiver is shut off restores the operation of the defective component until normal cabinet heat causes the capacitor or other unit to become defective again.

We do not recommend removing the back panels of the cabinet as you mentioned. We doubt that this would provide sufficient ventilation to prevent the intermittent operation. It is better to check the tubes and components until the defective one is found. This will be a lengthy process because intermittent components are difficult to locate. Some technicians place the chassis in a carton so that the poor ventilation will cause a more prompt breakdown of the intermittent component. When this occurs, of course, it is easier to find the defective part.

Test picture tube

I am attempting to set up a bench deflection unit consisting of a 17BP4A with a Merit MDF-70 yoke, a permanent magnet focalizer, and a beam-bender.

This unit is to be used to service console television receivers which have the picture tube fastened to the cabinet. I have made adapters for the various picture tube pin connections and have extended the high-voltage and deflection leads approximately 30 inches. This works all right except I cannot get enough sweep to fill the face of the tube. I shortened the lead to 15 inches and this did not help. What could cause this?—A. T., Peabody, Mass.

This is a practical and useful item, but most shops have run into the same difficulty you have experienced. The reduced sweep is usually caused by a mismatch between the yoke and the original output transformer. Often this is accompanied by poor linearity and other defects. The raster will also be reduced when the high voltage which is applied to the picture tube is in excess of that required. This increases beam velocity and makes it more difficult to sweep fully.

If the yoke is a fairly close match to the receiver, the troubles will be minimized, but when different types of sets are serviced you will be unable to get good results in each instance. The length of the leads you mentioned would not cause this condition, and little can be done to get consistent results. However, the device is still useful so long as you take into consideration the type of picture it produces during servicing.

*Author: *Mandl's Television Servicing*

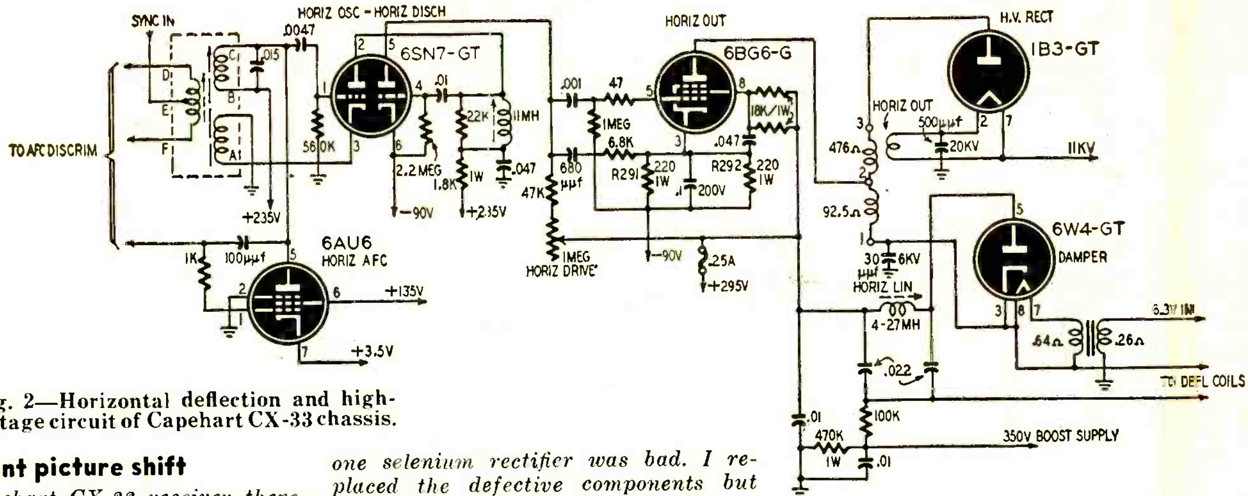


Fig. 2—Horizontal deflection and high-voltage circuit of Capehart CX-33 chassis.

Intermittent picture shift

In a Capehart CX-33 receiver there is an intermittent shift and loss of width. I have checked voltages in the low-voltage and horizontal-sweep circuits, and have replaced every capacitor and resistor in the horizontal a.f.c. circuit which did not check satisfactorily. This made the intermittent condition less frequent but it still persists.

I have replaced the high-voltage transformer, the 6W4-GT filament transformer, and all the tubes in the horizontal circuit. This did not correct the condition, but lowering the screen resistor on the 6BG6-G helped some. I have done everything except make a wholesale replacement of components and would appreciate any information which might help.—L. S., Tonawanda, N. Y.

Inasmuch as you have replaced the transformer and tubes you should check the 0.1-μf capacitor in the cathode circuit (pin 3) of the 6BG6-G. Also check the 30-μμf located at pin 3 of the damper tube. See Fig. 2. If these are open or leaky it can cause picture shift.

If this does not help, the following changes are recommended by the manufacturer: Change the .001-μf capacitor between the plate of the horizontal discharge tube (pin 5) and the grid of the output tube (pin 5) to .0047 μf, 600 volts. Change the .0047-μfd capacitor and the 560,000-ohm resistor (both located between terminal C of the horizontal oscillator transformer and ground) to a .001-μf, 600 volts and 100,000 ohms, ½ watt, respectively.

For intermittent shrinkage the manufacturer also recommends the following: (1) Add a 110-ohm, 2-watt resistor in series with the two 220-ohm resistors (R-291 and R-292) connected to the cathode (pin 3) of the 6BG6-G. (2) Increase the 6BG6-G screen-dropping resistance to a total of 12,000 ohms, 2 watts. The present resistance on the screen is 9,000 ohms, provided by two 18,000-ohm, 1-watt resistors in parallel. You may add another 3,000 ohms in series or replace the present resistors with a 12,000-ohm, 2-watt unit.

Repeated ballast failure

In an Emerson 638 receiver I am having trouble with repeated burnouts in one section of the ballast tube. Initially the focus coil was cold and one selenium rectifier was bad. I replaced the defective components but the ballast opened again. I tried a new one and the same thing happened. All tubes and components tested all right. What could cause this condition?—P. M., Staten Island, N. Y. C.

In a number of early Emerson receivers the selenium rectifier feeds the focus control through a resistor in the ballast tube as shown in Fig. 3. The fact that this resistor opens indicates excessive current flow through it. This is usually caused by a shorted capacitor, and you should check the associated filter capacitors in this circuit. You mentioned checking tubes and components, but undoubtedly you missed the component which is overloading the ballast and rectifier. If the ballast did not open, it would damage the selenium rectifier. This is probably what occurred initially: the rectifier burned out prior to the ballast resistor opening up.

It is possible that you checked the capacitors with an ohmmeter, but this does not always give a good check because they may read all right with an ohmmeter but break down under load. Use a capacitor checker capable of subjecting the units to voltages under normal working conditions or try direct substitution. Inasmuch as the focus circuit also feeds B plus voltages to other stages of the receiver, the overload may be somewhat removed from the immediate vicinity of the ballast tube and focus control.

Changing focus

In a Fada 880 projection receiver the focus changes repeatedly for several hours. After this the condition may not occur for some time. Clarity can be restored for a few seconds with the focus control. The brightness control also affects the focus. (The condition is shown in the photo on page 46.) A new h.v. unit, picture tube, and several other tubes have been installed without improvement. Can you help me?—F. F., Nashua, N. H.

Considering the changes that you have made, I feel that the trouble is in the focus circuit which is shown in Fig. 4. As you will note, a voltage of minus 100 is applied across the focus control and focus coil network and the brightness control. The ion-trap coils and a bleeder network are connected in series with the focus-control circuit. Any defective resistor or loose connection in these components could cause the condition you described. Thus, you should check the resistors indicated as well as the ion trap and focus coil, for the latter may be intermittent. Also

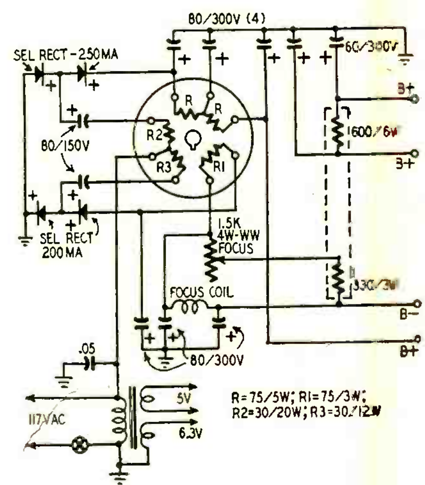


Fig. 3—Low-voltage supply and ballast-tube circuit in the Emerson 638 chassis.

place a voltmeter across one resistor at a time to note whether voltage changes occur during focus changes.

Also check the filter capacitors in the low-voltage power-supply system,

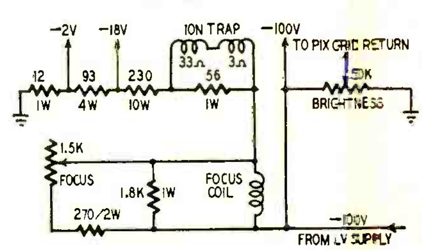


Fig. 4—Focusing circuit in Fada chassis.

particularly those tied to the focus control network. Intermittent leakage in a filter capacitor will change the load on the power supply and affect voltages.

A remote possibility is that the line voltage fluctuates, and this also should be checked as a matter of routine. END

SIGNAL TRACING IN TV RECEIVERS

by
The Engineering Staff,
Scala Radio Co.

Part II—Picking the right probe for each type of service job can boost your output and your income

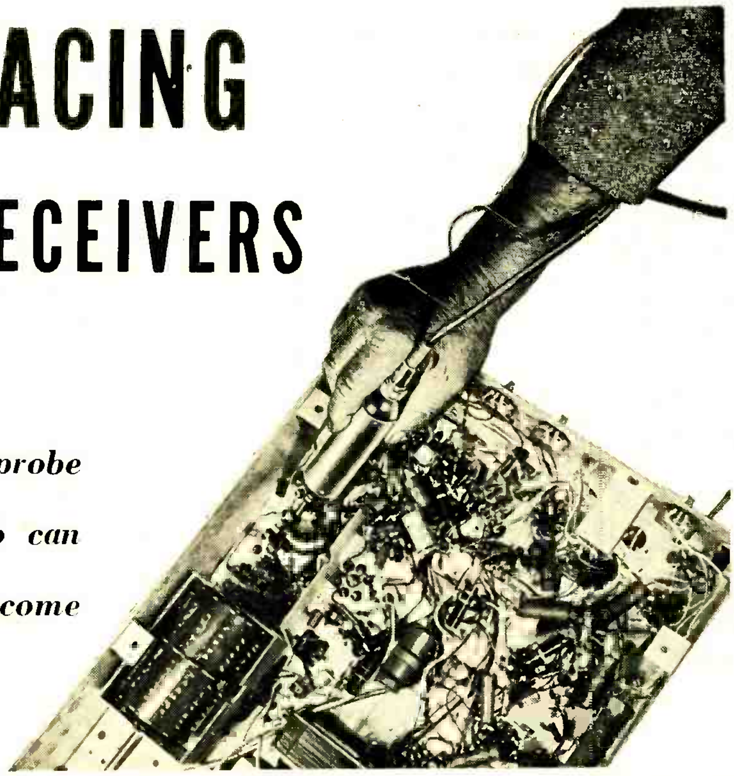


Fig. 1—Signal tracing in a TV i.f. amplifier with a crystal demodulator probe. Note probe ground clipped to chassis as close as possible to signal take-off.

TELEVISION technicians who mean business usually ask only one question about oscilloscope probes: "How can I use the probes to do my job faster or better?" The *complete* answer to this question would fill a very large book, but the highlights of probe application and some of the important sidelights are covered in this article.

The specific probe needed for any trouble-shooting job depends on the type of signal to be traced. This, in turn, depends on which circuit of the receiver is under test, and whether or not the receiver can supply its own test signal.

For example, Fig. 1 shows a crystal demodulator probe tracing a signal through the i.f. amplifier of a TV receiver. If a normal TV-station signal can be traced, the display on the scope screen should look like Fig. 2. (In this case the scope sweep was set at 60 cycles, with internal sync, to show one vertical blanking and sync pulse.) On the other hand, if the TV signal is weak, the scope trace may be too small to be useful. The only solution here is to substitute an AM generator for the TV station, and drive enough signal through the TV i.f. amplifier circuits to give a usable indication on the scope without overloading the receiver circuits.

Even with comparatively strong generator signals, excessive hash from stray fields around the TV chassis may obscure the scope trace unless the probe is provided with a shielded output cable as shown in Fig. 3.

Crystal demodulator probes can be given various response characteristics, either for better waveform reproduction or greater sensitivity, or to provide a better impedance match for certain types of tests. For example, the video waveform in Fig. 2 can be seen in better detail (Fig. 4) by using a probe with less sensitivity but better frequency response. Fig. 4 is a much more accurate picture of the vertical blanking interval. However, the TV technician is usually more than willing to sacrifice fidelity of waveform to get increased sensitivity for probing in low-level circuits like the mixer and first-i.f. stage.

A crystal probe designed for maximum sensitivity may be ideal for simple signal tracing, but it will not be suitable for checking video-amplifier response, or observing critical waveforms in sweep and high-voltage circuits. Since the technician usually does not want to invest in several specialized probes for different applications, commercial probes generally represent compromise designs which will meet the greatest number of application requirements in a satisfactory manner.

I.f. gain and alignment

In simple signal tracing with a high-sensitivity crystal-demodulator probe,

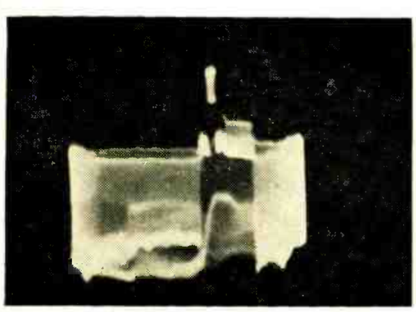


Fig. 2—Typical video-signal waveform seen with a crystal-demodulator probe.

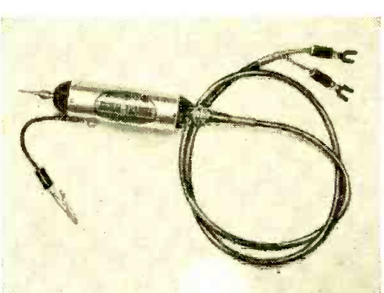


Fig. 3—Probe and output leads must be shielded to prevent picking up hash.

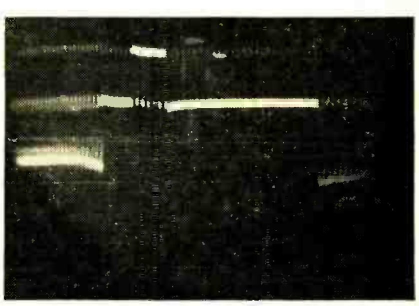


Fig. 4—The vertical-blanking interval of Fig. 2 shown in greater detail.

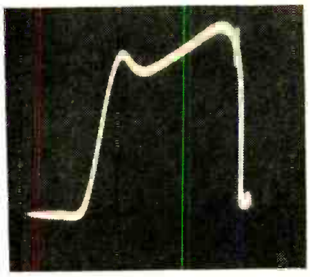


Fig. 5—A typical scope pattern observed when tracing a sweep signal through the input stages of a TV i.f. amplifier.

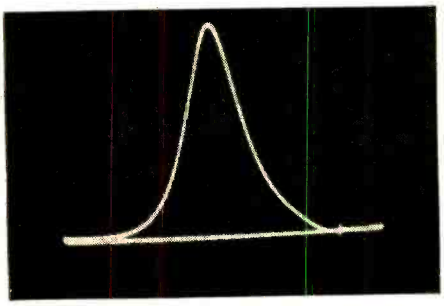


Fig. 6—Sweep-signal trace produced in the output stages of the i.f. amplifier.

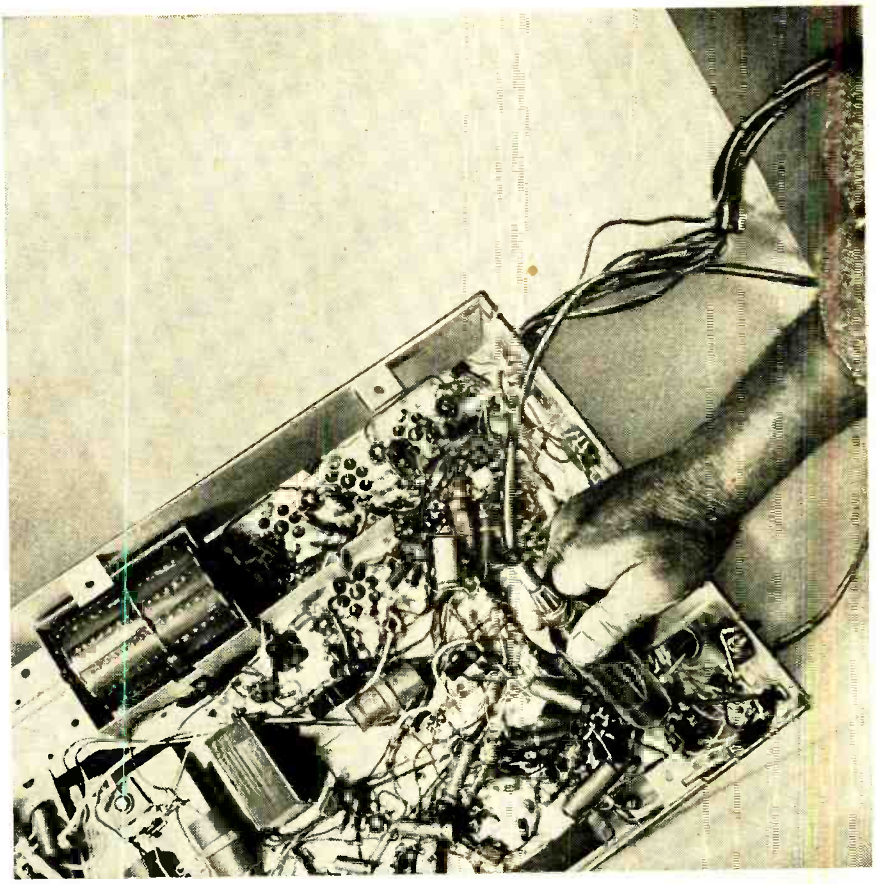


Fig. 7—A low-capacitance probe being used to check the horizontal sync waveforms in the automatic gain control circuit of a television receiver.

the technician is interested only in the relative change in the height of the pattern from stage to stage. Tests are usually made from plate to plate, rather than from grid to grid, since the plate circuits usually have lower impedance than the grid circuits, and are not loaded down to the same extent.

When tracing a *sweep signal* through an i.f. amplifier for alignment, the scope should show a pattern like Fig. 5 or Fig. 6. (The over-all selectivity is poorer in the early i.f. stages, and the pattern occupies a greater horizontal span on the scope.) It is a common error to assume that a pattern like Fig. 5 always represents a true single-stage or two-stage response. Actually, the true response of stages cannot be obtained unless the crystal probe is applied *across the plate load* of the last tube; and this plate load must be made *nonresonant* by shunting the tuned circuit with a 200- or 300-ohm resistor. Curves like Fig. 5 or Fig. 6 which are obtained by merely applying the crystal probe at the grid or plate of an improperly loaded tube have little value for accurate alignment work. (Special low-impedance probes are available which automatically provide the required circuit loading. See Part I, in the April RADIO-ELECTRONICS.)

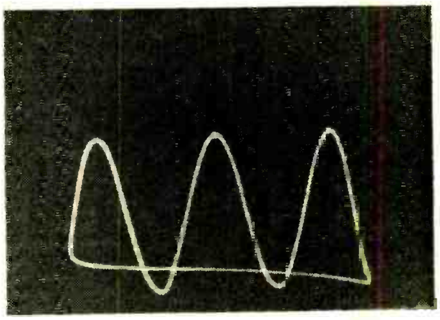
Sync and sweep circuits

A TV-station signal is almost always used in tracing sync-circuit troubles, except in some very difficult cases where no signal at all can get through. The *low-capacitance* probe is the most useful type for working in these circuits since it is least likely to disturb circuit conditions through its loading effect. Fig. 7 shows a low-capacitance probe checking horizontal-sync-pulse waveforms for shape and amplitude in the keyed-a.g.c. section of a TV receiver.

Waveforms in sync and sweep circuits are characterized not only by their *shapes*, but also by their *peak-to-peak* amplitudes. Both these characteristics are generally given by the manufacturer in the service data for the receiver. Methods of measuring peak-to-peak voltage are beyond the scope of this article (see "Peak-to-Peak Calibrator," by George E. Row, in last month's RADIO-ELECTRONICS), but look for trouble in any circuit where the measured voltage is more than 20% off the specified value.

Of course, even if the peak-to-peak voltage is correct, waveform distortion as shown in Fig. 8 and Fig. 9 indicates trouble. Obviously, this type of trouble-shooting cannot be done properly unless the technician has the necessary reference data as well as the right probe at hand.

In the sweep and high-voltage circuits the receiver supplies its own signal for test. (This may not always be possible, especially in some types of horizontal sweep circuits. For example, where the horizontal oscillator gets its plate voltage from the B plus boost line it may be a question of "Which came first—the chicken or the egg?" If the oscillator fails, there will be no B plus boost; if the B plus boost circuit fails, the oscillator won't work. In these cases you can save yourself lots of time and aggravation with the auxiliary power supply described in the "TV Service



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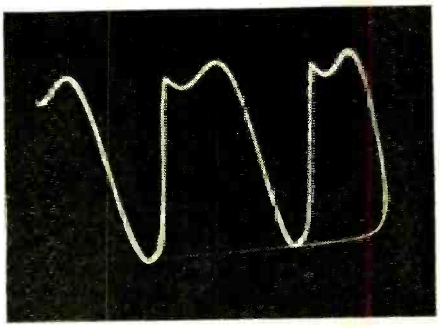


b

Fig. 8—(a) Normal oscillator waveform in a Synchrolock-type horizontal-sweep circuit. (b) Distorted waveform indicates circuit defects. For maximum accuracy in identifying circuit troubles, waveforms in this section of a television receiver should always be picked off with a special low-capacitance probe.

Clinic" in the December, 1952, RADIO-ELECTRONICS.—*Editor.*)

Some of these horizontal sweep voltages are high enough to damage the scope input circuit unless a suitable *high-voltage capacitance-divider* probe is used. Fig. 10 shows one of these probes checking the sweep waveform at the plate of the horizontal amplifier. (If you make a mistake and use a crystal probe or a low-capacitance probe at this point, you can probably kiss the probe and the scope input circuit goodby. A breakdown here may even burn out the flyback.)

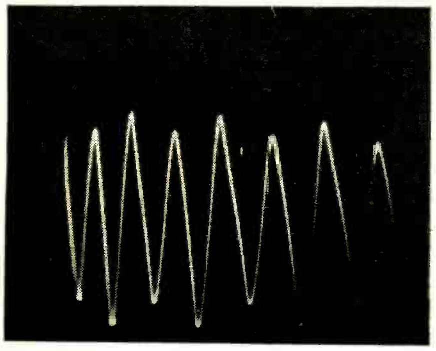


Fig. 9—Spurious low-frequency modulation of the horizontal-sweep waveform.

A typical high-voltage waveform is shown in Fig. 11. Like the sync and other sweep waveforms, these kickback waves should have the shapes and peak-to-peak amplitudes specified by the manufacturer.

Although crystal probes require no adjustments, a high-voltage capacitance-divider probe must be adjusted to provide the right input-attenuation factor for each type of scope. Low-capacitance probes are also adjustable for minimum waveform distortion. Probe manufacturers supply the necessary instructions with their products.

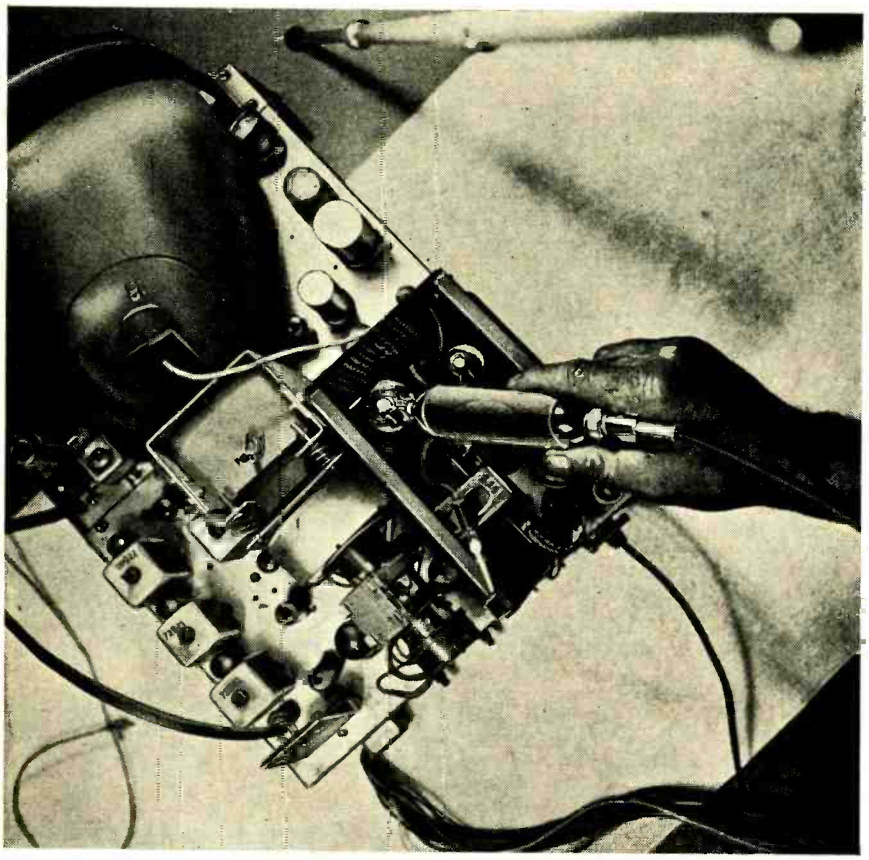


Fig. 10—High-voltage capacitance-divider probe for checking h.v. waveforms.

Grounding the probe

Technicians sometimes overlook the importance of grounding the probe correctly. Note that in Fig. 1 the probe is grounded as close as possible to the signal take-off point in the receiver. Unless this is done there may be spurious patterns due to ground-current effects at high frequencies. Many technicians think they can dispense with the annoyance of connecting and disconnecting the probe ground in i.f. signal tracing simply by running a permanent ground lead from the scope case to the receiver chassis. In practice, a lead this long almost invariably causes erratic operation.

Grounding requirements are less severe with low-capacitance probes—in fact, with this type of probe the ground connection may sometimes be omitted—*but a high-voltage probe must always be grounded!* Unless the ground lead *on the probe* is clipped to the receiver chassis or B minus line the whole test system will be hot, and you may get a severe and possibly dangerous shock. Remember, even *before step-up* in the flyback transformer, there is a 6,000-volt pulse at the plate of the horizontal output tube!

(TO BE CONTINUED)

Fig. 11—Normal 6-kv flyback pulse at plate of horizontal-output amplifier. The capacitance-divider probe attenuates the pulse by a factor of 100 to 1 to avoid damaging the scope input circuit.

THEATER-TELEVISION STANDARDS PROPOSED BY FILM INDUSTRY

THE standards proposed by the motion picture industry for its nation-wide theater-TV microwave network were made public recently at the first FCC hearing on the request for frequency allocations. The Motion Picture Association of America, Inc., and the National Exhibitors Theatre Television Committee, have asked for a total of 12 intercity channels—each 30 mc wide—in the frequency band between 5,925 mc and 6,285 mc. Two channels for remote pick-ups (frequencies not specified) were also requested. In addition, the industry asked for a group of channels above 10,700 mc for distributing programs to chains of theaters in the same city from a centrally located transmitter.

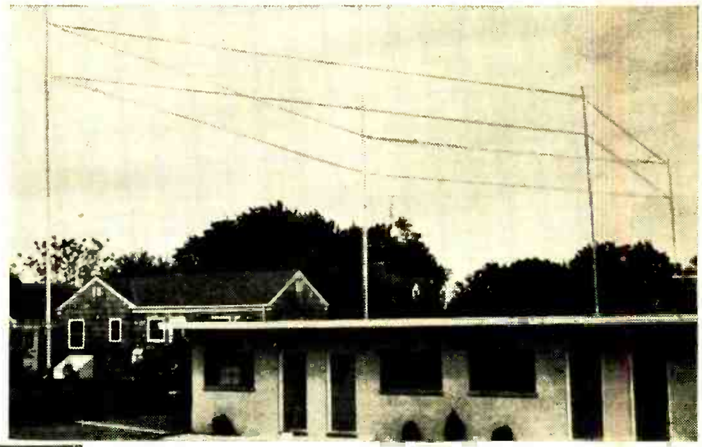
The proposed monochrome picture standards are based on providing a TV picture at least equal in quality to standard 35-mm motion picture film. They call for a 735-line picture, with a video bandwidth of 10 mc, and less than 10% distortion. Pictures will be sent by FM to reduce noise and co-channel interference. Sound will be sent by pulse-width modulation, on the "back porch" of each horizontal sync pulse. Under the proposed standards, audio frequencies up to 8,000 cycles can be transmitted by this method, which is about equivalent to the upper frequency limit of most theater-film sound tracks.

The local-distribution channels (above 10,700 mc) would each be 55 mc wide. This will allow local transmitters to use greater frequency deviation than the intercity links to overcome the higher noise levels in large cities. Separate parabolic antennas will be beamed at each theater from a central 200-foot distribution tower. Each theater will have its receiving antenna mounted on a 100-foot mast.

Further hearings on the engineering and public-service aspects of the proposed network have been scheduled. END

HIGH-GAIN RHOMBIC FOR TV

By PAUL RAFFORD, JR.



THE stacked rhombic antenna described here delivers about the ultimate obtainable in TV antenna performance. It was erected at Southampton, Long Island, 85 miles almost due east of the Empire State Building in New York City. The transmission path crosses an area noted for its high TV signal absorption. TV reception from New York stations is generally very poor—usually too weak to give satisfactory pictures with standard antennas except during periods of strong tropospheric propagation. We were fortunate to be in a locality where practically all TV signals arrive from the same point, and to have the necessary room, so an all-channel rhombic was a feasible solution to our fringe-area problem. The gain realized appears to be around 15 to 20 db, increasing with frequency. The viewing quality of channels 2, 4, and 5 (all located on the Empire State Building) is quite good under conditions where nearby Yagi antennas produce weak and unstable pictures.

Stacking two rhombics has two major advantages: first, there is close to 3 db additional gain over a single rhombic; and, second, the normal rhombic impedance of around 800 ohms can be reduced to 400 ohms by stacking. This gives a good match to standard 300- or 400-ohm transmission line. The spacing between stacks was chosen as 6 feet, approximately one-half wavelength on channel 4. This required the use of 50-foot poles to minimize the difference in gain between the upper and lower antennas, the difference between 44 and 50 feet being only about 1 db.

Any rhombic that has to cover the 4-to-1 frequency range represented by the v.h.f. TV bands, must necessarily be a compromise design. The greater the number of wavelengths per leg, the less the compromise necessary. The amount of real estate available was the limiting factor for this antenna, and a length of 88 feet per leg decided on. This is equal to about 5 wavelengths on channel 2 and 18 wavelengths on channel 13. Full dimensions are given in Fig. 1.

Referring briefly to rhombic antenna theory, the relatively high gain is obtained by orienting four long-wire antennas so that their major lobes lie along the line of maximum response to the desired station and connecting them so that their voltages are additive. The angle that each major lobe makes with its wire depends upon the length of the wire in wavelengths. The longer the wire, the smaller the angle between it and its major lobe. Similarly, the smaller the angle between lobe and wire the narrower the lobe becomes. If the wire is long enough, there will be only a few degrees difference between the angles made by the lobes for the lowest and highest response frequencies. However, the lower-frequency lobes will be broader than those of the highest frequency. If the antenna is aligned for maximum response on the highest TV channel, the broader lobes on the lower channels will still provide substantial pickup even though they are not aligned exactly.

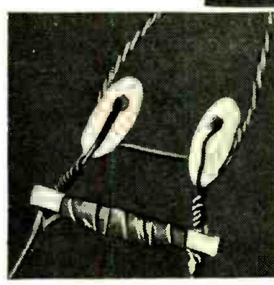


Fig. 2—800-ohm resistors are mounted on ceramic bars, wrapped in h.v. tape, and coated with a moisture-proof spray.

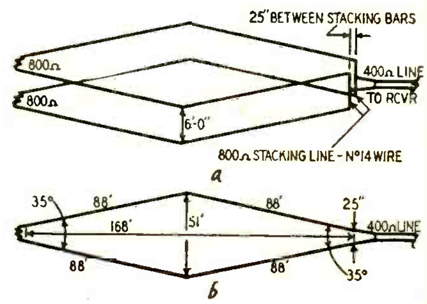


Fig. 1—Rhombic plan and perspective.

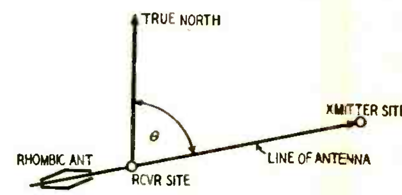


Fig. 3—Antenna line is found by measuring angle θ on Airways regional map.

The antenna wires must be perfectly horizontal. A slight incline of one or two degrees will not do much harm, but, if the antenna is erected on the side of a hill, take care to adjust the heights of the four poles to keep the whole antenna in a horizontal plane.

Open transmission line was used to reduce losses to a minimum. Most open-wire line is designed with an impedance of around 400 ohms, which matches the stack quite nicely. The stacking bars between rhombics have an impedance of 800 ohms, and are made of No. 14 wire, spaced 25 inches apart.

Each rhombic is terminated at its far end with a ½-watt, 800-ohm carbon resistor. These are mounted on insulators, as shown in Fig. 2, and covered with plastic insulating tape. The whole assembly is covered with a plastic spray for weatherproofing.

For those interested in constructing this antenna or one similar to it, the ARRL *Antenna Handbook* gives considerable information on constructing and raising many types of antennas and towers. The 50-foot poles for this antenna were built of 2 x 4's in a simplified "T" construction described in the *Handbook*. A good deal of care must be used in orienting the antenna. Much of the gain will be lost if this is not done accurately. The most accurate method is to get an Airways regional map which includes the sites of TV stations and the receiver, and measure the angle θ that the connecting line between them makes with the *true north*. See Fig. 3. (You can get Airways regional maps at your local airport or from aircraft-supply houses. They are corrected so that all bearings can be taken directly from the map with reference to true north.—*Editor*) In laying out the antenna be careful not to confuse true north with magnetic north, as the error will be appreciable in some areas. The North Star can be used for laying out the proper directions or true north can be found by other methods given in the *Antenna Handbook*. A good lightning arrester should be installed on the transmission line as close to the antenna as possible and with a direct ground connection to a rod driven into the earth.

The total cost of the antenna ran around $85.00, divided as follows: lumber, $40.00; guy wire, $13.00; rope, $8.00; antenna wire, $10.00; hardware, $14.00. END

Design Data ON VIDEO AMPLIFIERS

By
ALAN G. SORENSEN

Part III—More on high-frequency compensation

IN PART I of this series (RADIO-ELECTRONICS, March, 1953) we covered the *shunt-peaking* method of high-frequency compensation. This method provides excellent compensation and is very stable, but limits the gain obtainable from the compensated stage. In most cases—especially in television receivers—we want the greatest possible gain from a given number of tubes. If we can find a type of compensation that will give 50% more gain per tube, we can accomplish as much with only two tubes as we can with three in the shunt-peaking circuit. There is such a method, and it is shown in Fig. 1. This type of high-frequency compensation is known as *series peaking*.

The output load of V1 considered by itself consists of R_L shunted by C_a, which is the sum of the output capacitance of V1 and the stray circuit capacitance associated with the tube socket and wiring. The decreasing reactance of C_a as the frequency is raised bypasses more of the output voltage and reduces the gain of the tube.

If L2, the peaking coil, is correctly chosen, its inductance together with the circuit capacitance C_b, which represents the input capacitance of the following tube will cause it to approach resonance in the frequency range where without it the loss due to C_a and other stray capacitances would cause gain to drop off. As resonance is approached the impedance of the network is increased and the gain maintained. It should be substantially constant up to a given point, after which it will fall off rapidly. Series peaking will not give quite as good phase shift characteristics as will shunt peaking.

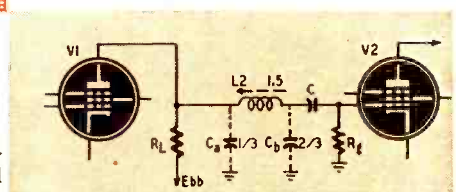
For best results, capacitance C_a should be half as large as C_b. So dividing the capacitance makes it possible to use a bigger plate resistor, and of course if the plate resistor can be increased by 50% the gain will be increased in like ratio.

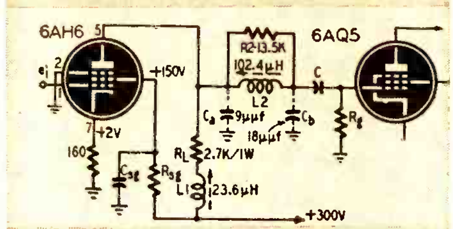
Obtaining this 1:2 capacitance ratio is a problem. Circuit elements may have to be changed about and a very critical parts layout has to be adopted. In some cases it will be necessary to add capacitance to C_a. In any case, the ratio of these capacitances must be quite closely proportioned.

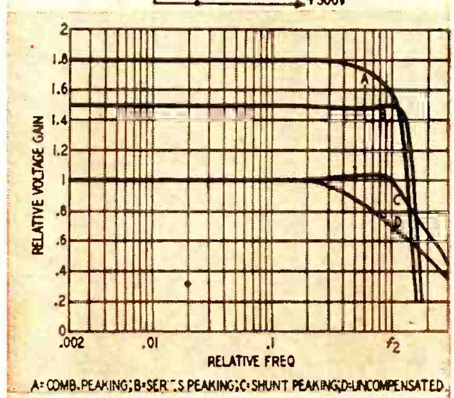
To illustrate the design procedure for this circuit we will again take a 6AH6 tube followed by a type 6AG7. As we found in Part I, the output capacitance of a 6AH6 is 2 μμf, and the total input capacitance of the 6AG7 is 15 μμf. In the completed circuit C_a would probably be 5 μμf, while C_b would probably be close to 20 μμf. This means that C_a will have to be increased to about 10 μμf in order to satisfy our ratio. It would be better to choose a tube with lower input capacitance.

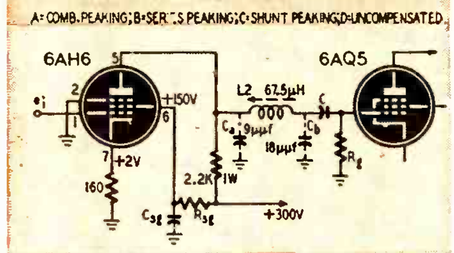
The difficulty here is that a tube with lower input capacitance will not give nearly as much gain. On the other hand, a tube with a large input capacitance will reduce the possible gain of the preceding tube because the plate resistor of that tube will be 1.5 times the reactance of the total capacitance. When the total capacitance is increased, the capacitive reactance will be lowered. This means a smaller R_L and a smaller gain factor. And, a tube with a small input capacitance will have a lower transconductance (gm), which again reduces the over-all gain. The whole thing is a vicious circle.

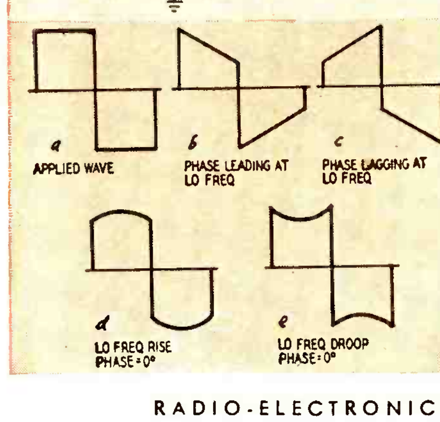
In the case of a television receiver, the problem is not too difficult. A gain of 100 will usually be adequate and we could use a 6AH6 followed by a 6AQ5.











Right, from top to bottom: Fig. 1—Series peaking for h.f. compensation. Fig. 2—Complete circuit of series-compensated video-amplifier stage. Values shown give 50% more gain than shunt peaking. Fig. 3—Relative frequency response and gain with various methods of peaking. Fig. 4—Combined shunt and series peaking for maximum gain. Fig. 5—Effects of phase shift (*a*, *b*, and *c*) and frequency distortion (*d* and *e*) on low-frequency square waves in a video amplifier.

The transconductance of the 6AQ5 is 4,100 micromhos, its input capacitance is 7.6 μμf, and its grid-to-plate capacitance is 0.35 μμf. Assuming a plate load of 2,500 ohms, we have:

$$\text{Gain (A)} = gm \times Z_L = .0041 \times 2{,}500 = 10.25$$

$$C_{gp}\ (1 + A) = 0.35\ (1 + 10.25) = 3.9375$$
(or 4 μμf approximately)

$$C_b = C_{in} + C_{gp}\ (1 + A) + C_{stray} = 7.6 + 4 + 6.4, \text{ or } 18\ \mu\mu f$$

A value of 6.4 μμf was assumed for the stray capacitance, to give an even value to C_b.

Every effort has to be made to keep the stray capacitance on the grid side to a minimum. Parts must be kept well away from the chassis. After C_b has been reduced as much as possible, C_a can be *increased* until the proper relationship is obtained. This can often be done by placing R_L close to the chassis. In our sample problem C_a should be very close to 9 μμf. It may even be necessary to add a very small capacitor from plate to ground.

To actually measure these capacitances, a bridge is required. Disconnecting the leads to peaking coil L2 and connecting the bridge between plate and chassis will give the stray component of C_a. Connecting the bridge between grid and chassis will give the stray component of C_b. The tubes are removed during these measurements, and the tube capacitances are computed mathematically. The B plus side of resistor R_L should be temporarily grounded. This is because the B supply line may not represent a short circuit at the frequency used in the bridge (often 60 cycles). All precautions which apply while measuring very small capacitances are very important here. Especially lead dress of the test prod wires.

It is simple to compute R_L and L2:

$$R_L = 1.5 \times X_{ct} = \frac{0.2385}{f2 \times C_t}$$

$$L2 = 0.67\ C_t\ (R_L)^2$$

where C_t represents the total capacitance of C_a and C_b, and X_{ct} represents their net reactance, while f2 is the frequency to which response is to be maintained (see Fig. 3). We can set it at 4 mc, and our total capacitance C_t is 25 μμf.

$$X_{ct} = \frac{0.159}{f2 \times C_t} = \frac{0.159}{4 \times 10^6 \times 27 \times 10^{-12}}$$

$$= 1{,}472 \text{ ohms;}$$

$$R_L = 1.5\ X_{ct} = 1.5 \times 1{,}472 = 2{,}208 \text{ ohms}$$
(call it 2,200 ohms);

$$L2 = 0.67\ C_t\ (R_L)^2 = 0.67 \times 27 \times 10^{-12} \times 2{,}200 \times 2{,}200 = .000067456 \text{ henry, or } 67.5\ \mu h.$$

We now can calculate all the high-frequency parts values. The other parts are calculated as outlined in Part II. At low frequencies peaking coil L2 is an effective short circuit.

The stage gain can be found next. Since the cathode is unbypassed, the gain will suffer somewhat from degenerative feedback. Or we could bypass it and obtain the maximum gain. With the cathode bypassed, a plate load of 2,200 ohms, and a gm of 9,000 μmhos, the gain is about 20, while without bypassing, it is about 8 (8.1).

The gain of the 6AH6 tube will thus be 8.1 as compared to 4.8 for shunt peaking, an increase of 3.3. However, this increase in gain is the only advantage of series peaking. As shown in the graph of Fig. 3 the response will deteriorate very rapidly after f2 is passed. Also the phase characteristics will not be quite as good. The circuit is used quite extensively in television receivers and does quite a good job.

A combination circuit

There is a still more complex compensation circuit known as series-shunt peaking, or combination peaking. It is exactly what the term implies; a combination of both series and shunt circuits, as shown in Fig. 4.

This type of circuit is much more complex. The gain will be about 80% higher than with shunt peaking but there are two disadvantages. The first is that, as shown in the curve of Fig. 3, the response will drop off before f2 is reached. Secondly, the phase characteristics will not be as good as with either shunt or series peaking used alone. Even so, the circuit is often employed in television receivers because of the higher available gain.

The theory of shunt and series circuits applies to the combination type. There is only one difference, and that which has to do with resistor R2. The distributed capacitance of peaking coil L2 must be kept to a minimum to prevent a rise, or peak, in the response at the high frequencies. By shunting L2 with a resistor, we can reduce the Q of the filter circuit and thereby eliminate any such rise. The value of this resistor is found experimentally and will usually be about 5 times the value of R_L.

$$R_L = 1.8 \times X_{ct} = \frac{0.2862}{f2 \times C_t}$$

$$L1 = 0.12\ C_t\ R_L^2$$

$$L2 = 0.52\ C_t\ R_L^2$$

To get into the calculation of these components, we will again take f2 to be 4 mc. The shunt and stray capacitances will still total 27 μμf. C_a will have to be dealt with again because of the addition of coil L1, but it must still be close to 9 μμf.

$$X_{ct} = \frac{0.159}{f2 \times C_t} = \frac{0.159}{4 \times 10^6 \times 27 \times 10^{-12}}$$

$$= 1{,}472 \text{ ohms.}$$

$$R_L = 1.8\ X_c = 1.8 \times 1{,}472 = 2{,}649.6 \text{ ohms}$$
(2,700 ohms approximately).

$$L1 = 0.12\ C_t\ |R_L|^2 = 0.12 \times 27 \times 10^{-12} \times 2{,}700 \times 2{,}700 = 23.6\ \mu h.$$

$$L2 = 0.52\ C_t\ |R_L|^2 = 102.4\ \mu h$$

Resistor R2 will be about five times R_L, or about 13,500 ohms. It will be necessary to measure the response at the high frequencies and determine the actual value by experiment. The gain would be 24.3 with the cathode bypassed or 10 unbypassed. Quite an increase over shunt peaking! Low-frequency compensation is applied to this type of compensation by the same methods used with shunt peaking (explained in Part II).

In oscilloscopes it is often desirable to have an extremely flat response up to f2, with a minimum of phase distortion. This can be attained by using conservative values in a shunt-peaking circuit. The idea is to first use a low value of K for L1; somewhere between 0.3 and 0.414. In this way there will be no peak in the response. Next, if we calculate the parts using an f2 slightly higher than actually required of the amplifier, the response will be very uniform up to the highest frequency needed. The usual case is to make R_L about 0.85 times X_{ct}. This will result in a 15% reduction in over-all gain. This circuit will give the best frequency and phase characteristics of any type. The useful computations are:

$$R_L = 0.85\ X_{ct}$$
$$X_{L1} = K \times X_{ct}$$
$$L1 = K \times C_t \times (X_{ct})^2$$

We have covered the various methods of compensating vacuum-tube response at both the high- and low-frequency ends of the spectrum. A few notes on construction might be useful at this point. The most important precaution is to keep the stray capacitances to a minimum. Also to select tube types which have low interelectrode capacitances. These capacitances are the only reason for the falling off in high-frequency response. Plate resistor R_L must be a noninductive type. Any inductance in this resistor will add to that of coil L1. There are few ready-made commercially available peaking coils. They will have to be wound by the constructor. It is also important to keep the distributed capacitance of these coils to a minimum. Any capacitance will add to that of the circuit. Directions for winding these coils will be explained in Part IV.

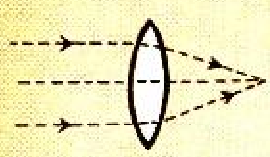
When the amplifier is completed a response curve should be drawn. A square wave test of the low frequencies is very useful, as shown in Fig. 5. At the high frequencies the signal generator input should be checked with a wide-response v.t.v.m., or any other suitable means, so that the input signal can be kept constant.

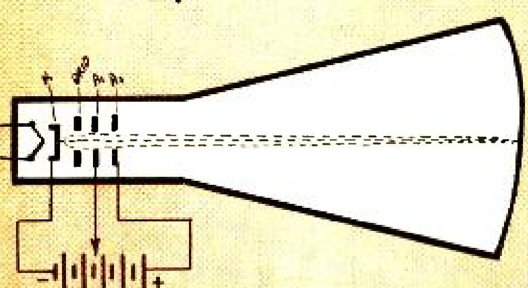
(TO BE CONTINUED)

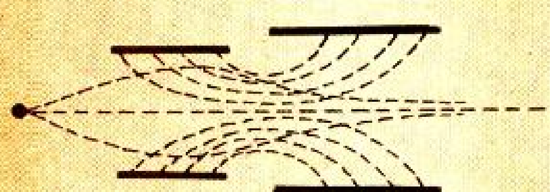
TELEVISION? . . . it's a cinch!

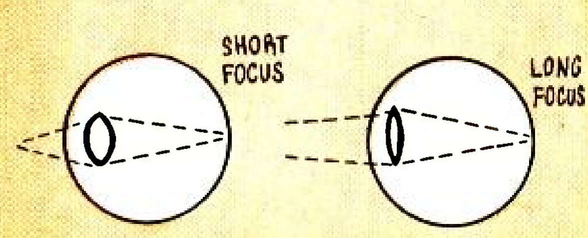
By E. AISBERG

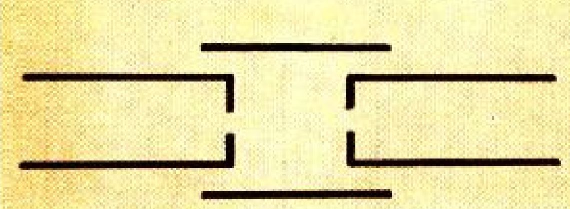
Third conversation continued: The electron lens; focusing the beam; electron return; electrostatic deflection; how the picture is produced.











The electronic lens

Will—That brings us back to the problem of concentrating the beam. How are you going to get those electrons to stick together?

Ken—You do it with an *electron lens:* Electron beams act like light rays and obey their own electronic optical laws. Those are pretty much the same as the laws dealing with ordinary light that you learned of in physics.

Will—Don't tell me that you can make an electron lens out of glass. The electrons couldn't get through it!

Ken—No, the electron lens isn't made of glass. There are a number of ways to bunch the electrons into a fine pencil-like beam. One of the oldest—and one still used on small tubes—is to add a second anode, at a higher voltage than the first. Each of these anodes has its own electric field, and their interaction causes the electrons to come to a point some distance ahead of the second anode. By regulating the voltages on one or both anodes, the paths of the electrons can be bent more or less. Thus you can alter the *focal length* of the lens so the beam comes to a sharp point right at the screen.

Will—Adjustable, eh? This electron lens is better than an optical one.

Ken—Not at all. The lens of your eye—for example—can modify its focal length to accommodate to near or distant objects.

Will—I suppose this is what they call electrostatic focusing. But our triode is now a tetrode!

Ken—I can even show you cathode-ray pentodes! But this is not exactly what they mean when they say electrostatic focusing today. In a modern electrostatic focusing tube, the anode cylinder is cut into two parts, separated a little from each other. Then another cylinder—a little bigger than the others—is slipped over and spaced very exactly from them. The latest types keep this cylinder at cathode voltage, though a few early ones had about 250 volts on the cylinder and some went up to 2,200. Again you have interaction of electric fields which acts as a lens, focusing the beam somewhere beyond the anode. This type of *automatic focusing* tube was developed in 1951 and is being manufactured in a number of types.

Will—But you told me that the first focusing method was an old one, used in some small tubes. Now this is a new method (or a new variation of an old method) which seems to be used in a few large tubes. What happens in between? Is there another way to focus?

Ken—I was wondering when you were going to ask that! Most of the tubes in sets today are focused in an entirely different way. But let's finish with our electrostatic tubes. Then next time we talk you will be in a better position to understand other focusing methods.

Hard road for electrons

Will—Now, what happens to the electrons after they reach the screen? They surely have to get back to the voltage supply they started out from?

Ken—That question never bothered the tube manufacturers very much. They let the electrons sort of shift for themselves. After they have struck the screen at high velocity . . .

Will—High velocity? About how high?

Ken—That depends on the voltage applied to the last anode—and to the *accelerating electrode*, which we will come to in a minute. It's proportional to the square root of those voltages. With 10,000 volts to speed them up, the electrons may reach a speed of 7 miles a second. But with 20.000 volts, they wouldn't travel at a speed greater than about 9½ miles per second.

Will—Why should an electron have to get up speeds like that?

Ken—Because the harder the electrons hit the screen, the more light they make.

Will—But we still haven't found out what happens to them *after* they hit the screen!

Ken—Because they move so fast, each electron kicks up several more when it hits, like raindrops falling into a puddle of water. Then these . . .

Will—. . . secondary electrons . . .

Ken—I see you haven't forgotten our old talks on radio. These secondary electrons travel slowly and as best they can back toward the anode. In modern tubes, we make it easier for them by coating the inside of the cone with graphite. A connection to this coating is made with a flexible lead to a button on the side of the cone. The graphite coating is kept at a higher voltage than any other element in the tube, and is the *accelerating electrode* I mentioned a few minutes ago. It helps speed up the electrons after they pass what we have been calling the anode.

Will—Why the flexible lead? Sounds messy. Can't we just connect to one of the pins in the base?

Ken—No, the voltage is so high that it's more practical to keep the lead as far from the others as we can.

Will—Now I think I can see the whole circuit. The electrons leave the cathode, go down the center of the "grid" and through the hole in one or more anodes, and finally reach some part of the screen. Then they work their way back along the inside surface of the tube to the positive end of the high-voltage supply (and if you want to complete the circuit, through that to the cathode) I guess the hardest part of the journey is from the point that the beam strikes to the edge of the screen?

Ken—Yes. The fluorescent layer is far from being a good conductor. In some tubes there is a thin aluminum backing behind the layer. It's only about a molecule thick—too thin to bother the high-speed electrons coming from the gun. But it does stop the low-voltage secondary electrons and helps them to get to the edge of the tube. The real reason for this aluminum layer is to increase the image brightness. It reflects the light rays that start toward the inside of the tube and sends them back toward the viewer.

The spot has its ups and downs

Will—Now we have an electronic pencil to draw our picture on the screen. All we need is to control it! How do we pick up this pencil and move it around on the screen to make the picture?

Ken—Think a little. When a real gun fires its bullets, do they travel in a straight line?

Will—Of course not. They follow a curve—a parabola—because gravity pulls them down.

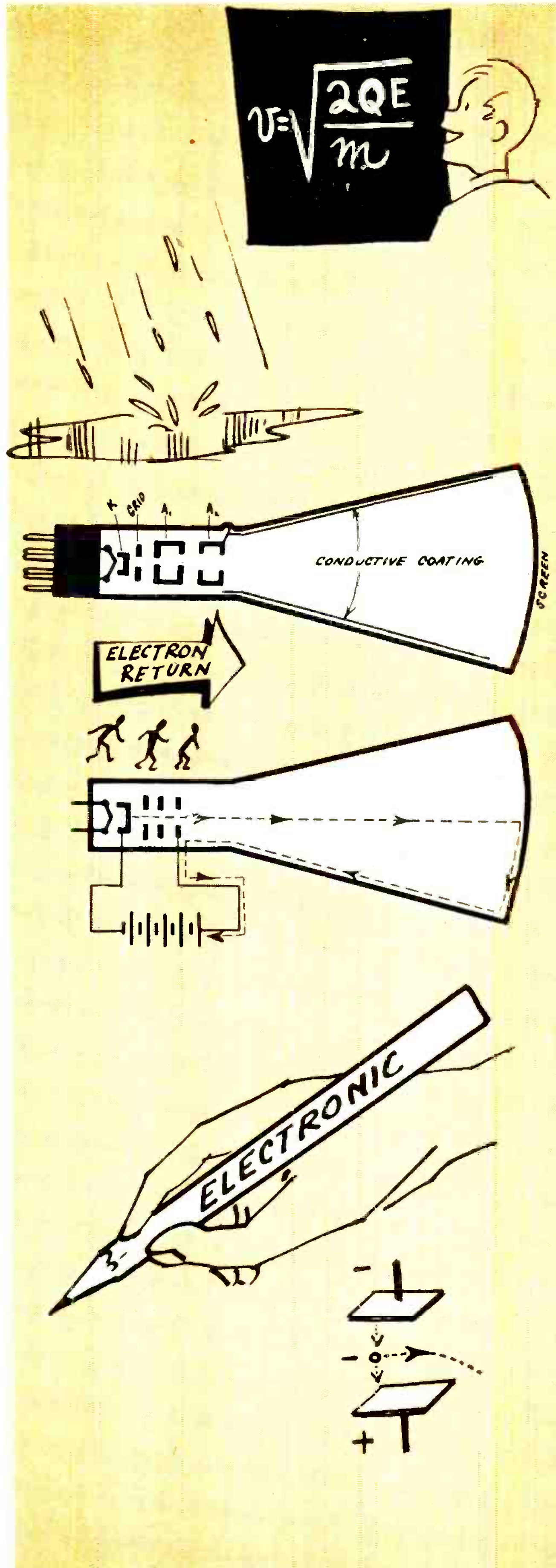
Ken—Then can you figure out how to apply a force to make the electron stream curve?

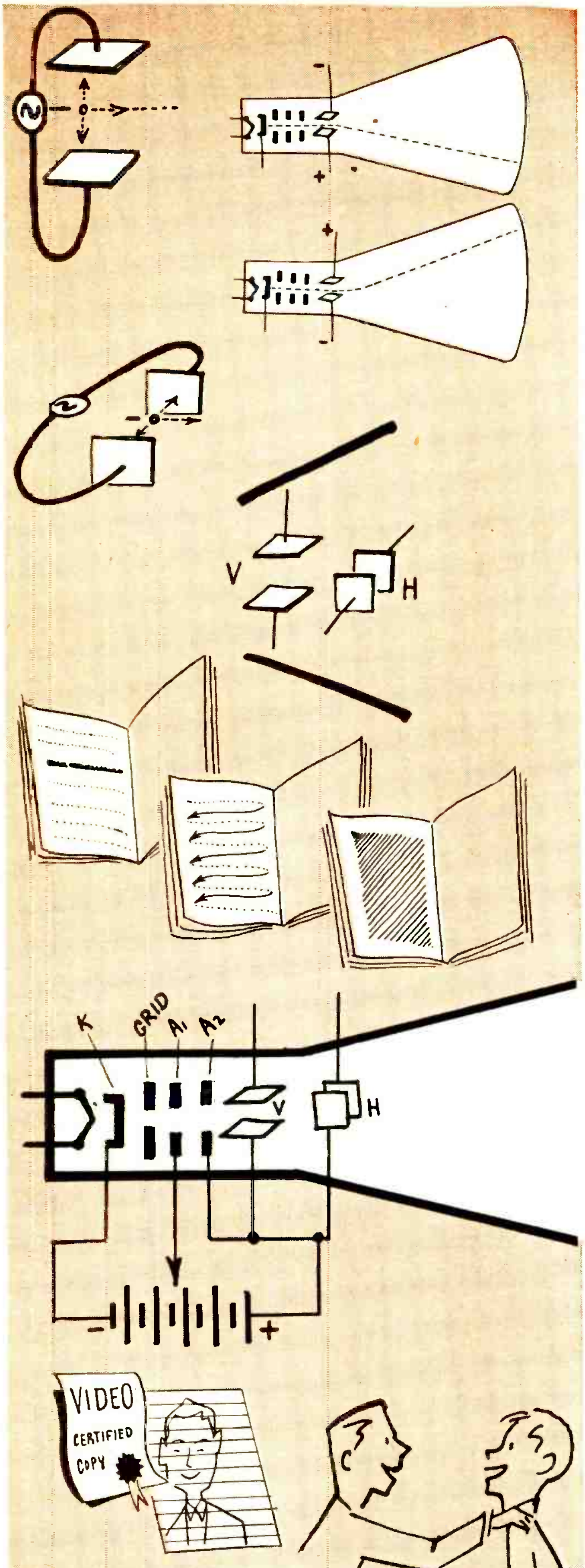
Will—I get it! We can put a positive plate under the beam, to attract it the way the earth does the bullet. Then the electrons will be pulled downward.

Ken—Good reasoning! And you'll do even better if you put a second plate—charged negative—*above* the beam.

Will—I see. One plate pushes and the other pulls. But these two plates become a capacitor.

Ken—That's right. But we haven't any reason to apply a constant voltage or charge to our *deflection plates*. That would simply pull the spot up or down a little and leave it there. Now, what would happen if we put an *alternating* voltage across our plates?





Will—On one alternation the top plate will be positive and the lower negative, so the spot will go up. Then the bottom plate becomes positive and the top negative, and the spot goes down.

Ken—You see the spot travels along the vertical diameter of the screen. Now if the frequency of the alternating voltage is 30 or more cycles a second . . .

Will—. . . Then we'll see a bright vertical one, because all the positions of the spot will run together in the eye!

A 90-degree twist

Ken—And now suppose you set another pair of plates along the path of the beam, but put them on the sides instead of above and below.

Will—Then we can move the spot from left to right. And if we use a.c. on the plates, we make a horizontal line. There's only one funny thing: the *vertically* mounted plates give us the *horizontal* deflection, and the *horizontal* plates give us the *vertical* deflection.

Ken—That has made trouble. Some authors (and teachers) have tied green students in knots by talking about "horizontal plates" when they meant "horizontal deflection plates," and *vice versa*.

Drawing the picture

Will—Now the spot can be moved both ways, but I still don't see how it can trace out a television image.

Ken—Let's not hurry this too much; I hope you'll be satisfied with just a rough idea for now. Suppose we apply a slow alternating voltage to the deflection plates, so the spot will move at uniform speed across the tube screen from left to right, and appear again at the left just as soon as it disappears at the right, and so on.

Will—It would be just like reading the same line of a book over and over.

Ken—That's exactly what I was trying to get across! Now let's give the spot a much slower motion from top to bottom, by applying a lower-frequency voltage to the vertical deflection plates.

Will—So when we get to the end of one line, we won't come back to the beginning of the same line, but to a little lower point?

Ken—Exactly. And since the spot keeps moving downward at a uniform rate, the same thing will happen for all the lines. But when the spot has got down near the bottom of the tube, we'll reverse the voltage on the vertical deflection plates very rapidly, so the spot will jump to the top of the screen and start on its slow trip down again.

Will—Just like finishing one page and turning to the next. That's all quite clear, but your spot still hasn't done anything but trace out a series of lines of equal brightness. They should give us a very evenly lighted rectangle. It's like a book in which all the letters are identical, or better, one full of glossy blank pages. Just where and how do we get our TV picture?

Ken—We surely must have forgotten some very important point! Suppose we vary the intensity of our beam so that each point on the image has just the proper brightness?

Will—I don't see how you can do that.

Ken—Stop and think a little. Or can't you take any more today? What was it that we used in order to modulate our light beam so that it reproduced the successively scanned points of the image so faithfully in the Nipkow apparatus?

Will—Why, the video signal, of course!

Ken—And to what element of the cathode-ray tube should we apply the video signal to make it modulate (or modify) the intensity of the scanning beam?

Will—Of course! To the control grid! Then the brightness of our spot at any point will depend on the video signal. And the transmitted image can be reconstructed exactly, element by element, on the tube screen.

Ken—Naturally, we have to *synchronize* the electron beam at the receiver exactly with that at the transmitter.

Will—Hold it a minute! Now I have about a hundred questions to ask!

Ken—Let me ask *one* first: Why don't we call it a day and leave our problems till next time we get together?

(TO BE CONTINUED)

The technician holds the ultrasonic applicator gun and 1-mc output crystal.

Ultrasonic Therapy Unit

By S. M. MILANOWSKI

ALTHOUGH ultrasonic therapy has been quite popular among European physicians for a period of almost ten years, it has been used so little in the United States that until the early months of 1952 virtually all ultrasonic medical equipment had to be imported from Germany.

Now, as the result of research at the New York University Medical School, Los Angeles' Cedars of Lebanon Hospital, Cook County Hospital in Chicago and Tulane University in Louisiana, doctors in the United States have manifested enough interest in ultrasonic therapy to justify the production of a new type *ultrasound* generator by Birtcher Corporation of Los Angeles.

Compared with equipment manufactured in Europe, Birtcher's ultrasonic-therapy unit is most notable for its extreme simplicity—having been designed to generate 0.14 to 3½ watts of ultrasound per square centimeter at a constant output frequency of 1,000,000 cycles per second.

As shown in Fig. 1, the generator is essentially a small radio transmitter with its output going to a quartz-crystal transducer instead of to an antenna. The output crystal is housed in the gun-like metal applicator shown in the photographs, and its 1-mc vibrations are applied to the patient's body by a metal diaphragm.

The 812-A is operated as a shunt-fed Hartley oscillator, with the output crystal connected across the grid portion of the oscillator tank.

The 83 mercury-vapor rectifier supplies *unfiltered* pulsating-d.c. plate voltage to the oscillator. These pulsations swing the oscillator output from zero to maximum 120 times per second. An automatic timer in the primary circuit limits the total dosage.

Operation of the unit consists first of turning a primary control knob to close the filament switch. A signal light on the instrument panel glows when the vacuum-tube filaments are warm, then the primary control knob is turned again. This applies plate power, and a second signal light glows if the tubes are operating properly. The indicator lamps are not shown in the simplified schematic in Fig. 1.

Next, the timer knob is set, and the output control is adjusted for the power required. A milliammeter may be referred to in making the latter adjustment, if necessary.

The most common method of applying ultrasonic vibrations for therapeutic purposes is to smear salve over the area to be treated, and to massage the salve-covered area with the applicator's diaphragm. In other cases, the applicator and part of the patient's body are immersed in water. Dense media such as salve or water are required for effective transmission of the energy to the patient, since 1-mc sound waves cannot be transmitted through even the thinnest layer of air with any degree of efficiency.

In some cases, ultrasound is applied directly to diseased or damaged portions of the body, or to nerve endings along the spinal column—thus using the nerves as power lines to reactivate paralyzed muscles, as well as to stimulate the glandular production of hormones.

According to such authorities as Dr. D. W. Kobak of Cook County Hospital, the chief thing likely to restrict the future use of ultrasonic therapy will be the skeptical attitude of the average physician—an admirable trait in many respects, but not the sort of attitude that facilitates the development and use of new ideas. END

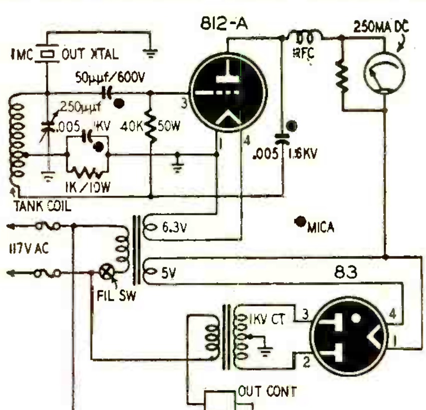
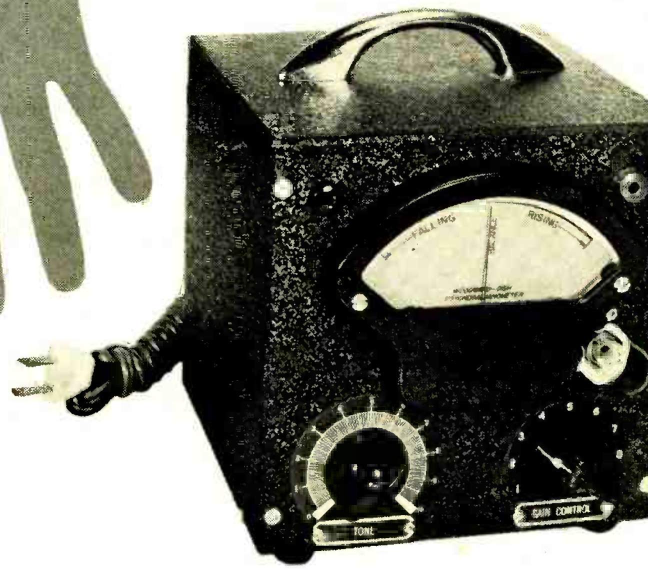


Fig. 1—Circuit diagram of Birtcher ultrasonic generator for medical use.

ELECTRO PSYCHOMETER



It assists psychotherapy to find sources of emotional disturbances

By ROBERT L. GISH*

WHEN the emotional state of an individual changes, his body reflects this change in many ways. The most obvious indicators are the respiratory rate, muscular tension, pulse rate, and blood pressure. However, there are many other factors connected with a person's body which also respond to changes in emotional states. One of the most significant is the body's resistance to the flow of electric current.

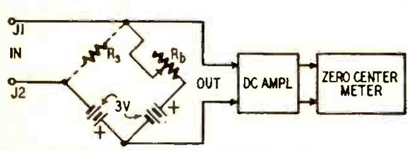


Fig. 1—Equivalent circuit of the psychometer. R_s is the subject's body resistance, and R_b balances the bridge for zero output before questioning begins.

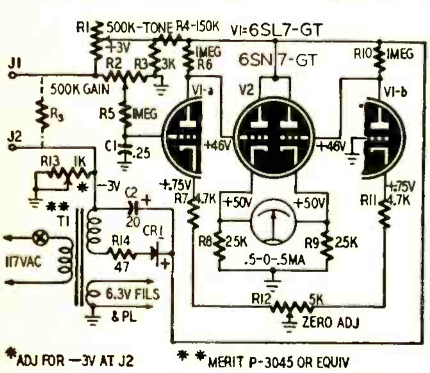


Fig. 2—Schematic of the standard-model psychometer. Deluxe models differ only in having the meter-protection circuit and warning light shown in Fig. 6.

* Philco Corporation

The discovery of the close correlation between emotional stress and changes in physical states has led to the development of highly interesting electronic devices for measuring and indicating these changes. One of the most useful of these instruments is the *psychogalvanometer* (or, more simply, the *psychometer*), which measures CHANGES IN BODY RESISTANCE.

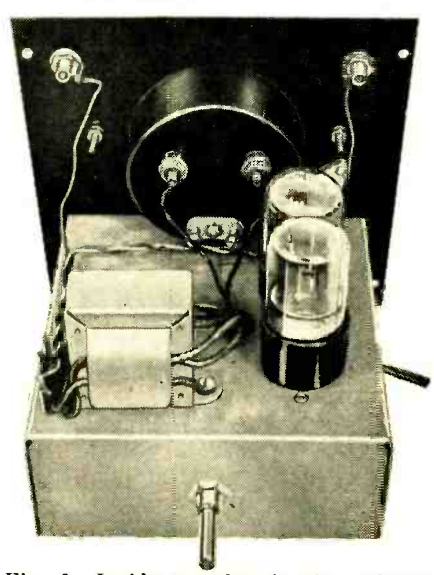


Fig. 3—Inside top-chassis view of the standard-model psychometer. The control at the back of the chassis is the static-balance potentiometer (R12 in Fig. 2, reset at start of therapy.

Scientists have discovered that if a person is connected across a highly sensitive body-resistance measuring device and then processed by any one of a number of techniques designed to help him remember and re-evaluate forgotten past experiences, there is a definite correlation between changes in body resistance and memories of times in the subject's past which involved emotional charge or physical pain.

The body-resistance changes usually indicate the degree of emotional charge or pain connected with an incident, even though the subject may insist in all sincerity that there was no disturbing incident in the area of time being scanned.

For a number of years, law-enforcement agencies have been using such devices, which soon acquired the colorful but rather unfortunate name of "lie detector."

Although the psychometer is often used as a lie detector, it does not actually register the truth or falsity of any statement. It *does indicate the emotional stress* produced when a person attempts to lie or to conceal the truth, and even the most rigidly self-controlled individual cannot fool the operator who is trained in the use of such an instrument. (He could, however, have the emotional charge reduced on all incidents which were associated with lying in his entire life, in which case he might then be able to avoid detection by the instrument.)

Actually, most so-called "lie detectors" measure pulse and respiratory

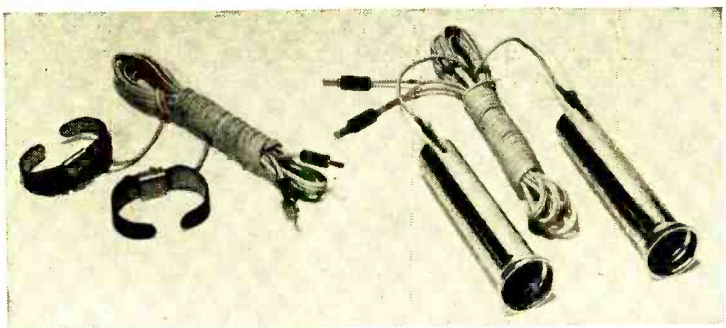


Fig. 5—Wrist-strap and hand-held electrodes.

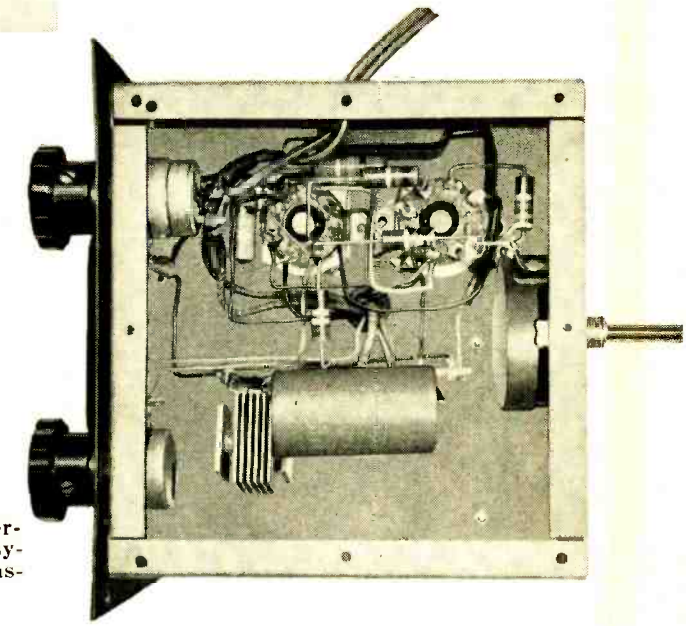


Fig. 4—Underneath the psychometer chassis.

rates as well as changes in body resistance. Many persons have ridiculed the idea that valid data can be gained through use of such machines, but in certain cases evidence obtained by means of these devices has proved so accurate that in many states serious thought is being given to legalizing admission of "lie-detector" evidence in court proceedings.

These discoveries have given psychotherapy a powerful tool for research and treatment, and the result has been a rapid increase in the use of the psychometer for this purpose.

The subject of this article is a simple but extremely sensitive psychometer. It has no critical circuits, is highly stable (even under line-voltage fluctuations), and is easy and very inexpensive to construct. It has been tested side-by-side with several other more elaborate models, including one commercial model which retails for over three times its cost, and it has been found to be at least equal to any of them in sensitivity and stability, and far superior in simplicity of operation.

Theory of operation

The psychometer is essentially a balanced bridge circuit in which changes in body resistance appear as changes in voltage across the output terminals. Fig. 1 is a simplified schematic which shows the principle on which the psychometer operates.

The subject is connected across the input terminals J1 and J2 by means of wrist or hand electrodes, and represents the equivalent resistance R_s. The other legs of the bridge are represented by balancing resistor R_b and the two 3-volt batteries.

When R_b is adjusted to equal R_s the voltage drop across each arm of the bridge is exactly 3 volts, and there is zero voltage across the output terminals. Any change in R_s will unbalance the bridge and produce a voltage difference which can be amplified to produce a large deflection even on a relatively insensitive meter.

As explained above, research workers in this field have found a direct relation between the change in R_s and the degree of emotional charge or pain associated with a memory area. Thus the amplitude of the deflection on the output meter indicates the relative intensity of the disturbance and shows the effects of therapy.

The psychometer circuit

Fig. 2 is the schematic of the psychometer. The input bridge is formed by R_s, R1, R3, and R13. R3 and R13 replace the batteries in Fig. 1. Although R3 and R13 are not equal resistances, the voltages across them are equal, which produces the same effect. R2 is simply a voltage divider across the bridge output terminals which allows any desired fraction of the bridge-unbalance voltage to be fed to the grid of V1-a.

R5 and C1 form an integrating network which prevents abrupt changes in R_s from wrapping the meter pointer around the scale-end stop pins. (Such sudden changes might occur if the body electrodes are shorted while R2 is near its maximum-output setting.)

The amplifier portion of the circuit is a two-stage, direct-coupled v.t.v.m. The 6SN7 (V2) is connected in a bridge circuit, with R8 and R9 forming two of the arms, and the internal resistances of the two triode sections forming the other two.

The 0-1-ma meter is connected between the cathodes of V2, so that no current flows through the meter when the currents through the two sections of the 6SN7-GT are equal. (This assumes, of course, that resistors R8 and R9 are exactly equal—a requirement which need not be met precisely because ample compensation is provided by the action of R12, as explained below.) The meter pointer is zero-centered either mechanically or by unbalancing the static currents through V2 with R12. Zero-centering the meter by unbalancing V2 does not affect the operation of the circuit.

The grid of V1-b is at ground potential at all times; thus the current through this triode is controlled by the

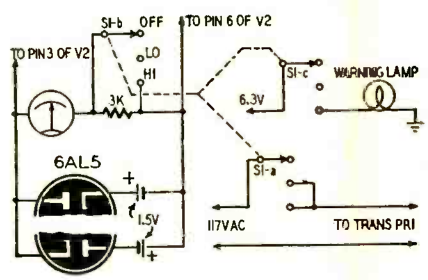


Fig. 6—Meter-protection circuit prevents shorts or large changes in resistance from driving pointer off scale.

setting of R12. R12 also controls the static plate current through V1-a. Since the currents through V1-a and V1-b determine the grid voltages of both sections of V2, R12 can establish static balance for the entire circuit. Simply reduce the GAIN control to minimum (effectively grounding the grid of V1-a) and adjust R12 for an exact mid-scale reading on the meter. This adjustment need not be made very often, and the zero-centering control was mounted on the back of the psychometer.

R6 and R10 are the plate-load resistors for V1, while R7 and R11 provide safety bias for V1-a and V1-b. They also produce a vernier effect on R12, which would otherwise be somewhat critical.

The power supply is a conventional half-wave circuit with a small selenium rectifier. The power transformer isolates the operator and the subject from any possible contact with the a.c. line. R14 is a surge resistor, included for rectifier protection. R13 in the B minus return provides the negative bridge-supply voltage, and is adjusted so that the negative d.c. voltage at J2 is exactly equal to the positive voltage across R3 (approximately 3 volts).

Even though both grids of V2 are operated at plus 46 volts there is a net bias of about minus 4 volts on each section because the cathodes are at about plus 50 volts at balance.

Construction details

Since the changes in resistance to be detected are relatively slow, the high-frequency response of the amplifier is limited deliberately to about one cycle per second. Layout and lead dress are not critical, and parts may be mounted and wired wherever convenient.

Fig. 3 and Fig. 4 show the parts layout and wiring details of the standard model. The shaded aircraft-type panel lamp illuminates the meter scale and provides a small amount of room illumination during therapy if desired. (The position of the shade is adjustable.)

Only two design points require special consideration. One is the selection of resistors and tubes. The circuit will operate most effectively if corresponding elements in each of the two push-pull stages are matched as closely as possible. The other is to connect the meter so that a decrease in body resistance produces a leftward deflection of the needle.

Contact electrodes

In developing the psychometer, a number of different types of electrodes were tested, including rod-type, can-type, and even woven-metal pad-type electrodes to be grasped by the subject. With these electrodes, the responses observed during therapy were often erratic, and were affected by even the slightest movement of the subject's body.

The novel wrist electrodes illustrated in Fig. 5 were developed to overcome these difficulties. Simply constructed of inexpensive leather wristwatch straps and small strips of stainless steel, they are admirably suited to the purpose. Before being fastened to the wrists of the subject, the electrodes are coated with a thin film of contact-stabilizing paste which renders the contact resistance less dependent on body movement and muscular tension. Any non-drying paste that is a good conductor of electricity and nonirritating to the skin can be used. [Some hygienic jellies sold by druggists (*Ortho-Gynol*, *Koromex*, or *Ramsey's*) are ideal for this purpose, because of their boric-acid content and their nonirritating effect on body tissues.]

Also shown in Fig. 5 is a pair of hand-type electrodes, for persons who feel uneasy when straps of any kind are attached to their wrists. The cylinders are chromium-plated brass fittings, available from any hardware store or plumbing-supply house.

Meter protection circuit

The meter should be protected from excessive deflection currents during preliminary adjustment of the controls before a therapy session, and while the subject is adjusting to a comfortable position. The circuit of Fig. 6 was developed to provide such protection and is incorporated in deluxe models of the psychometer.

S1 is a 3-pole, 3-position, shorting-type selector switch. In the LO position (meter protected) S1-a turns the psychometer on, and S1-b connects a 3,000-ohm resistor in series with the meter. The circuit operates exactly as before except that the deflection sensitivity is reduced slightly. (This can be compensated for by increasing the setting of the gain control). However, if R_s changes greatly or if the electrodes are shorted or disconnected while the gain control is near maximum, the large voltage difference between the cathodes of V2 will overcome the battery bias on one of the meter-protection diodes. The diode conducts, and shunts the meter. By the proper choice of circuit constants, the diodes begin to draw current at the exact full-scale-deflection points (when a current of 500 microamperes is passing through the meter and the 3,000-ohm resistor). Below these points, the diodes are biased to cutoff, and have no shunting effect on the meter.

When the switch is in the HI position (protection circuit disabled), the 3,000-ohm resistor is shorted out and S1-c lights the red warning lamp, alerting the operator to the fact that the meter-protection feature is disabled. Under these conditions, the low d.c. resistance of the meter never develops sufficient voltage to overcome the battery bias on either diode, and the protection circuit effectively ceases to exist.

The selector switch is normally thrown to the LO position when adjusting the controls, and then switched to HI if additional sensitivity is needed. It is a convenient coincidence that in those rare cases where full sensitivity is required, the same conditions that produce the need for great sensitivity also automatically eliminate the need for meter protection. A typical case might be a person in deep and chronic apathy, whose responses to the recall of disturbing incidents are of very small magnitude and produce barely perceptible deflections.

Operation

In use, the psychometer is connected to the 117-volt a.c. line, switched on, and allowed to warm up for two minutes. Then, with the gain control reduced to minimum, the zero-centering control R12 is adjusted to balance the meter.

The electrodes are then connected to the subject's wrists (or placed in his or her hands if hand electrodes are used), and plugged into jacks J1 and J2 on the front panel. (Polarity need not be observed.) The GAIN control is then advanced slowly until a deflection is noted. The control marked TONE (the *bridge-balancing* control) is then adjusted to rebalance the meter, and the GAIN control is advanced once more.

Continue advancing the GAIN control (rebalancing the bridge with the TONE control, as necessary) until the optimum sensitivity point is reached. This is the point at which the needle has considerable play, but does not kick violently at the slightest sound or with the subject's breathing.

The instrument is now ready for use.

Tone scale

The meter scale is calibrated in terms of rising and falling "tone," a term used in the profession to indicate changes in the resistance of the subject on an emotional "tone scale" ranging from utter apathy (just above death) up through boredom, cheerfulness, exhilaration, and finally exaltation. (Most normal persons operate somewhere in the region between boredom and cheerfulness, with occasional acute dips or rises as they experience failures or successes in everyday life.)

The following is theory:

The psychometer does not measure *absolute tone*, nor does it register whether a person is sane, neurotic, or psychotic. Instead it indicates *changes in tone* during the progress of a therapy session, and thus serves as an excellent auxiliary means of determining what experience is or has been disturbing to the subject.

If a question is asked which has no connection with any emotionally disturbing or physically painful incidents in the subject's past, there is little or no change in the needle position. If the question relates to pleasant experiences, or produces a pleasurable reaction in the subject, the needle will move very definitely in the "rising" direction (to the right). On the other hand, any question, word, sound, or other method of communication which in any way relates to an aberrative, unpleasant, or disturbing experience will produce a rapid and pronounced deflection to the left.

Evaluating readings

As the subject's emotional "charge" is reduced through therapy, the average body resistance rises steadily. This is indicated by successively higher and higher balance settings of the TONE control as treatment continues. Since absolute body resistance varies considerably from individual to individual, the psychometer cannot be used to compare relative "sanity," or relative tone of two subjects. However, during the course of a session or over a period of several sessions, the changes in the average balance settings of the TONE control *do* indicate the direction and magnitude of the changes produced.

Range and sensitivity

The average hand-to-hand resistance of the human body is in the region of 50,000 ohms, although a few individuals have been found who measured as low as 5,000 ohms, or as high as 300,000 ohms. The average resistance between the wrists is about 200,000 ohms.

The sensitivity of the psychometer described in this article is such that with the GAIN control fully advanced, with a 50,000-ohm resistor inserted between the contact electrodes, and with the bridge balanced, a 2-megohm shunt placed across the electrodes will produce full-scale deflection of the meter. (This corresponds to a 2% change in resistance, a change exceeded many times in a typical therapy session.)

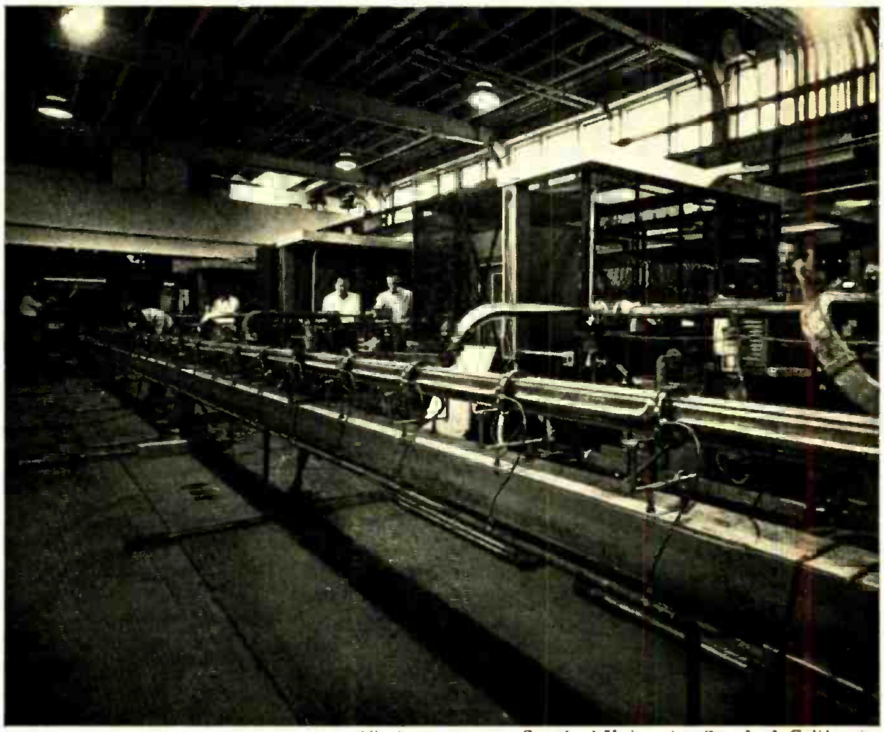
One of the simplest and most intriguing demonstrations of the psychogalvanic response to pain can be performed with any subject who will allow the electrodes to be placed on his wrists and then submit to a sharp pinch.

Simply adjust the machine as described above under "Operation," and then pinch the subject sharply on the arm or leg. No matter how energetically the subject attempts to avoid being affected by the pinch, and in spite of the fact that he can see the meter himself, the needle will falter momentarily and then drop very quickly to the left (tone falling) side of the scale. After a moment or two, the needle usually rises gradually back to the near-midscale region of the dial.

This is the point where the scanning function of the mind can be demonstrated. The subject is asked to "go back to" (or remember) the moment of the pinch, and to "feel" the pain again. Invariably, the needle will drop to the left again, although probably not quite as violently as before. Then, after several successive scans over the area of time of the pinch, the deflections diminish to an insignificant flicker and then cease entirely.

After the scanning is completed, the effect of the pinch can be considered to be "erased." This, then, is the value of electropsychometry — with only slightly more complex techniques, similar erasure can be accomplished with aberrative experiences in the subject's past life. The psychometer picks out the significant incidents, and also indicates when each emotional charge has been reduced.

Incidentally, these machines are excellent devices for finding out which one of the children wrote in the fresh cement. Build one, and try it! END



All photos courtesy Stanford University, Stanford, California

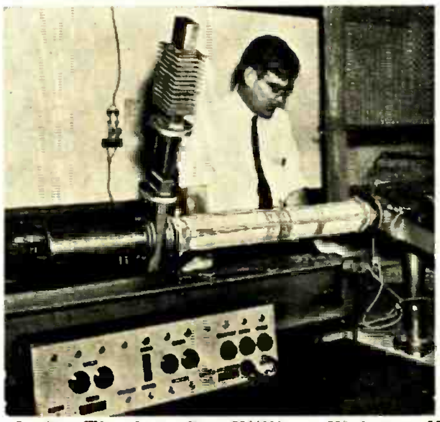
Accelerator tube is in the foreground; twisted waveguides pipe accelerating pulses from Klystron generator stations in screened enclosures at the rear.

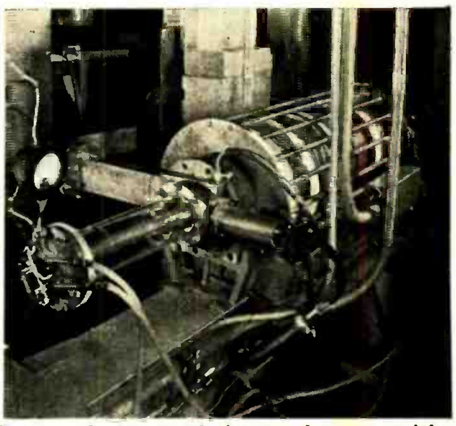
STANFORD'S LINEAR ACCELERATOR

Makes Electrons Break All Speed Records

THE long pipe above is the main part of a piece of equipment designed to accelerate electrons to the greatest speeds ever known. It will speed them up to 99.99999% of the speed of light—about as fast as anything can get. Electrons are injected into the 300-foot tube in 80,000-volt pulses. They arrive in the tube at half the speed of light, are bunched and almost doubled in speed in the next short section, and are then booted forward by a wave which is produced by a separate Klystron for each 10-foot interval. Twenty-one of these tubes deliver 17,000,000-watt pulses of u.h.f., further increasing the speed of the electrons through the 220-foot accelerating portion of the tube. Seventy-eight pumps maintain the vacuum in the whole system.

The new linear accelerator is expected to speed electrons up to a billion electron volts, making many new forms of research possible. At this speed, electrons are expected to go right through the atoms of most matter (in contrast to the proton, which knocks the atoms to pieces). Scientists expect to learn much about the internal structure of the nucleus from the way the electrons are affected by such a trip through it. END





Left—The late Dr. William Webster Hansen, designer of the accelerator, with the first section that was constructed; right—filament from which electrons come is in glass tube, left; buncher which accelerates and groups them, at right.

Second of two installments on practical filter design

MORE ABOUT

By N. H. CROWHURST

THERE are definite limits to the use of approximations in designing filters. Even when all the precautions described in last month's installment are observed, the result often falls far short of what is claimed for it.

For example, take the types of high- and low-pass filters—frequently used for loudspeaker crossovers—which have two or three reactance elements in each feed. The low-pass sections which would feed the low-frequency speaker are shown in Fig. 6. They are a form of

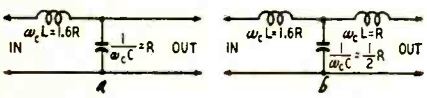


Fig. 6—Low-pass sections of crossover networks based on wave filter design. At *a* is a half-section network with *m* equal to 0.6. A full section, with the same value of *m*, is shown at *b*.

m-derived filter, though they differ from the types already mentioned. Figs. 7 and 8 show (at A) the kind of response curves published for these circuits. The curves B are the actual curves for the filter, feeding a load of R, and with zero source impedance. Curves C are those actually derived for the same circuits by a method of computing that avoids approximation.

The difference is not very great, but the phase characteristic or the impedance characteristic may often be more important than the attenuation or transfer characteristic. The phase shift in the vicinity of cutoff, using these accentuated slopes is much more rapid than with the types employing constant-resistance derivation; also the impedance at the input terminals fluctuates considerably.

Constant-resistance types

Perhaps first the fact that no single high-pass or low-pass filter by itself possesses a constant-resistance characteristic should be emphasized. Constant resistance is only possible by using complementary filters, such as were given in the article "Loudspeaker Crossover Design" (RADIO-ELECTRONICS, July, 1952). Then the impedance at the input terminals to the combined arrangement is a constant resistance.

Mathematically the correct relationship between circuit values for this design can be approached in several ways, because the arrangement possesses several unique features simultaneously. Without going into mathematical details, the important difference from the other types is that no approximations are used, so the result can really achieve all the things claimed for it. These may be summarized as follows:

1. When supplied with a gliding tone of constant voltage at the input terminals, the total energy delivered to the output circuits is constant.
2. The impedance presented at the combined input terminals is constant and resistive.
3. The difference in phase between signals delivered to the two outputs is constant.

Another point to emphasize here is that, for these facts to hold, both circuits must be terminated by the correct *resistance* load.

The mathematical process of finding the correct values consists of developing expressions for the attenuation, phase response, or input impedance, using any complementary values of reactance in the two filters, and substituting the appropriate conditions as stated above into the algebra; this will produce simultaneous equations which when solved give the correct values for a constant-resistance filter. It is not necessary to give all the mathematics here, because the results can always be obtained from someone who has already done it all. As was shown in the author's article "Loudspeaker Crossover Design," constant-resistance types can be derived using up to three elements in each wing of the filter.

Fig. 9 shows a comparison of constant resistance and wave filter derived types using the same configuration. For comparison, Figs. 7 and 8 also show the constant resistance response for the same configurations.

Some questions to ask

Finally, the author would like to suggest some questions that the prospective user of a filter should always seek an answer for before proceeding. These questions have many times proved a safeguard in his personal experience, and for this reason he recommends them to others.

First, *what impedances does it work with—both ends?* Usually some characteristic impedance will be stated, but information may not be given as to whether this characteristic impedance is for terminating the filter at the output end or the input end, or both.

The next question is, *what impedances does the filter itself reflect when correctly terminated?* Usually the most important reflected impedance is that presented by the input of the filter when it is correctly terminated at its output. However, in some circumstances reflection the other way may be important; for example, if the filter is feeding the input of an amplifier, the frequency response of the amplifier depends on its being correctly terminated at its input end; the circuit connected to the input transformer of the

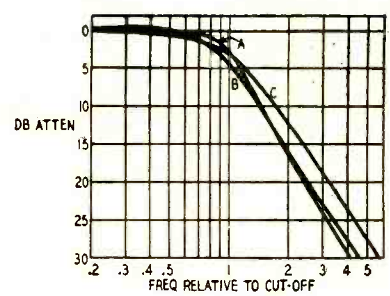


Fig. 7—The above curves show the response of the low-frequency section of Fig. 6-a. *A* is the curve usually published for the values shown; *B* is the actual curve for the filter; *C* is the circuit's response with the constant-resistance filter values of Fig. 9.

amplifier must have the stated source impedance value. When the input circuit is a filter it follows that the user should be satisfied that the filter reflects the correct terminating impedance throughout the frequency range.

A third question is, *Am I using the correct impedances throughout the fre-*

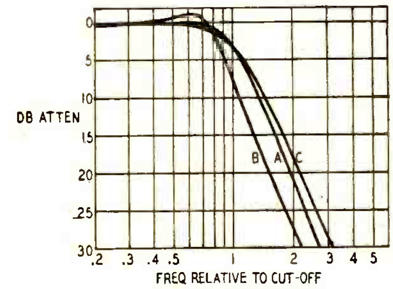
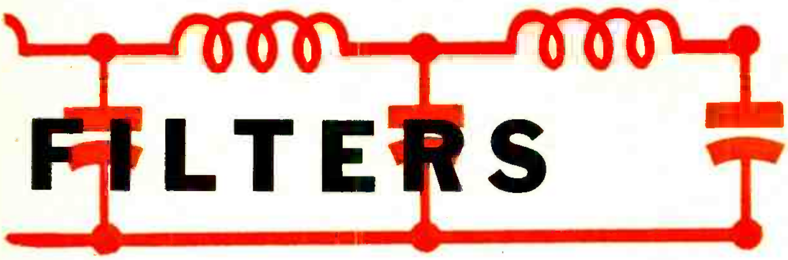


Fig. 8—Response of low-frequency section of crossover network of Fig. 6-b. *A* is the curve usually published for the values given in the figure; *B* the actual curve, feeding load R, source impedance zero; and *C* the response with values for a constant-resistance filter.



FILTERS

Constant-resistance crossover networks are easy to design with these formulas

quency range? Even the constant-resistance types achieve their true properties only when they are both terminated by the correct constant-resistance loads. As was explained in the author's earlier article, loudspeakers do not do this, although selection of the right filter configuration may compensate for this shortcoming.

A reader recently asked if a constant-resistance type could be designed to feed a 15-ohm low-frequency unit and a 3-ohm high-frequency unit. This is quite impossible unless the filter incorporates an impedance-matching transformer, or pads out one of the values. In the low-frequency band the impedance at the input terminals will be 15 ohms, while in the high-frequency band it must be 3 ohms. Obviously constant resistance is impossible. However, the author has designed a unit that will achieve this result, incorporating the functions of push-pull or single-ended output transformer, variable crossover frequency and individual voice-coil matching; all in one component, little larger than a normal output transformer. This is the subject of a current patent application.

The fourth question is one the user would probably have asked anyway: *What is its attenuation characteristic?* And perhaps this one: What is its phase characteristic? Some form of attenuation characteristic is usually published for the filter. The author has found by experience that, if the conditions under which they are taken are not precisely specified (if the input and output impedances with which the filter works are not given) such characteristics are usually somewhat less than dependable, to say the least.

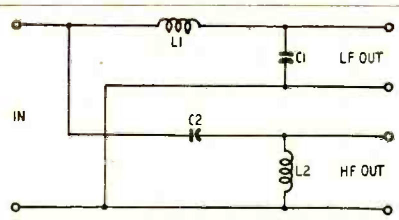
This statement is not accusing the manufacturers of misrepresentation in issuing such characteristics—the characteristic probably does give quite accurate information about the filter under *some* conditions. The real question is *whether those conditions are the practical ones which the user will apply.* The discussion in this article has shown what a variety of possible conditions could be assumed for the purposes of calculating response, or actually used for measuring one. Even if the response is the result of actual measurement, the conditions used for measurement may differ from those which the user is going to apply. END

Data for Wave-Filter Derived Types

$\omega_c L_1 = 1.6R$ $\quad \frac{1}{\omega_c C_1} = R$

$\frac{1}{\omega_c C_2} = 1.6R$ $\quad \omega_c L_2 = R$

Attenuation at $\omega_c = 4.65$ db
Phase difference at $\omega_c = 219°$
Input impedance at $\omega_c = 1.44R$



Data for Constant-Resistance Types

$\omega_c L_1 = 1.414R$ $\quad \frac{1}{\omega_c C_1} = 1.414R$

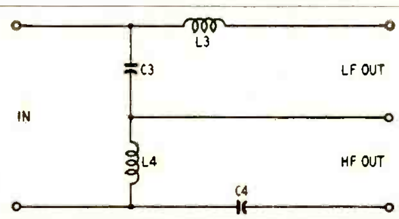
$\frac{1}{\omega_c C_2} = 1.414R$ $\quad \omega_c L_2 = 1.414R$

Attenuation at $\omega_c = 3$ db
Constant phase difference 180°
Constant input impedance R

$\omega_c L_3 = R$ $\quad \frac{1}{\omega_c C_3} = .625R$

$\frac{1}{\omega_c C_4} = R$ $\quad \omega_c L_4 = .625R$

Attenuation at $\omega_c = 4.65$ db
Phase difference at $\omega_c = 219°$
Input impedance at $\omega_c = .695R$



$\omega_c L_3 = .707R$ $\quad \frac{1}{\omega_c C_3} = .707R$

$\frac{1}{\omega_c C_4} = .707R$ $\quad \omega_c L_4 = .707R$

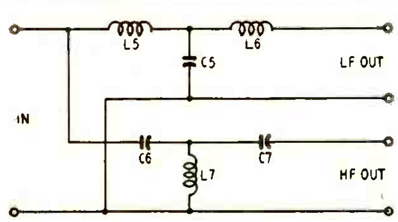
Attenuation at $\omega_c = 3$ db
Constant phase difference 180°
Constant input impedance R

$\omega_c L_5 = \frac{1}{\omega_c C_6} = 1.6R$

$\frac{1}{\omega_c C_5} = \omega_c L_7 = .5R$

$\omega_c L_6 = \frac{1}{\omega_c C_7} = R$

Attenuation at $\omega_c = 7.15$ db
Phase difference at $\omega_c = 390\frac{1}{2}°$
Input impedance at $\omega_c = 2.6R$



$\omega_c L_5 = \frac{1}{\omega_c C_6} = 1.5R$

$\frac{1}{\omega_c C_5} = \omega_c L_7 = .75R$

$\omega_c L_6 = \frac{1}{\omega_c C_7} = .5R$

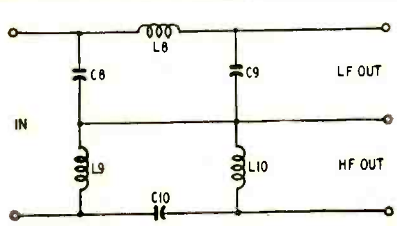
Attenuation at $\omega_c = 3$ db
Constant phase difference 270°
Constant input impedance R

$\frac{1}{\omega_c C_8} = \omega_c L_9 = .625R$

$\omega_c L_8 = \frac{1}{\omega_c C_{10}} = 2R.$

$\frac{1}{\omega_c C_9} = \omega_c L_{10} = R$

Attenuation at $\omega_c = 7.15$ db
Phase difference at $\omega_c = 390\frac{1}{2}°$
Input impedance at $\omega_c = .385R$



$\frac{1}{\omega_c C_8} = \omega_c L_9 = .67R$

$\omega_c L_8 = \frac{1}{\omega_c C_{10}} = 1.33R$

$\frac{1}{\omega_c C_9} = \omega_c L_{10} = 2R$

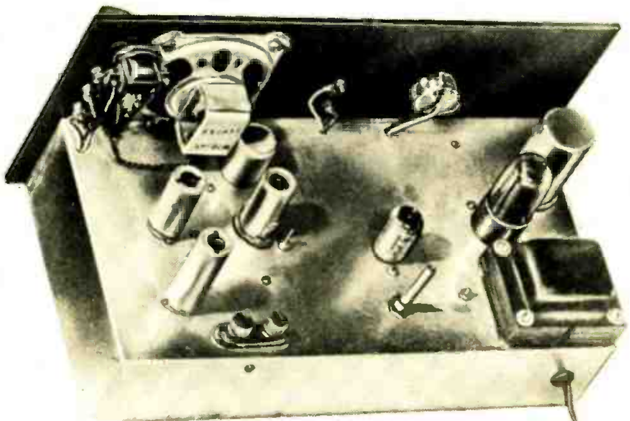
Attenuation at $\omega_c = 3$ db
Constant phase difference 270°
Constant input impedance R

N.B. Throughout the above tabulation R represents the working impedance and ω_c stands for 2π times the crossover frequency. Thus $\omega_c L$ means the reactance of L at crossover.

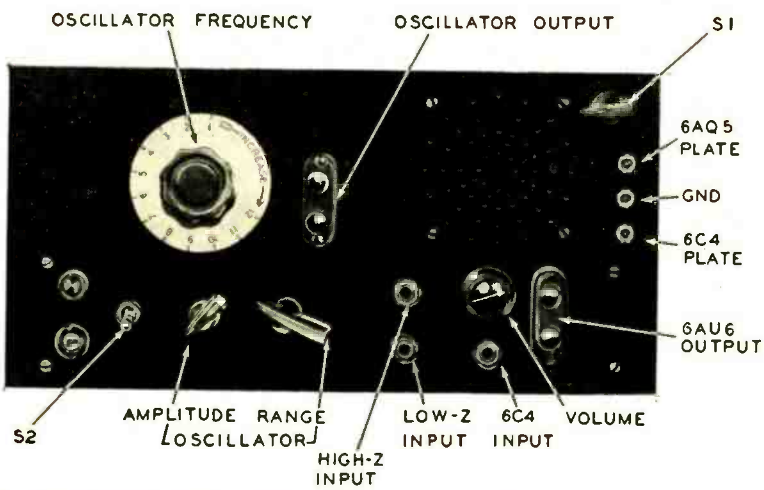
Fig. 9—Comparison of wave-filter and constant-resistance derivations for crossover networks using the same circuits.

SIGNAL TRACING AMPLIFIER

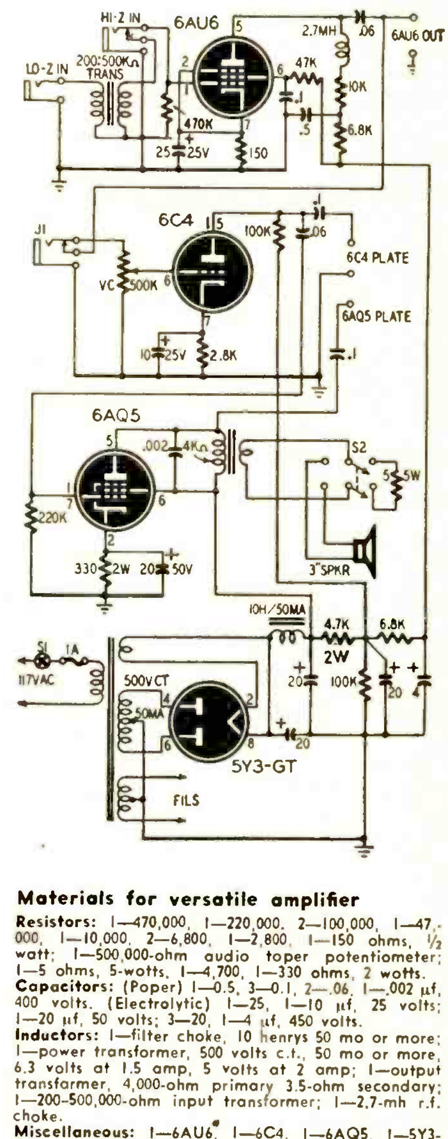
By PAUL S. LEDERER



Layout of the signal tracer isolates power supply and high-gain amplifier.



Panel arrangement with controls and terminals. The oscillator circuit is not shown in the schematic at the right, but the source is given in the text.



THIS is a description of a useful and versatile amplifier which will appeal to most audio enthusiasts and experimenters.

My original idea was to construct a small audio amplifier for signal tracing and other general uses. Then I decided to incorporate a wide-band amplifier for driving a v.t.v.m. whose lowest full-scale range is 3 volts.

The completed amplifier incorporates these two ideas. It consists of a 6AU6 broad-band amplifier, a 6C4 voltage amplifier, a 6AQ5 power amplifier, and a 5Y3-GT rectifier. The input to the 6AU6 stage has a 200-500,000-ohm audio input transformer with two input jacks so arranged for high- and low-impedance inputs. Two output terminals complete this stage which uses shunt peaking to achieve a gain of about 45 (within 3 db) from about 50 cycles to 400 kc.

If more gain is desired in the first stage, a larger plate-load resistor can be used (in such a case the bandwidth will decrease unless it is properly compensated with a larger shunt coil).

The volume control is at the input to the 6C4. A closed-circuit jack (J1) disconnects the first stage if necessary. The 6C4 stage has a gain of about 16. Its response is adequate for non-high-fidelity requirements. From the 6AQ5 stage, the output is single-ended, with a switch which disconnects the speaker and throws in either an external speaker or a dummy load (the latter is necessary when it is desired to get large output voltages, otherwise with the normal speaker in the volume would be unbearable). Two extra terminals make it possible to feed out voltages from the plate of the 6C4 and the plate of the 6AQ5 (through blocking capacitors).

Miniature tubes make it possible to build the amplifier very compactly, although I did not do so as I planned to add an audio oscillator to the same chassis at a later date. Just prior to taking the photographs, I added the oscillator described on page 28 of the August 1948 issue.

Materials for versatile amplifier

Resistors: 1—470,000, 1—220,000, 2—100,000, 1—47,000, 1—10,000, 2—6,800, 1—2,800, 1—150 ohms, ½ watt; 1—500,000-ohm audio taper potentiometer; 1—5 ohms, 5-watts, 1—4,700, 1—330 ohms, 2 watts.
Capacitors: (Paper) 1—0.5, 3—0.1, 2—.06, 1—.002 μf, 400 volts. (Electrolytic) 1—25, 1—10 μf, 25 volts; 1—20 μf, 50 volts; 3—20, 1—4 μf, 450 volts.
Inductors: 1—filter choke, 10 henrys 50 ma or more; 1—power transformer, 500 volts c.t., 50 ma or more, 6.3 volts at 1.5 amp, 5 volts at 2 amp; 1—output transformer, 4,000-ohm primary 3.5-ohm secondary; 1—200-500,000-ohm input transformer; 1—2.7-mh r.f. choke.
Miscellaneous: 1—6AU6, 1—6C4, 1—6AQ5, 1—5Y3-GT; 1—s.p.s.t. switch, 1—d.p.d.t. switch, 1—small PM speaker, 1—fuse, 1—fuse post, 1—open-circuit jack, 2—closed-circuit transfer-type jacks; binding posts, terminal strips, chassis, panel, assorted hardware, hookup wire.

Substituting a small voice coil-to-grid transformer at the input makes it possible to use the amplifier as an intercom by adding an external speaker and a talk-listen switch. END

AUDIO HUM CHECK LIST

By EUGENE F. CORIELL, Major, USAF*

THE elimination or reduction of a.c. hum is one of the most common problems in servicing audio amplifiers and the audio portion of receivers. There are a great many causes of hum, and the technician's ability to remember them seems to vary inversely with his need. The purpose of this article is to condense some of the published material on this subject into a check-list of hum causes and remedies —a list which the harried technician can refer to in a hurry when things look grim on the bench. No claim is made that the list is exhaustive. Very little theory is given, the reader being referred to the literature indicated in the footnotes for detailed discussion. At the end of the article there are a few somewhat heroic hum-elimination measures for use when the situation is drastic enough to warrant them.

Power supply hum

1. Line cord plug reversed in a.c. wall outlet.
2. Defective rectifier tube.
3. Defective electrolytic filter capacitor. Replace the electrolytic, or shunt a paper capacitor across it.
4. Defective filter choke.
5. Choke needs tuning. Shunt it with capacitor so the combination tunes to the hum frequency.[1]
6. Power transformer and choke improperly oriented or too close to audio transformers. Should be at opposite end of chassis from input transformer. (Rotate a.f. transformers for minimum hum.)
7. Omitted or open a.c. line filter capacitors.
8. Lead from power transformer center-tap goes through one hole in chassis while other leads from same winding go through another hole. This forms a single magnetic turn which induces hum-producing circulating a.c. around a portion of the chassis.
9. 110-volt a.c. input wiring too close to hum-sensitive elements.
10. Mechanical vibration from transformer or vibrator causes cyclic variation in spacing of tube elements. This hum is produced by microphonism in tube.
11. Poor waveform in a.c. supply line.
12. A.c. supply voltage too high or too low.
13. Isolation transformer (1:1 voltage ratio) needed in a.c. supply line.
14. Separate power-supply chassis too close to amplifier chassis.
15. Hum - balancing potentiometer across filament supply has been omitted; is improperly adjusted; or is the wrong size.[1, 2]
16. Half of power-transformer secondary defective in full-wave power supply.
17. Unequal emission from plates of full-wave rectifier tube.
18. Power-transformer filament winding not grounded at center-tap or end of winding.
19. Power-supply filter overloaded. Add regulator or reduce load.[3]
20. Shield on mercury-vapor rectifier omitted or ungrounded.
21. Chassis forms a common core-lamination between power and audio transformers. Mount power transformer on brass bushings.
22. Common lead used to carry filament return and B minus between separate power supply and amplifier chassis. Use separate leads for each.
23. Filament leads not twisted.
24. Remount power transformer vertically so laminations are at a right angle to chassis.[4]
25. Filament and 110-volt a.c. leads physically located too far above or below chassis.

Hum in associated circuits

1. No earth ground on amplifier.
2. No common grounding conductor between associated chassis.
3. Feedback due to multiple earth grounds on interconnected equipment.
4. Defective connection between amplifier and microphone or turntable.
5. Impedance mismatch between amplifier and microphone and turntable.
6. Unbalanced microphone or turntable is feeding balanced input to amplifier. Install 1:1 isolation transformer between them.
7. Coiled-up slack in microphone or turntable cables which become effective hum-pickup coils.
8. A.c. power line cabled with microphone pair or other audio circuits.
9. Inductive coupling between turntable motor and magnetic pickup. Try two-conductor shielded pair between amplifier and pickup, the braid being used only as a shield and grounded to the amplifier chassis. Bond motor casing to amplifier ground with separate wire. (A 4-pole motor is less troublesome in this respect than a 2-pole unit.)
10. Capacitive coupling between a.c. line and both the turntable motor frame and the amplifier chassis. Ground motor frame to amplifier chassis by separate conductor, rather than by the pickup shield. The latter should be grounded only to the amplifier chassis and should carry only signal current.[5]
11. Low-frequency rumble from turntable mistaken for a.c. hum. Check for mechanical misalignment of motor and driving system, and dried-out or missing rubber mountings on the motor.
12. Hum picked up by tuner antenna from nearby power lines. Reorient or relocate antenna.
13. Modulation hum (or tunable hum) from tuner. Generally due to defective or missing line filter capacitor, or to leakage between heater and cathode in r.f., oscillator and converter tubes. In superhets, may also be caused by insufficiently filtered oscillator plate supply.[1]
14. Speaker hum-bucking coil leads reversed.
15. Defective electrodynamic speaker field winding used as choke.
16. Poorly soldered joints at junctions of chokes and filter capacitors with chassis.
17. Acoustic coupling between loudspeaker and input tube. Put a

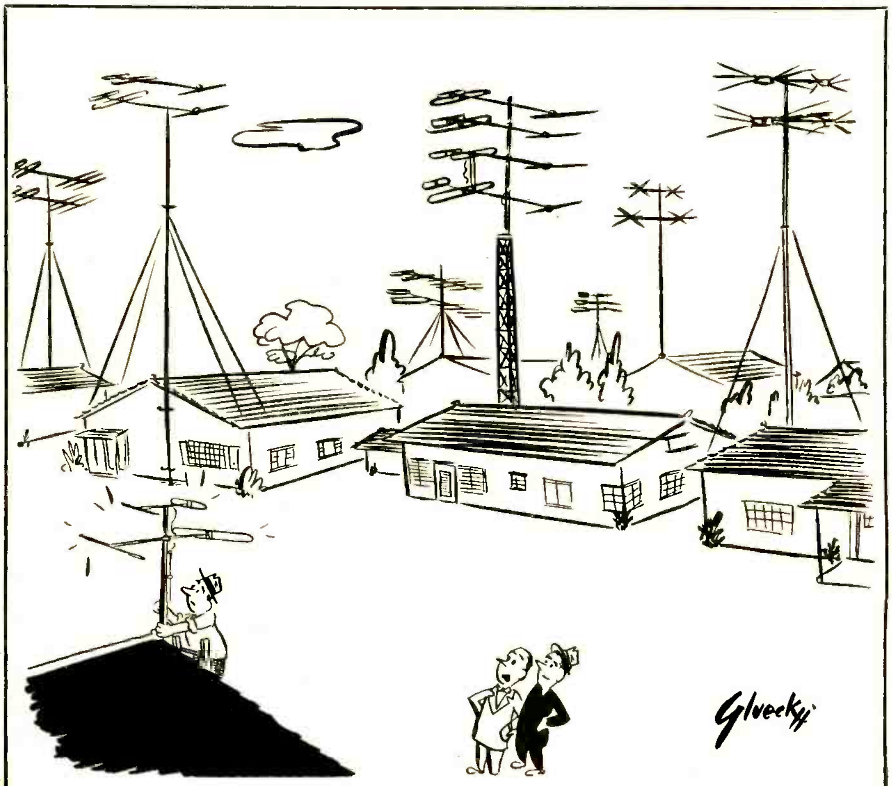
Radio Technical Officer, Armed Forces Information School, Fort Slocum, New York.

heavy rubber band around the tube to dampen the resulting vibration — or install floating socket.

18. Interference from short-wave diathermy machines, fluorescent lamps, commutator sparking, and other non-audio sources. Try commercial interference filter, or an isolation transformer with electrostatic shield in the a.c. line, the low-level input circuit, or in both.
19. Dynamic microphone located in an a.c. field.
20. Magnetic field in vicinity of tape-recorder playback head. Locate a small piece of sheet iron or Permalloy near the playback head and determine experimentally its exact position for minimum or zero hum.[2]

Hum in amplifier proper

1. Gain controls of unused channels advanced with no microphone or turntable connected.
2. Defective tubes.
3. Defective decoupling resistors and capacitors.
4. Open or leaky cathode-bypass, screen bypass, and coupling capacitors.
5. High-resistance non-soldered grounds. For example: Between transformer casings and chassis and riveted ground lugs.
6. Grid-lead shield not grounded.
7. Dirty or corroded grid caps or tube-base prongs.
8. Grid-cap shield missing or ungrounded.
9. Grid leads too close to filament leads.
10. Grid leads too long. This may cause inductive or capacitive hum pickup, especially if they sag and alter the lead dress.
11. Grid lead and grid return too far apart. The loop they form across cathode and grid must be reduced in area by running these leads close together or by having the grid-lead shield serve as the grid return.[5]
12. Circuit grounds made to wrong point or points on chassis.[2,5]
13. Metallic tube shields missing or not grounded to chassis.
14. Open grid circuit.
15. Unmatched push-pull tubes.
16. Unshielded plate lead in low-level stages.
17. Magnetized tubes. Replace, or demagnetize them with a recording-tape degausser, watchmaker's demagnitizer, or other effective means.[2]
18. Design calls for a tube of inherently high hum-level. For example a 6SJ7 which has the grid lead brought out to a prong in the tube base close to filament prongs tends to have a higher level than a 6J7 which has the grid lead brought out to a grid cap.[2,4]
19. Heater-to-cathode leakage inside the tube. Replace tube or increase capacitance of cathode bypass capacitor or reduce the heater voltage.
20. Leakage or capacitive coupling between tube prongs across tube socket insulation.
21. Improper bias due to defective cathode resistor or bias cell.
22. Audio transformer leads reversed.
23. Shell of metal tubes not grounded.
24. Screen bypass too small on pentodes (increase to improve filtering). Plate-load resistor too large on triodes (decrease resistance to reduce low-frequency response).
25. Omitted or defective R-C filter network in plate circuit of critical stages.[3]
26. Defective hum-bucking coils in input transformers.
27. Leakage between bypass capacitors in single-cam multiple capacitor assemblies.
28. Replace single common cathode resistor in push-pull stages by adjustable independently bypassed resistors for each cathode.[6] Adjust resistors for equal cathode currents.
29. Input tube located too close to power transformer. Try tube shield and re-orienting transformer.
30. If low-frequency response is not important, reduce capacitance of coupling capacitors and resistance of grid resistors.
31. Sheet-iron shield needed around power transformer.
32. Replace input transformer with one having several telescoping alloy shields.
33. Use physically smaller input transformer.



"He got an inferiority complex?"

Last ditch measures

1. Use d.c. on heaters.
2. Use high-frequency a.c. heater supply.[7]
3. Apply d.c. bias (about + 45 to 60 volts) to a.c. heaters.[7]
4. Rebuild power supply on separate chassis.
5. Apply a hum voltage 180 degrees out of phase with existing hum.[3]
6. Install negative feedback loop that provides maximum feedback at the hum frequency.[3]
7. Install 1:1 audio-isolation transformer (with electrostatic shield between windings) in input circuit ahead of input transformer, or replace input transformer with one having an electro static shield.
8. Rebuild amplifier on nonmagnetic chassis.

References

[1] *Principles and Practices of Radio Servicing* by H. J .Hicks. 2nd Edition, page 103.
[2] "Controlling Hum in Audio Amplifiers" by Lawrence Fleming. *Radio News*, November, 1950.
[3] "Hum Elimination" by J. C. Hoadley. RADIO-CRAFT, February, 1946.
[4] "Hum Reduction" by A. F. Dickerson. *Electronics*, December, 1948.
[5] *Recording and Reproduction of Sound* by Oliver Read. 2nd Edition, page 670.
[6] "Reducing Hum Levels" by Jack King. RADIO-CRAFT, June, 1946.
[7] "Heater Supplies for Amplifier Hum Reduction" by Frederick W. Smith. *Audio Engineering*, August, 1948.

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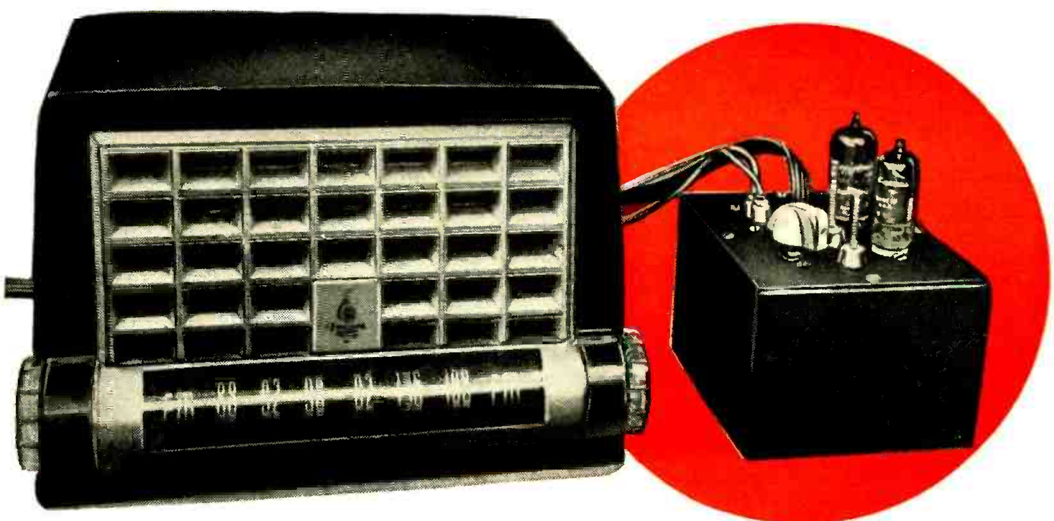
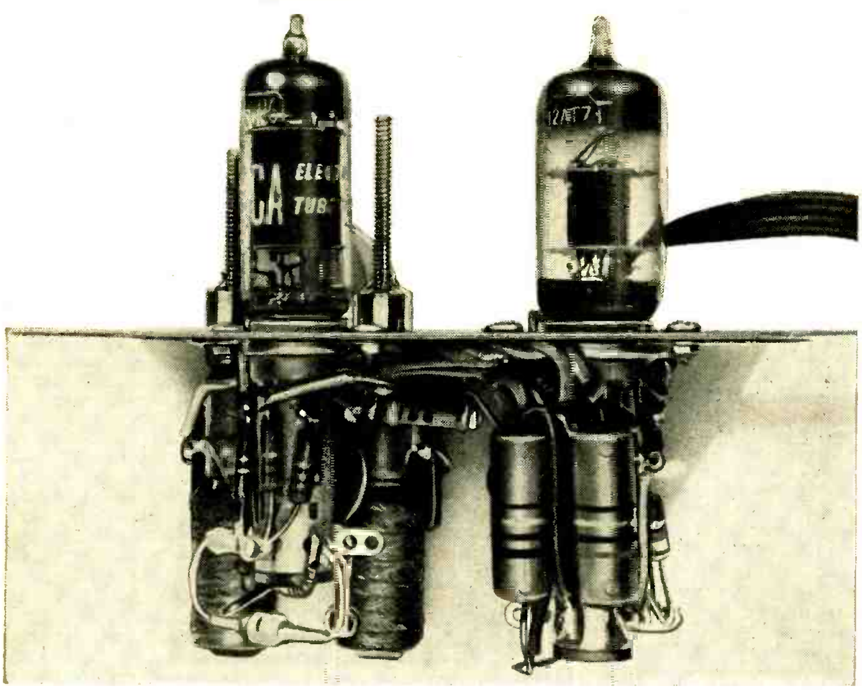
Adapter Unit kills FM commercials





Miniature tubes and turret-type sockets keep the "Commercial Killer" compact enough to fit inside many FM receivers. The slug-tuned coils resonate at ultrasonic frequencies that control receiver volume during announcements.

Free your home listening from ads aimed at "captive" audiences

By RAYMOND SHELDON

FM HAS made possible a number of broadcast-station activities that were out of the question on the old AM band. Without the listener being aware of it, his favorite FM station may be putting out a facsimile transmission, a second FM program, or various control signals along with its regular programs. These unheard signals are transmitted on an ultrasonic sub-carrier.

Have you ever noticed how much louder the commercials are than the music when you hear a "transitcast" program on a bus, or a "storecast" program in a supermarket? The commercials don't leave the station that way. An ultrasonic tone transmitted just before or along with the commercial automatically boosts the receiver volume for the announcement.

Almost every sizable city in the United States now has at least one FM station engaged in storecasting, transitcasting, functional-music broadcasting, or a combination of these services for captive audiences. Ultrasonic tones boost the volume of the commercials for store or transit subscribers, and silence the functional-music receivers during all voice announcements.

Several different tones may be used in this way to carry out any number of control functions. For instance, a station may serve two competing chains of supermarkets by silencing the receivers in one chain during commer-

(Continued on page 73)

cials for the other. Meanwhile, music-service receivers in bars, restaurants, and offices are silenced automatically for both sets of announcements.

Receivers for functional music are customarily rented out by the FM station or affiliated organizations. These are usually good-quality, crystal-controlled FM receivers which incorporate the ultrasonic control units. They are installed and maintained by the renting organization, and provide high-fidelity, voice-free music most of the day and night.

Two basic systems are used for ultrasonic control of receiver volume. In the first and simplest system a single ultrasonic tone, say 21,000 cycles, is transmitted during the voice announcement. This steady tone biases one of audio tubes in the receiver beyond cut-off and silences the set as long as the tone is on.

Usually, only one chain of receivers is controlled in this manner, as there is danger of audible beat notes between otherwise inaudible tones if two or more are transmitted simultaneously. The sustained tone system is seldom employed due to this lack of flexibility.

In the second, and more common, system, a single ultrasonic tone is transmitted briefly (for 0.5 to 7 seconds) *before* the announcement. This silences the receiver and keeps it cut off until a second tone of a different frequency transmitted immediately *after* the announcement restores it to operation.

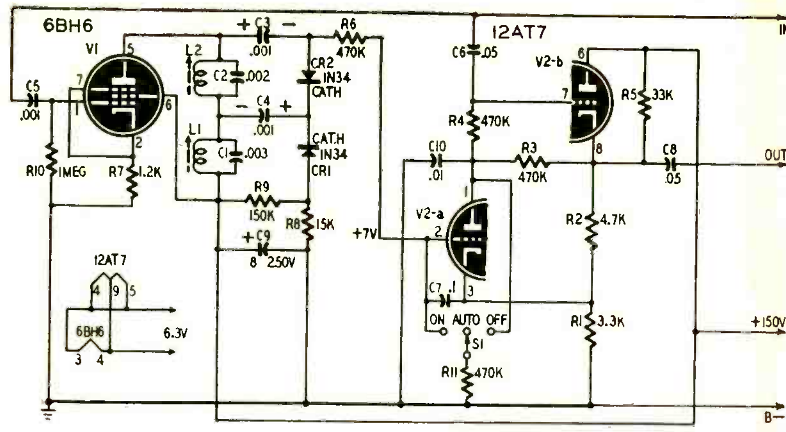


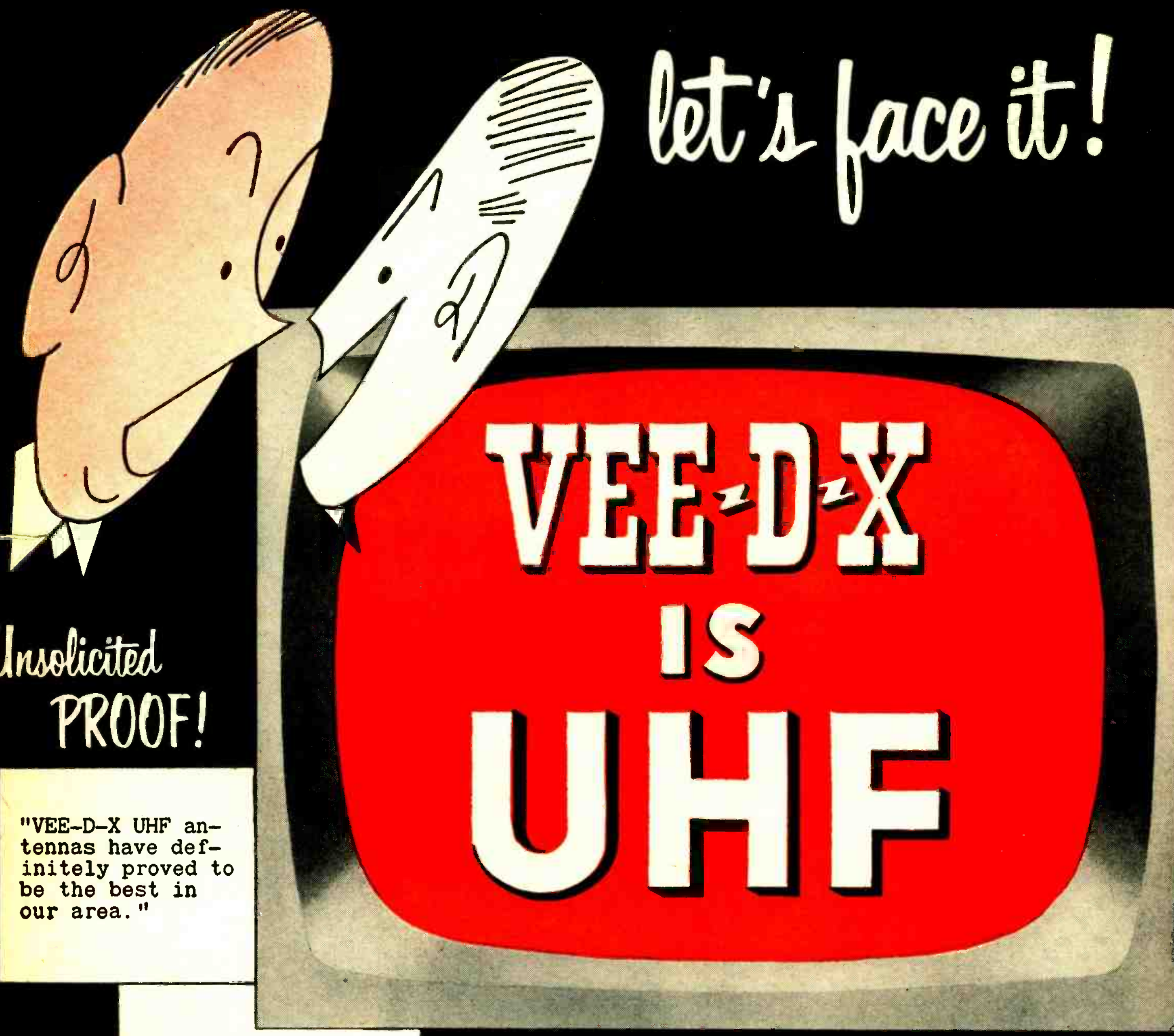
Fig. 1—Circuit of the "Commercial Killer." Ultrasonic control frequencies selected by trap circuits at left open and close audio feed-through circuit at right.

Various tones may then be transmitted sequentially to control various chains of receivers, and an endless variety of combinations can be employed.

How it operates

Table I shows what might be a typical system of this type. The 18-kc tone is transmitted before every voice announcement. This mutes all sets except those in supermarkets, which are boosted. The way is now clear for a frozen-food commercial, for instance. If the commercial is to be for the bus company instead, a brief 21-kc tone is sent out. This will emphasize the announcement in the buses while silencing it in the supermarkets. Afterward, a 26-kc tone restores all sets except the offices and factories. Since continuous music in these establishments may be tiring over long periods of time, they are usually restored only at alternate 15-minute intervals. The use of separate tones for restoring offices and factories makes it possible to play lively music (presumably to speed production) during factory segments, and slower, relaxing music during intervening 15-minute segments for offices.

The author was intrigued by the possibility of taking advantage of this broadcast service by adapting his own FM set to silence the storecast com-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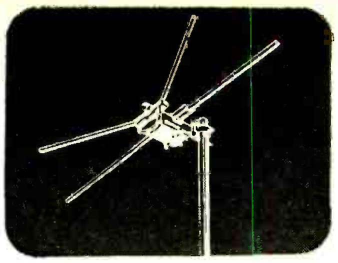

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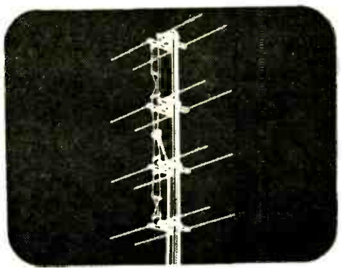

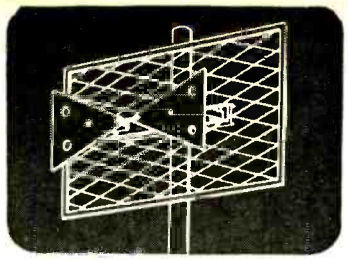

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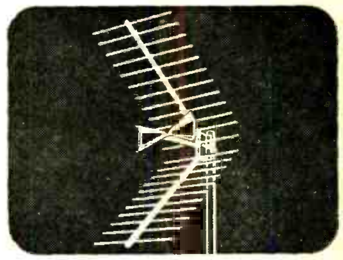

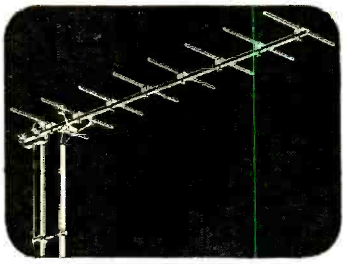

UHF LONG JOHN YAGI

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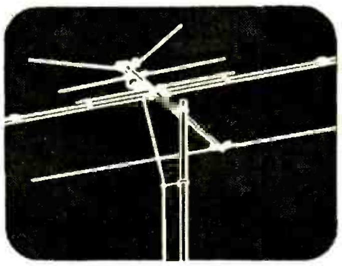
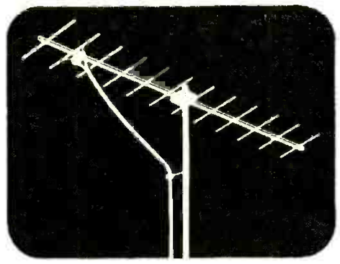
The famous VEE-D-X all-channel (2-83) UHF-VHF antenna. Has printed circuit channel separators* that permit use of a single transmission line. Model UQT list only $14.25.



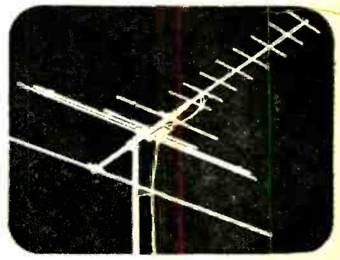


UHF LONG LONG JOHN YAGI

The most powerful of all single channel antennas for fringe areas. A rugged twelve element yagi that delivers 14 db gain. Unusual band width of 60 mc. Solid aluminum elements with tough-as-steel fiberglass boom. Model LLJ-U list only $7.65.

THE ULTRA Q-TEE-S

Designed for all-channel VHF and fringe area UHF. Operates similar to Q-Tee except UHF portion is powerful 8-element yagi cut to specific channel. Model UQT-S list only $17.60.



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VEE-D-X ALONE OFFERS YOU EVERYTHING YOU NEED FOR BEST UHF-VHF RECEPTION IN ANY AREA

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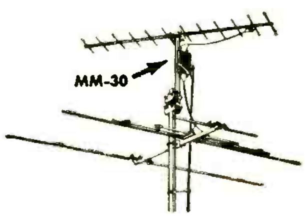

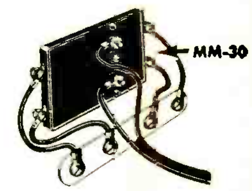

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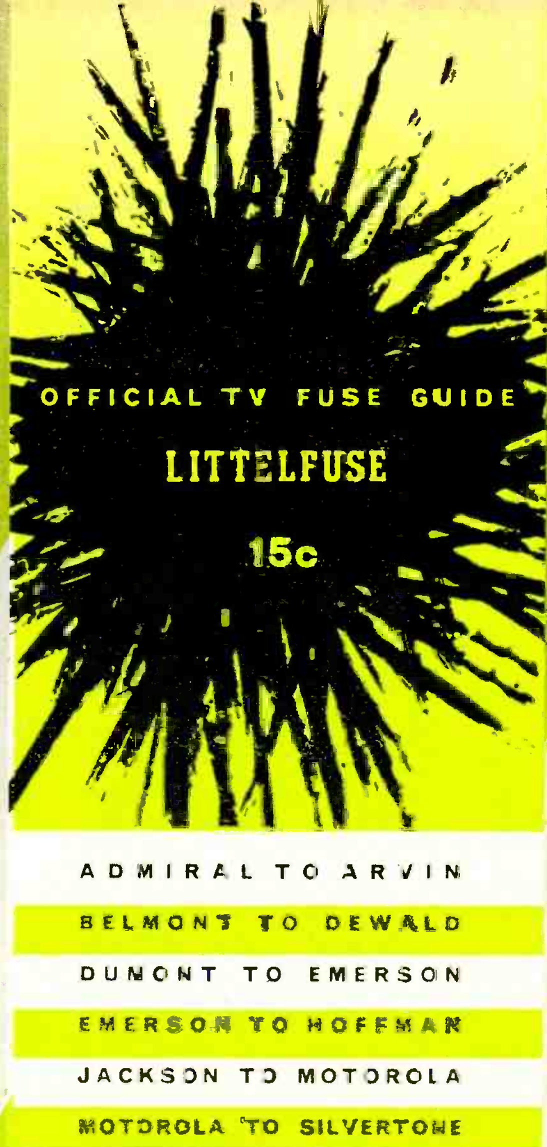
2. Connect a crystal diode from grid to ground at the input to the amplifier. Couple an audio oscillator through a small capacitor (0.001 μf or so) to the grid, and tune for a beat note when the tone comes on. The oscillator frequency at zero beat is the tone frequency. Use the second harmonic of the oscillator if it does not cover the ultrasonic range.
3. You can align the adapter as listed below, directly on tones received from the station. This is most accurate, and may be used for trimming the final adjustment in any case. The main disadvantage to this is that you have only a few seconds before each commercial in which to seek a response.

Alignment

Connect a v.t.v.m. or a high-resistance d.c. voltmeter across crystal diode CR-1 with the adapter connected to a source of power. Feed in from an audio oscillator an ultrasonic tone of the correct frequency for an *off* pulse. Rotate the core of L1 for maximum positive voltage at the cathode of CR-1. Repeat this procedure for the *on* pulse, adjusting the core of L2 for maximum *negative* voltage at the *plate* of CR-2, with the voltmeter connected directly across the diode. To check, connect the voltmeter across the two diodes in series, and vary the input frequency between that of the *off* and *on* tones. The output should rise sharply positive at R6 for the *off* tone and negative for *on* tone. Proper operation of the flip-flop requires at least 3 or 4 volts d.c. at this point from either tone. The flip-flop operation may now be checked, either by passing a signal through it or by metering the voltage at the cathode of V2-a for the *on* and *off* conditions. If the unit fails to lock up in one position, the cause is probably a weak 12AT7 section or improper supply voltage.

The 12AT7 should be good, to prevent leakage and excessive heater-cathode hum. Some bargain tubes were found highly resistant to cutoff, passing an audio signal even with a bias of −50 volts. A good tube should show at least 60 db rejection of the voice announcements if care is taken to keep external coupling low. Be sure to use separately shielded wires for input and output.

For use with the sustained-tone system of operation, the adapter should be simplified as shown in Fig. 3. In this application only one resonant circuit is required. The positive bias developed across the .001-μf capacitor during the transmission of the control tone increases the plate current drawn by the lower triode section of the 12AT7. The drop in voltage at the plate (pin 1) makes the grid of the upper triode (pin 7) more negative. This cuts off the upper triode and prevents signals from passing through the cathode output circuit. The short time constant of the bias circuit (.047 seconds) restores normal operation as soon as the control tone ceases. END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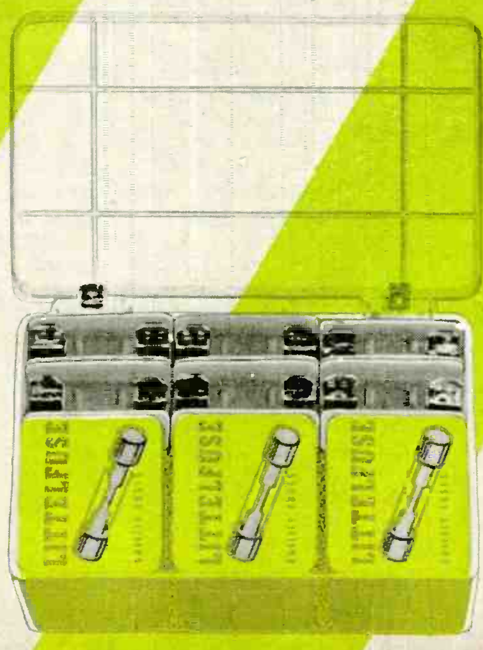
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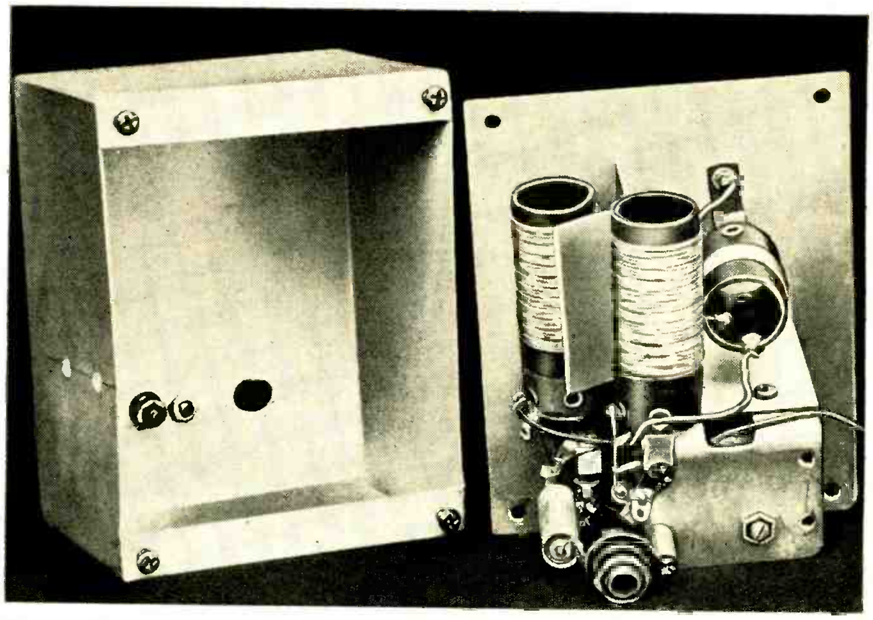


Fig. 1—This bandpass-coupled AM tuner has a voltage-doubling crystal detector.

hi-fi VOLTAGE DOUBLING BROADCAST TUNER

By N. L. CHALFIN

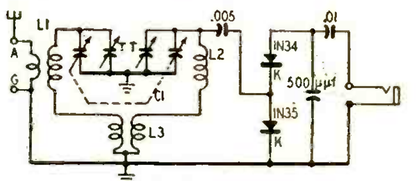
ALTHOUGH the audiophile prefers FM reception to AM reception, there are a great many occasions when, in the absence of FM stations on the air, a high-fidelity AM tuner would be desirable. The cost of such a tuner should be as low as possible, and it should not be required to pick up anything but local transmitters.

All of these requirements are met by the crystal-diode tuner shown in Fig. 1. It covers only the broadcast band and has the double-tuned bandpass circuit that has become familiar to high-fidelity audio fans in the Miller high-fidelity t.r.f. tuner.

A disadvantage of any crystal tuner without r.f. amplification is its low output level. The broad-band tuning characteristic we are seeking attenuates the output still further. This disadvantage is largely overcome by the fact that most modern high-quality amplifiers are designed to work out of low-output high-fidelity phonograph pickups. The output of a bandpass half-wave crystal-diode tuner on strong local stations is about equal to one of these pickups. With two diodes connected in a voltage-doubling circuit, the output is quite a bit higher.

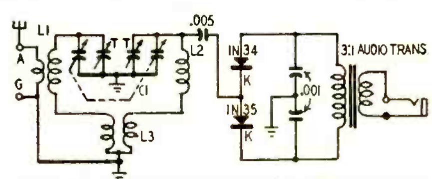
The tuner circuit

Reference to the schematic of Fig. 2 reveals that the circuit is similar to one of the bandpass circuits of the Miller tuner. The difference appears in the half-wave voltage-doubler detector. A full-wave doubler arrangement is illustrated in Fig. 3. The half-wave connection of the diodes gives more output. It also permits grounding one side of the circuit without requiring an isolation output transformer.



C1=365-420μμf DUAL WITH TRIMMERS; L1=MILLER 242-A; L2=MILLER 242-BP; L3=MILLER EL-56; CAPS 100WV

Fig. 2—Tuner with half-wave doubler.



C1=365-420μμf DUAL WITH TRIMMERS; L1=MILLER 242-A; L2=MILLER 242-BP; L3=MILLER EL-56; CAPS 100WV

Fig. 3—Full-wave doubler schematic.

Type 1N34 diodes or the 1N35 matched pair may be used for the detector. The diodes used in the original model were Hughes type 1N90.

The coils were removed from a Miller tuner that was still doing fine after 15 years of use, but had to be dismantled

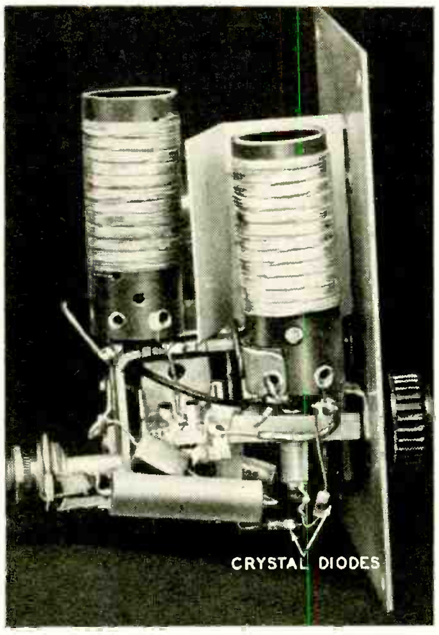


Fig. 4—The hi-fi tuner assembly. The isolating shield is bent to form a mounting bracket for the tuning capacitor.

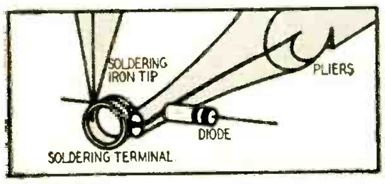


Fig. 5—Pliers carry off excess heat.

to fit the space requirements of our home receiving and record-playing equipment. The coils include a type 242RF in the antenna circuit, a 242BP in the output, and an EL56 negative-mutual-coupling coil. If new coils are purchased, a Miller type 242A is preferable for the antenna coil.

The tuning capacitor is a dual 365-μμf unit (420-μμf per section will also do). A bracket is bent up to act as a combined decoupling shield and tuning-capacitor mount as shown in Fig. 4.

Crystals are easily damaged by high temperatures. No undue heating or pressure should be exerted, particularly at the lead junctions. During soldering, grip the leadwire with long-nose pliers

Materials for tuner

Miscellaneous: 1—242-A or 242-RF antenna coil, 1—242-BP bandpass coil, 1—EL-56 negative-mutual-coupling coil (J. W. Miller Co.); 1—two-gang tuning capacitor, 365 μμf or 420 μμf per gang; 2—germanium diodes, type 1N34, 1N90, or equivalent; 1—.005-μf, 1—500-μμf mica or ceramic capacitors; (optional values for full-wave voltage-doubler circuit: 1—.01 μf, 2—.001 μf); 1 plate-to-grid audio transformer, step-up ratio 3 to 1 (optional); 1 single-circuit phone jack or equivalent audio connector; cabinet; hardware; wire; solder.

between the diode and the soldering point. See Fig. 5. The pliers should remain in place for a few seconds *after the solder has hardened* to carry off the residual heat, and prevent it from damaging the crystal.

We built this tuner into an aluminum case 4 inches wide by 5¼ inches high by 3¼ inches deep, as shown in Fig. 1, but it will fit nicely in a 3x4x5-inch commercial utility box, or a 3x5 file-card cabinet. END

REACTANCE TUBE TUNING VERNIER

A dual-purpose circuit: it brings in hard-to-tune signals—and holds them

By RONALD L. IVES

A REACTANCE tube, controlled by the discriminator, to facilitate accurate tuning and to compensate for minor drifts in the tuned circuits, has become almost standard in FM receivers. Many workable designs are now available, and a good a.f.c. system can be added to the average FM receiver in a few hours, at little cost.

Although not commonly used on civilian equipment, the same principles (and substantially the same equipment) can be used as a micrometer tuning control for almost any good all-wave receiver. Such a control is especially desirable when a "Q-Fiver" or "SSSC" attachment is used, because with these a motion of the tuning controls too small to read on the dial makes the difference between signal and no signal.

Reactance-tube tuning works on the general principle that a vacuum tube, connected in a wide variety of circuits, functions as a reactance, either inductive or capacitive, depending upon the connections[1,2,3,4,5]. These controls all follow the general formula, $Z = gm \times RC$ if capacitative, and $Z = RC/gm$ if inductive. Gm is the mutual conductance of the tube under operating conditions; R and C are as shown in Fig. 1. These

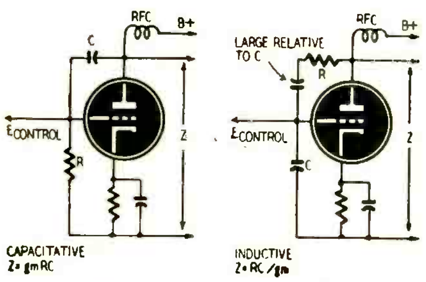


Fig. 1—Two reactance tube circuits.

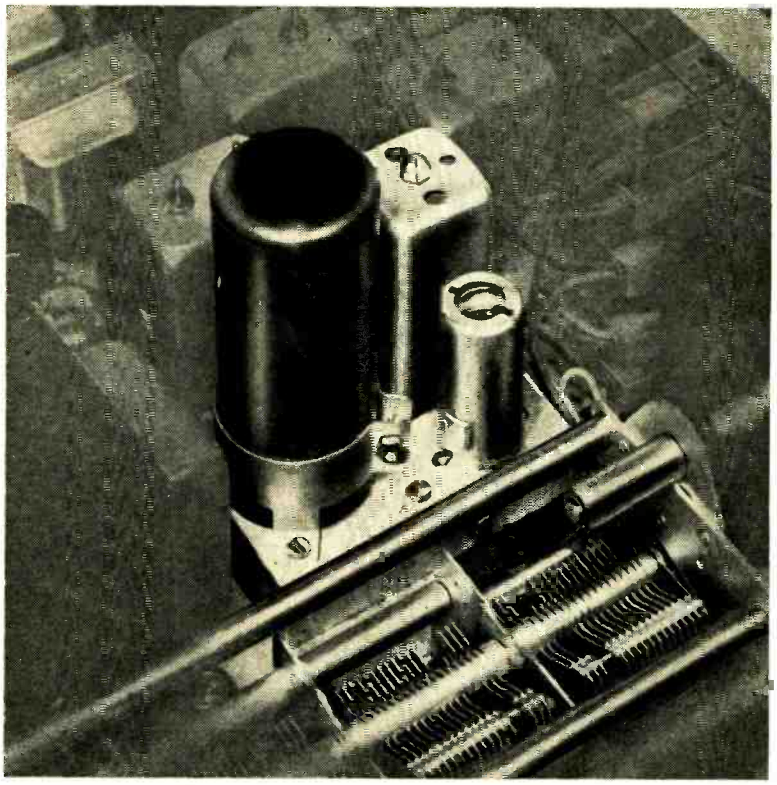
circuits perform "as per formula" at low frequencies, when circuit components are easily determinable; but actual values are hard to compute at frequencies of 50 mc or more, because of the relatively large unavoidable distributed capacitance and lead inductance of almost any practical circuit.

One of the more satisfactory a.f.c. circuits in commercial use—and one admirably suited for use as a tuning vernier in addition to its a.f.c. function—is shown in Fig. 2-a[6], and the method of obtaining control voltage from the discriminator is shown in Fig. 2-b. When the coupling capacitor, C_c, is less than about 50 µµf, the circuit acts like a variable capacitor, with maximum capacitance (tube saturated) about equal to C_c, and minimum capacitance (tube cut off) slightly greater than the grid-to-plate capacitance of the tube used. When the output of this circuit is connected across the oscillator tank (with a slight trimmer correction), and the input is connected across the discriminator (as in Fig. 2-b), with proper polarization, carrier strength when tuning across an FM signal appears as in Fig. 3. If the direction of tuning is reversed, the diagram will be a mirror image of that shown. Once the a.f.c. is in control, the "hold" range is approximately 200 kc each side of center in this case.

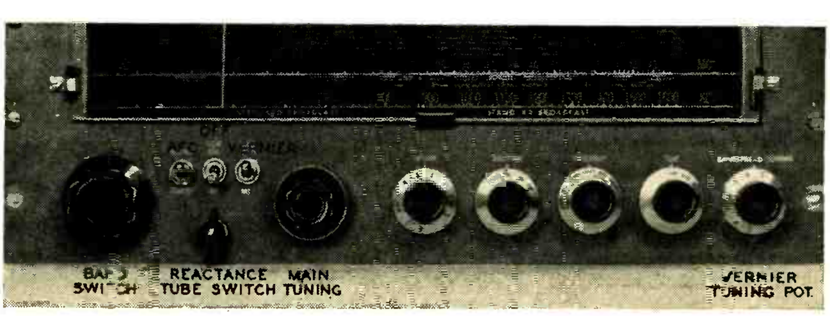
The grid voltage of the reactance tube may be controlled manually, instead of being the difference voltage produced when a slightly off-tuned signal is impressed upon a discriminator. The reactance-tube circuit then becomes a very effective tuning vernier. Its tuning range is approximately equivalent to a 2-6 µµf trimming condenser.

Practical tests of this reactance-tube circuit show that it functions beautifully both as an a.f.c. device and as a tuning vernier. Critical listeners may wish for some improvement of the circuit with regard to hum, oscillator loading, and stability.

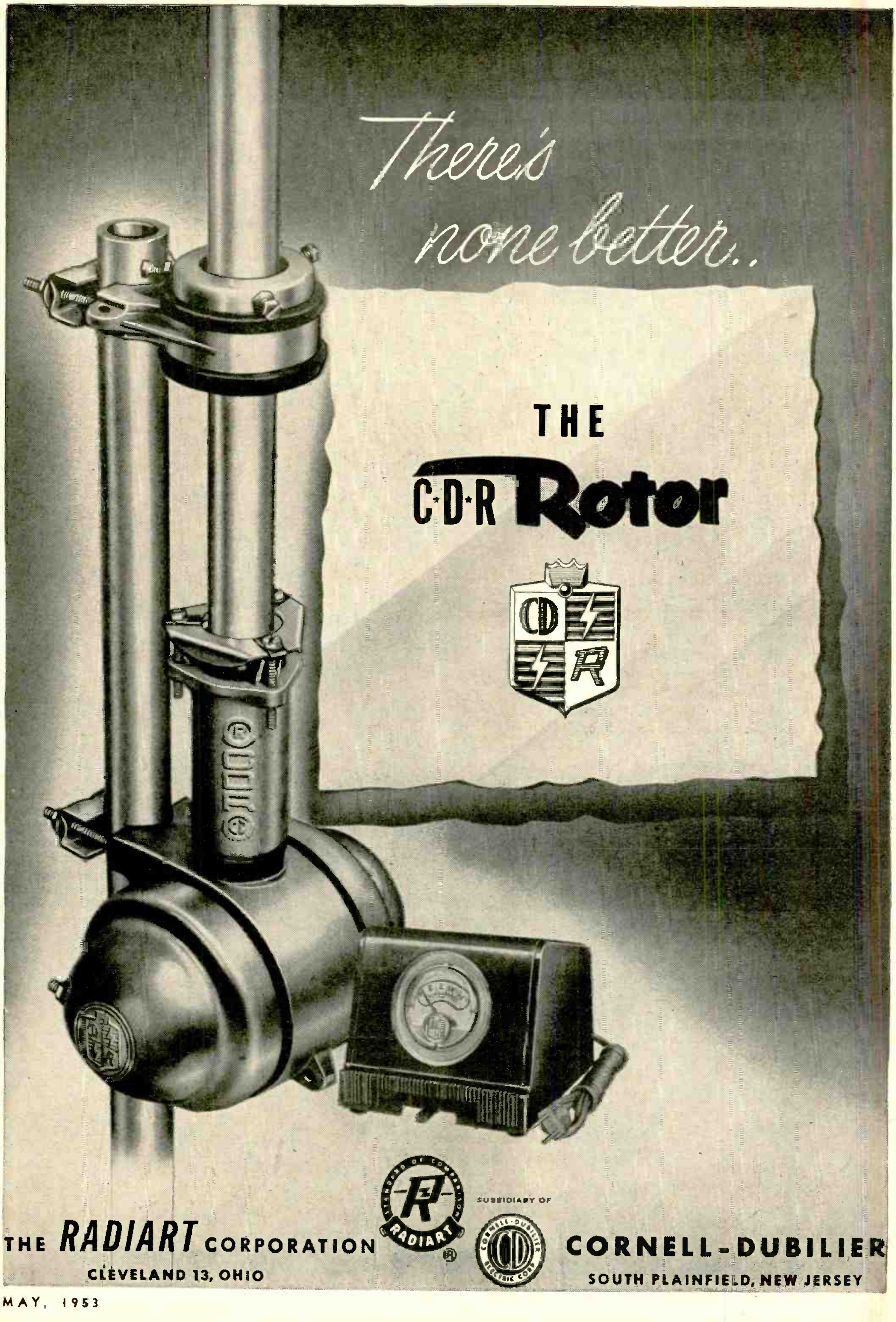
The hum problem is easily solved by using d.c. on the reactance-tube filament. This is obtained by inserting the tube filament between ground and the receiver's power-transformer plate-winding center-tap, and shunting it with a 4,000-µf, 25-volt dry electrolytic



The reactance tube circuit assembly in an all-wave receiver. Leads from the reactance circuit to the oscillator tank capacitor are kept very short.



How one vernier control was installed. Spacing from tuning control is wide.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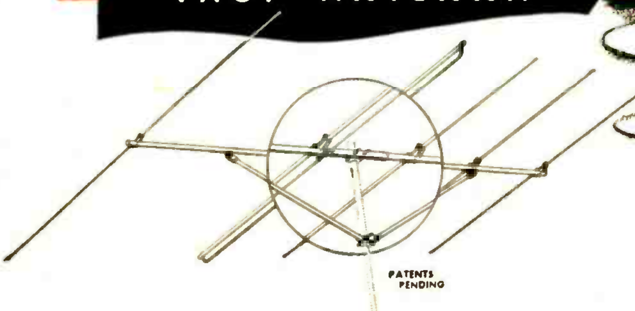

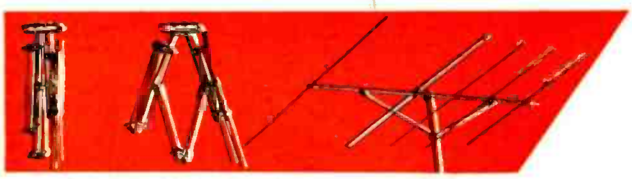

capacitor. This produced a drop of 12 volts in the plate supply, which was offset by replacing the 20-μf filter input capacitor by one of 80 μf. Further hum reduction was obtained automatically in this receiver, as the other half of the 12AT7 reactance tube was used as a noise limiter, replacing an a.c.-heated 6H6. Where the receiver drain is greater than 150 ma, a shunt resistor—as shown in Fig. 4—must be installed and adjusted till filament voltage is correct.

Oscillator loading at the higher frequencies was reduced by inserting a 1-mh choke between the plate of the reactance tube and the 10,000-ohm isolating resistor. The value is not at all critical, and any convenient choke will work here.

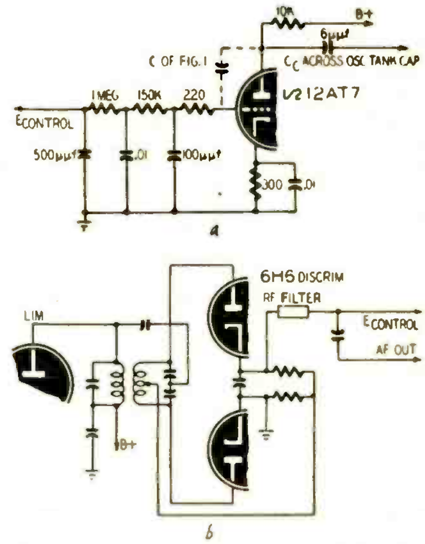

Fig. 2-a—A typical commercial a.f.c. circuit; b—discriminator connection.

The stability problem was solved with slightly more difficulty. Several independent corrections were necessary. The a.f.c. circuit, if inadequately filtered, provides a path from the i.f. output to the converter, a wonderful opportunity for feedback of various sorts. Shielding the input filter (Fig. 4), plate filter, and cathode circuit produced a definite improvement in stability. All components except the coupling capacitor (C_c) and the plate choke fitted easily onto a terminal strip, which was enclosed in an i.f. transformer can. Plate-circuit isolation was improved by an .02-μf capacitor and a second 10,000-ohm isolating resistor between the reactance-tube plate-voltage input and the receiver

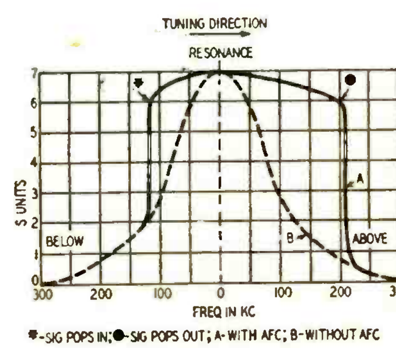

Fig. 3—Effect of a.f.c. on receiver.

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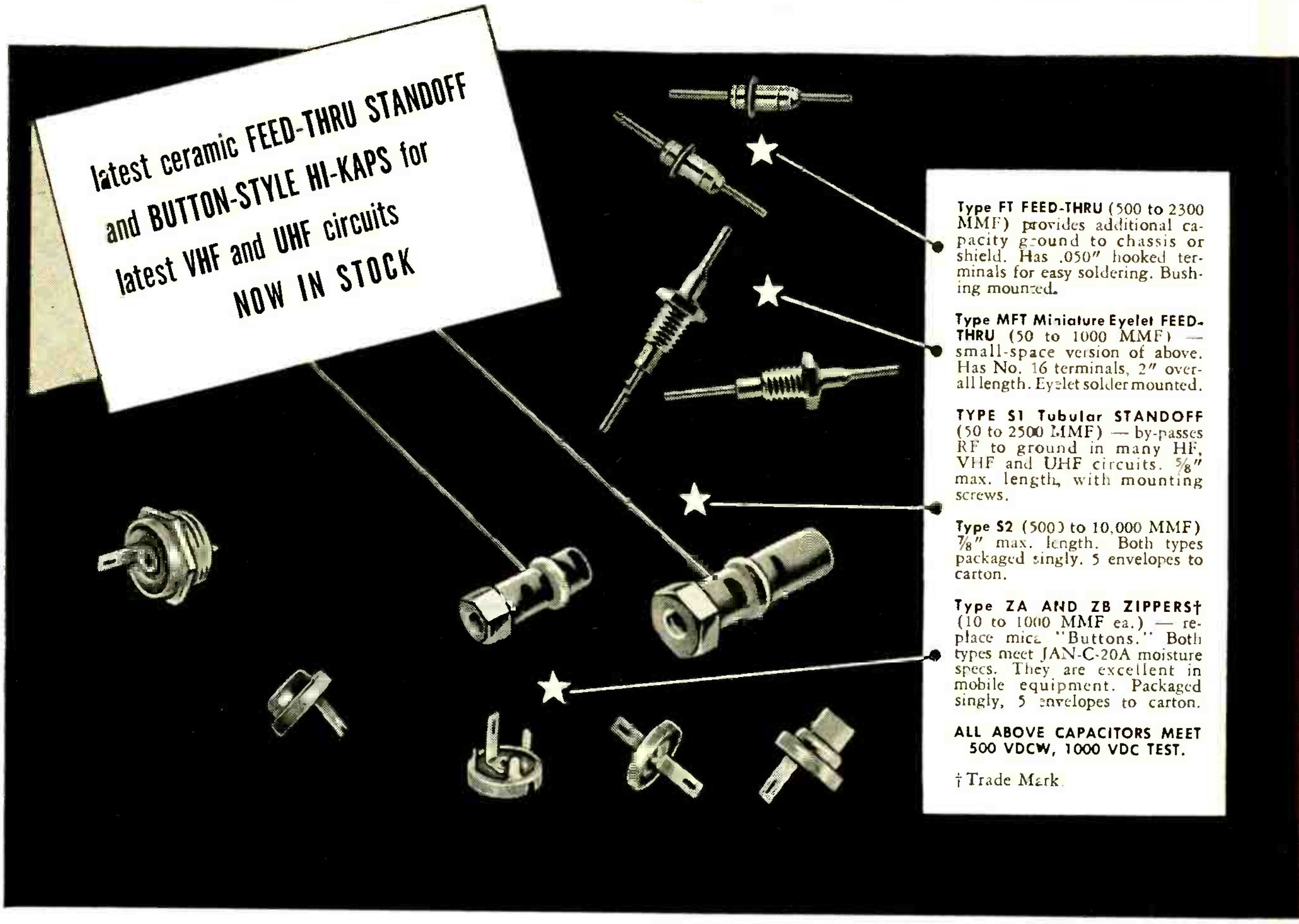

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plate supply. Small remaining instabilities were rectified by shielding the discriminator output lead with curtain rod, grounded at one point only, and by feeding the vernier potentiometer through a dropping resistor from the regulated d.c. supply of the oscillator. (In another similar installation, a tuned 10.7-mc trap was found essential.)

The reactance-tube circuit as finally installed in the receiver is shown in Fig. 4. This is the circuit of Fig. 2-a, with added shielding and plate circuit isolation, plus a switching and manual tuning circuit (lower portion). Appearance of the installation, constructed as a subassembly in a steel chassis 1 x 2½ x 4 inches, is shown in the photo. Extreme rigidity of the mounting of the coupling capacitor, and use of No. 14 bus bar leads (as short as possible) in the high-frequency circuits, made the installation practically immune to vibration.

For satisfactory operation, the leads from the reactance-tube plate, through the coupling capacitor (C_c), to the os-

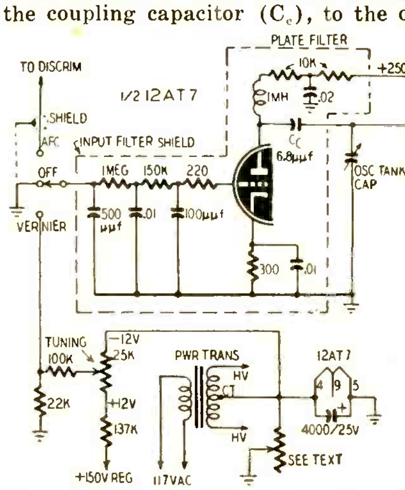

Fig. 4—This is either an a.f.c. circuit or manual-control tuning vernier.

Materials for circuit of Fig. 4

Resistors: 1—1 megohm, 1—150,000, 1—137,000, 1—100,000, 1—22,000, 2—10,000, 1—300, 1—220 ohms, ½ watt; 1—25,000-ohm potentiometer.
Capacitors: (Electrolytic) 1—4,000 μf, 25 volts. (Paper) 2—.01, 1—.02, 1—.0001, 1—.0005 μf, 400 volts. (Ceramic) 1—6.8 μμf.
Miscellaneous: 1—12AT7, 1 switch, 3-point; 1 r.f. choke, 1 mh; wiring, hardware, chassis, etc.
Other components shown in the figure are part of the main receiver or are explained in the text.

cillator tank capacitor, must be very short. The tuning potentiometer can be placed wherever convenient, as all leads to it are "dead" with respect to r.f. This is particularly convenient when the a.f.c. and vernier are added to commercially made equipment, where panel space is not plentiful. Spacing of main-tuning and vernier-tuning controls also makes for convenient tuning, as one hand can be used for each control. One such spaced arrangement is shown in one of the photographs.

Installing a reactance-tube vernier and a.f.c. system in an all-wave receiver is simple in most instances. *Before any work is done on the receiver, make sure that it is properly aligned, and that all components are working properly.*

Install the reactance tube circuit. Set the switch at "off." Realign the oscillator circuit only by reducing the capaci-

tance of the oscillator shunt trimmer. With the constants shown (Fig. 4), this reduction should be about 4.5 μμf. Now the receiver should function exactly as it did before the vernier was installed.

Set the switch at AFC, and tune in a previously logged station. If the station "snaps in" or "pops in" close to the logged position, the circuit needs no further attention. If it is heard faintly at some distance from the resonant position, then drops out as resonance is approached, is again heard exactly at resonance, and behaves the same on the other side of the resonant position, the discriminator polarity is wrong, and can be corrected by reversing the leads from discriminator secondary to discriminator-tube plates.

Set the switch at OFF and the tuning potentiometer to dead center. Tune any AM station exactly to resonance, using a v.t.v.m. from the a.v.c. line to ground if no other resonance indicator is convenient. Change switch setting to VERNIER and note results. If the station is still tuned exactly to resonance, the vernier is properly adjusted. If some adjustment of the vernier is found necessary to bring the station to resonance, a slight change in the main vernier dropping resistor (137K, Fig. 4) may be desirable.

When all functions are properly adjusted, a station tuned to resonance at OFF will also be tuned to resonance when the switch is turned to AFC and when the switch is turned to VERNIER with the potentiometer at center position.

In the installation described, the tuning range of the vernier was nearly six times as great as desired, and was reduced by a voltage divider consisting of a 100,000-ohm resistor and a 22,000-ohm resistor, connected from tuning potentiometer arm to ground, with the control voltage tapped off at their junction (Fig. 4).

Tests of this reactance-tube installation show that the a.f.c. function leaves little to be desired and that it will "hold" any signal of normal strength through all ordinary vagaries of line voltage and normal receiver drift.

When used as a tuning vernier, it covers the tuning range below which the mechanical vernier, augmented by a 5–1 planetary drive, is ineffective. As adjusted, the reactance vernier is most effective in "slotting" an undesired signal when using the crystal filter, and in peaking a desired signal when using SSSC.

Construction, installation, and alignment time occupy about three evenings or one Saturday. Parts cost, using best grade components, is less than $15.00 overall. END

[1] J. F. Rider. "Automatic Frequency Control Systems," New York, 1948, pp. 53-105.
[2] F. E. Terman. "Radio Engineers' Handbook," New York, 1953, pp. 654-656.
[3] Samuel Seeley. "Electron-Tube Circuits," New York, 1950, pp. 373-377.
[4] D. G. Fink. "Television Engineering," New York, 1952, pp. 403-404.
[5] R. L. Dawley (Ed.). "The Radio Handbook," 13th Ed., 1951, Santa Barbara, Calif. pp. 206-210.
[6] Anonymous. "A Straight FM Tuner with A.F.C.," FM-TV, Vol. 9, No. 12, Dec., 1949, pp. 18-19 et seq.

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TRIGGER CIRCUIT RELAY AMPLIFIER

By L. H. TRENT

VACUUM-TUBE relay amplifiers have some disadvantages. The chief one is the constant idling current which flows through the relay. If the vacuum tube is operated beyond cutoff, a large signal is required to operate the amplifier. Thyratrons are better, but are not uniform in their characteristics.

By operating a vacuum tube in a trigger-type circuit, you can take advantage of the full sensitivity of an amplifier tube. The operational characteristics of a trigger circuit are very similar to those of a thyratron tube, without the disadvantages. The current through the relay will be either zero or maximum, with no in-between state.

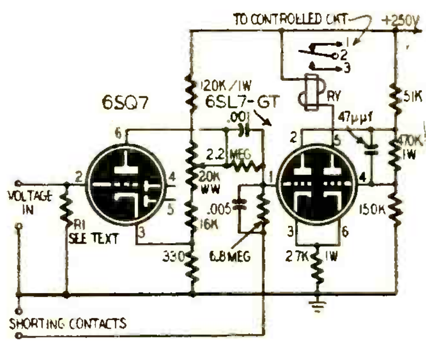

Fig. 1—A synthetic thyratron circuit.

To use the trigger circuit to its fullest advantage, an amplifier stage is needed. The trigger circuit has a certain area of operation where there is voltage (or circuit) hysteresis which makes it necessary for the input grid to be raised or lowered through a voltage range of approximately three times the normal class-A conditions for triggering to occur.

With a 6SL7-GT tube in the trigger circuit, the hysteresis amounts to about 6 volts. With a simple triode amplifier circuit, the circuit hysteresis is then divided by the voltage gain. The resulting hysteresis loop is only about 0.13 volt in area. Fig. 1 shows a relay amplifier based on a Schmitt trigger circuit which has a triggering time of about 2 microseconds.

The triggering level can be set where desired, for either polarity of input signal. With high resistance in the plate circuit of the amplifier tube, the plate voltage is low and a negative input signal is needed to trip the relay circuit. For a positive input signal, the reverse conditions apply.

The load resistor (R1) in the grid of the amplifier tube should match the impedance of the signal source. For a photocell, the resistance will be about 4 to 10 megohms. But for use in meter-

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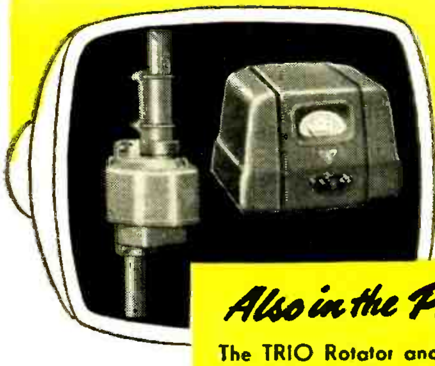

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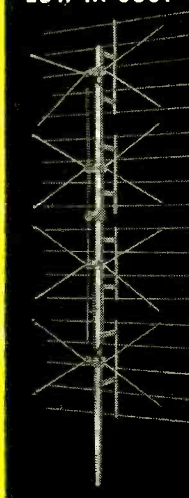

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ing a current circuit, the resistance may be extremely low. The average input level is 1 volt for satisfactory tripping. The exact value of resistance must be determined experimentally. The relay may have a coil resistance of 2,500 to 10,000 ohms. It should have s.p.d.t. contacts and operate at 2 to 5 ma.

Fig. 2 shows a protection circuit for a class-C transmitter tube. Its operation is so sensitive that a 10% decrease in drive will trip the relay and remove the short from R2 to provide protective bias for the circuit.

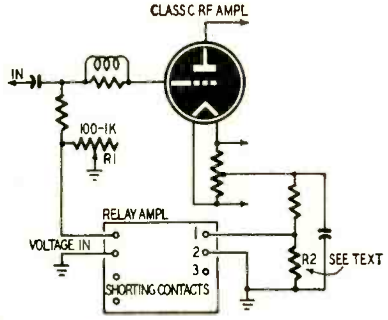

Fig. 2—Circuit used as a tube saver.

Fig. 3 shows the relay amplifier connected as a combination fire and burglar alarm. The 20,000-ohm variable control is adusted so the relay pulls in and opens the external alarm circuit when the phototube is in normal room darkness. Light (from an intruder's flashlight or from flames) falling on the phototube will cause the 6SQ7 plate current to rise and lower the grid voltage on the input section of the trigger circuit. The relay releases and closes the alarm circuit through its back contacts.

A set of normally closed switches may be attached to doors and windows

---

Materials for relay amplifier

Resistors: 1—470,000, 1—120,000, 1—27,000 ohms, 1 watt; 1—6.8, 1—2.2 megohms, 1—150,000, 1—51,000, 1—16,000, 1—330 ohms, ½ watt; 1—20,000 ohms, wirewound potentiometer. See text for R1.
Capacitors: (Ceramic) 1—47μμf, 1—.001, 1—.005 μf.
Miscellaneous: 1 relay, 2,500 to 10,000-ohm coil, operating at 2 ma or less with s.p.d.t. contacts; 1—6SQ7 tube, 1—6SL7-GT tube. Sockets, chassis, terminal strips, wire, solder, assorted hardware.

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and connected in parallel as shown in Fig. 3. When all the openings are closed, the switches are open. Opening any of the windows or doors permits the switch to close and lower the grid voltage on the trigger tube.

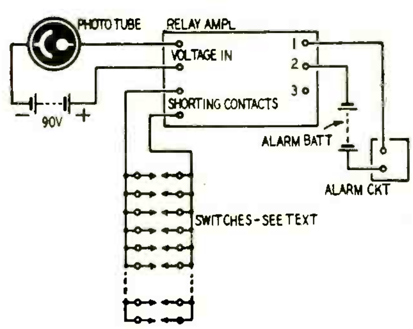

Fig. 3—Fire or burglar alarm circuit.

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By replacing relay RY with a 10,000-ohm resistor, the circuit will become an excellent wave squarer. Replace the fixed resistor R1 in the grid of the amplifier tube with a variable control of 100,000 ohms or more. With 0.5 volt applied to the amplifier grid, a square wave of the same frequency may be obtained from the plate circuit (pin 5) of the trigger tube. The circuit will operate to higher than 100 kc, the frequency depending on the capacitance to ground. The square wave will provide an excellent sync source for a scope. END

COUPLING RADIOS BY THEIR I.F.'S

Any two receivers which have the same intermediate frequency can be hooked together by the i.f. stages. Since most sets use 455-456 kc. i.f.'s, it is possible to hook almost any two receivers together. (It may sometimes be advisable to realign one of the i.f.'s for greater gain.)

This has certain definite advantages. For example, a small all-wave set with only one i.f. stage can be hooked into a broadcast receiver which has a good i.f. strip, adding to the sensitivity and selectivity of the all-wave set and providing a cheap means of amplification.

The hookup is simple, and somewhat resembles a b.f.o. hookup (Fig. 1). One end of a piece of shielded wire is wrapped two or three times around the second detector plate lead (output of the i.f. system) in the small set. The other end is wrapped two or three times around the grid lead of the first i.f. tube in the large set. The braided shield over the wire is grounded on *both* chassis. (Watch out if your small set is an a.c.-d.c. job!)

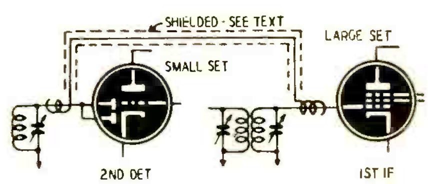


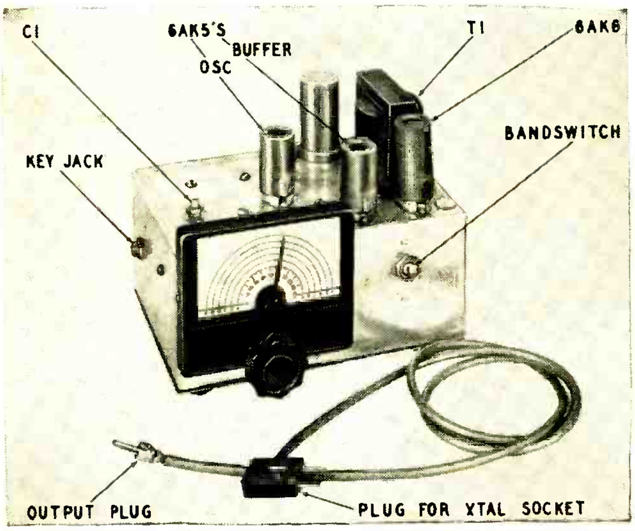
Fig. 1—How the two i.f.'s are coupled.

Since the received signal is now traveling through the i.f. and audio stages of the large receiver, it may be necessary in some cases to remove the output tube on the smaller set to kill the speaker. All tuning is done on the small all-wave set, but the audio control of the broadcast receiver is used. The large set is left tuned to a quiet spot on the broadcast band where no signal from the front end will interfere with the short-wave signal.

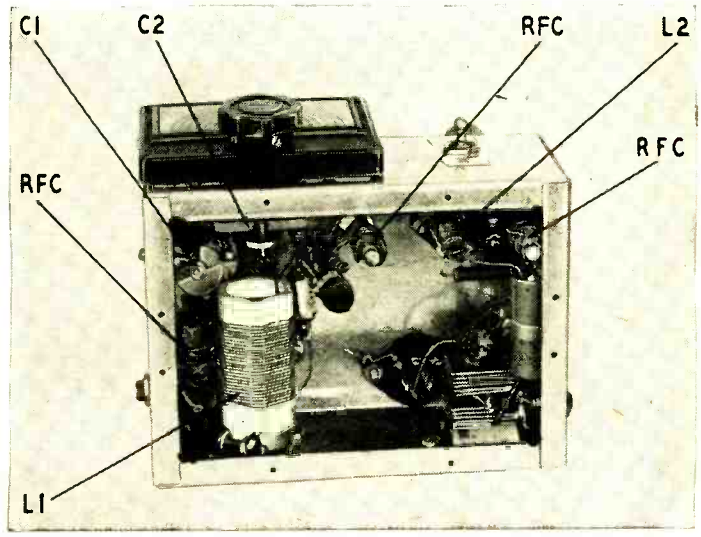
When tying two a.c.-d.c. sets together, polarity must be observed. One chassis might be hot while the other might be at ground. Don't get the coupling between receivers too tight, or you might overload a tube and create distortion.
—*B. W. Welz*

TWO BAND VFO

By I. QUEEN, W2OUX



A view of the v.f.o. with front panel and cabinet removed.



Under-chassis view of the v.f.o. showing major components.

ARE you rock-bound to one or two frequencies within your band of operation? Would you like to get more replies to your calls? If your answer is yes to both of these questions, then put aside the crystals and switch over to a good v.f.o. The photographs and diagrams show the construction of a simple v.f.o. and exciter which has enabled us to nearly quadruple the number of contacts for a given number of calls.

A year ago, W2CPA, then 12 years old, received his novice license and began working the 50-kc novice section of the 80-meter band. The power input was 30 watts into the "Novice Transmitter" described in the July, 1952, issue. The antenna was only 20 feet long and 12 feet high. The station log for this period shows an average of only one contact for every 12 calls.

A few months later, W2CPA earned his general class license and began operating on three crystal-controlled frequencies in the higher-frequency bands. The ratio of calls to replies dropped to 7 to 1.

When we put this v.f.o. into service, the ratio of contacts to calls dropped to about 3.5 to 1. Since we are still using the same antenna and power input, we feel that the v.f.o. is entirely responsible for the increase in the number of QSO's.

The circuit

This 3-tube self-contained v.f.o.-exciter substitutes for crystal control. It can be connected to the average crystal-controlled rig by simply removing the crystal and plugging the v.f.o. output connector into the crystal socket and connecting a single 6.3-volt lead to one side of the transmitter filament circuit. Output is either 3.5 to 3.65 or 7.0 to 7.3 mc, depending on the setting of the band-switch.

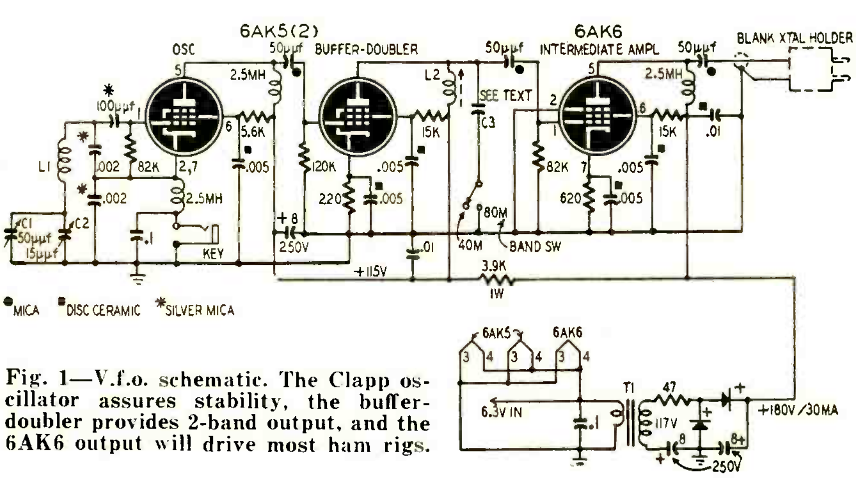


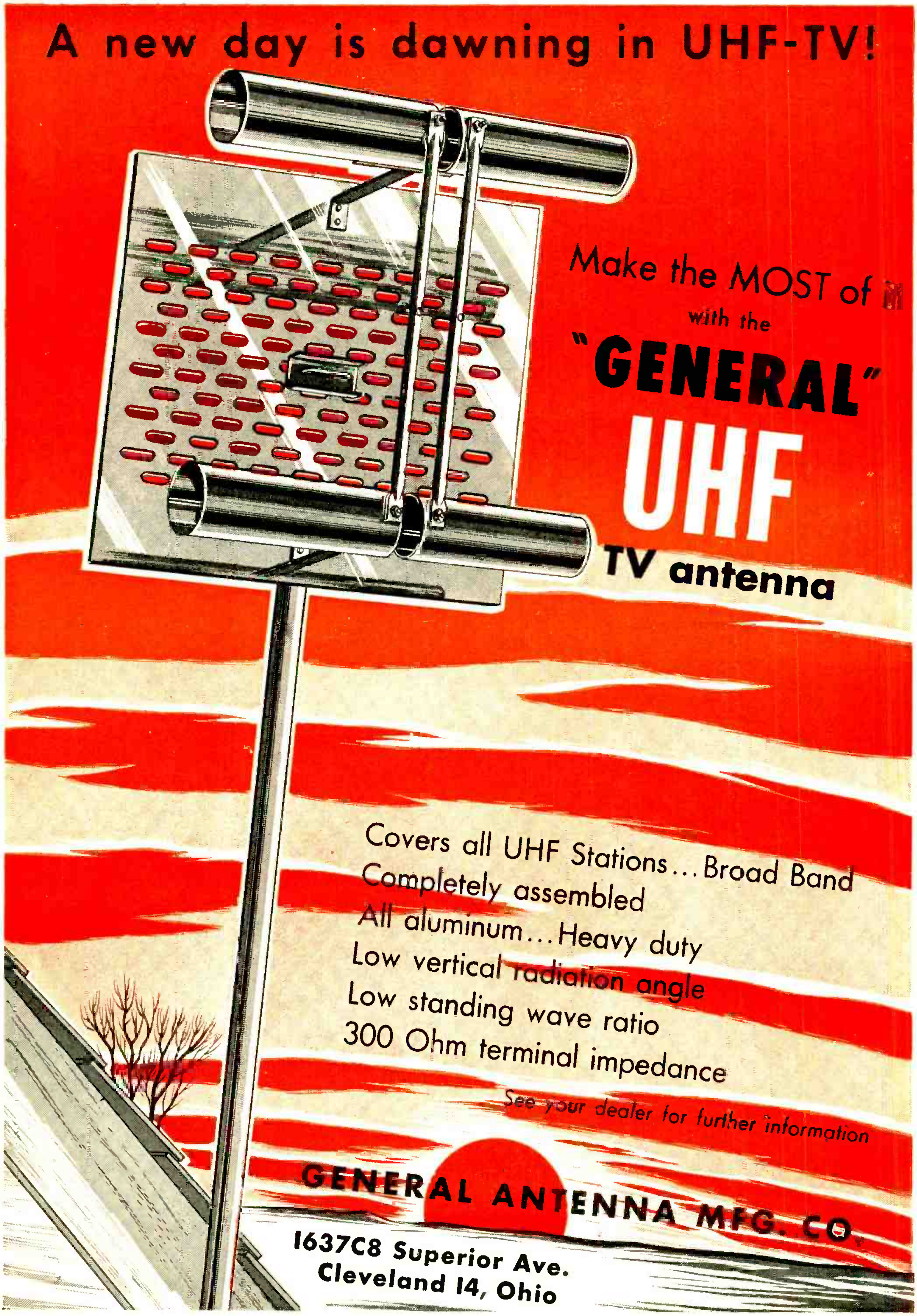
Fig. 1—V.f.o. schematic. The Clapp oscillator assures stability, the buffer-doubler provides 2-band output, and the 6AK6 output will drive most ham rigs.

The circuit is shown in Fig. 1. The oscillator is a 6AK5 in the familiar Clapp circuit. The oscillator coil (L1) consists of 26 turns of No. 22 enameled wire wound on a 1⅜-inch diameter ceramic form grooved so the winding is 1½ inches long. C1 is a midget APC type 50-μμf air trimmer used as the band-set control. It has a slotted shaft with a locking nut which prevents the shaft from being turned unintentionally. It is mounted below the chassis with its shaft extending through the top. C2 is a 15-μμf double-bearing air variable capacitor used as the main tuning control. An antibacklash vernier dial should be used to simplify tuning and logging. We used a Millen type 10039.

The second stage is a 6AK5 buffer-doubler. The plate coil L2, is tuned to 80 meters by C3 when the band-switch is closed (in the 80-meter position). When the switch is open, the circuit is tuned to 40 meters by stray and distributed capacitances. L2 consists of 50 turns of No. 30 enameled wire spaced to occupy 1 inch on a ⅜-inch slug-tuned form.

The 6AK6 is used as an intermediate power amplifier. Its output appears across the 2.5-mh r.f. choke in the plate circuit and is fed through a blocking capacitor to the grid circuit of the crystal oscillator in the main transmitter. Fig. 2 shows how the exciter output plug connects to the grid of a triode, a pentode, or a modified Pierce oscillator.

The power supply uses a 6.3-volt filament transformer connected in reverse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as a power transformer. Filament voltage (6.3 volts) from the transmitter is fed to the secondary, and approximately 117 volts appears across the primary. This voltage is stepped up to 180 by the pair of selenium rectifiers and 8-μf capacitors in a voltage-doubler circuit.

Adjustments

The oscillator is adjusted and calibrated with the aid of a well-calibrated receiver or a frequency meter. Close C2 and set C1 so the frequency is just a few kc inside of 3.5 mc. With C2 open, the oscillator should tune to a frequency 2 or 3 kc inside of 3.65 mc. This makes it impossible to work outside the 80- or 40-meter bands.

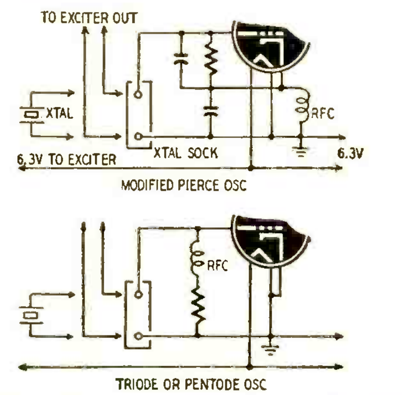

Fig. 2—The v.f.o. feeds r.f. into the crystal socket on the amateur transmitter.

Materials for exciter

Resistors: 1—47, 1—220, 1—620, 1—5,600, 2—15,000, 2—82,000, 1—120,000 ohms, ½ watt; 1—3,900 ohms, 1 watt.
Capacitors: (Paper) 2—0.1 μf, 600 volts. (Mica) 3—50 μμf; 1—70 μμf (for C3), 500 volts. (Silver mica) 2—.002 μf, 1—100 μμf, 500 volts. (Disc Ceramic) 2—.01, 5—.005 μf, 500 volts. (Electrolytic) 3—8 μf, 250 volts. (Air variable) 1—15 μμf, double-bearing midget; 1—50 μμf.
Miscellaneous: 2—60-ma or larger selenium rectifiers; 1—6.3 volt, 1-amp filament transformer; 1—3 x 5 x 7-inch aluminum chassis; 1—s.p.s.t. toggle switch; 1—vernier dial; 1—crystal holder; 3—7-pin miniature sockets; 1—phono plug and jack; 1—6AK6, 2—6AK5 tubes; 3—2.5-mh r.f. chokes. Wiring, coil forms, and hardware.

In setting up the doubler, set the oscillator to about 3.575 mc, open the band-switch, and adjust the slug in L2 for maximum output. You can do this by inserting a meter in the doubler plate circuit or in the grid circuit of the 6AK6. Tune for minimum current in the plate circuit or maximum current in the grid circuit of the 6K6.

Close the band-switch so the lower end of C3 is grounded. Try various values of fixed capacitance for C3 until the circuit peaks at 3.575 mc. This presetting maintains the output constant throughout the tuning range. In our case, 70 μμf was needed for C3.

The single power-supply lead between the transmitter and v.f.o.-exciter may be used only when the transmitter heaters are operated with one side grounded. It should not be used if the heater winding is floating or grounded at a center-tap. Instead, bring a separate lead from each side of the transmitter filament line and connect it across the secondary of T1. Do not ground the secondary of T1 or the heaters of any of the three v.f.o.-exciter tubes. END

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ADAPTING RELAYS to Special Uses

The author solves relay problems by adapting standard units. So can you. He tells you how.

By LOUIS E. GARNER, JR.

SERVICE technicians, audio and TV installation specialists, amateurs, and experimenters, needing a relay for a special remote control or switching setup, must make a selection from comparatively few "stock" items offered to the general public. When a desirable item is listed in a manufacturer's catalog, you may find that local distributors and retailers, catering primarily to the service trade, do not carry the item in stock.

On the other hand, a factory design engineer does not hesitate to specify a special relay for a new piece of equipment because he can be sure of getting it. Many manufacturers make only a few stock relays, with the major portion of their business represented by relays designed for special applications and supplied in quantity on special order. These special relays are usually made by modifying the number of contacts, coil resistance, contact arrangement, and other characteristics of a standard model.

If you have a relay problem, you may find the solution in this description of the more common techniques which many laboratory technicians use to adapt a common relay for specific applications.

Increasing sensitivity

Relay sensitivity is determined by a number of factors, including weight of the armature, spring tension, spacing between the armature and core, and coil characteristics. Many of these factors are beyond the control of the experimenter unless he is willing to actually rebuild the relay. However, the sensitivity of small relays, of the types used for control purposes in phototube circuits, capacitance alarms, and similar electronic circuits, may be increased by either of two methods.

The first is to reduce the spring tension. Do this by stretching the spring slightly or by bending either of the hooks holding the spring. In some relays, one end of the spring is attached to an adjusting screw, and spring tension may be changed easily . . . either by adjusting a nut or turning a screw. *If it is necessary to stretch the spring, it should be done very carefully. Take special pains not to overstretch the spring or to deform its shape.*

The other method of increasing sensitivity is to move the armature closer to the coil core. The best way to do this in the type of relay shown in Fig. 1 is by adjusting the back contact to move the armature down toward the core so the contacts are brought closer together. Therefore this technique is limited by the current and voltage at which the contacts make or break. Where only low currents and voltages are involved, contact spacing can be made quite close.

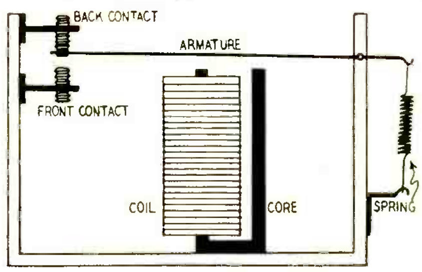

Fig. 1—A drawing showing the construction of a typical double-throw type relay. A single armature may carry several independent moving contacts.

Reducing relay sensitivity

Reverse the techniques described above to reduce relay sensitivity. That is, increase the spacing between armature and core or increase spring tension, or both.

In addition, resistors may be used either in shunt or series with the relay to change the sensitivity. Where the relay is operated by a current change, a shunt resistor is employed. Where control depends on a voltage change, a series resistor is used. Both methods are illustrated in Fig. 2.

Since the resistor size is determined by the control voltage (or current), the change in sensitivity desired, and the coil characteristics, it is generally difficult to specify the size beforehand. In most cases the resistor size is determined experimentally. For variable sensitivity, use a variable resistor.

Self-latching relay

More power is required to close a relay than is necessary to hold the relay in, once closed. This fact may be used to advantage in designing a self-latching relay circuit. The circuits for both current-controlled and voltage-controlled relays are given in Figs. 3-a and 3-b respectively. In Fig. 3-a, the resistor is adjusted to bypass sufficient circuit current so that the relay is held closed, but so that there is not sufficient current through the coil to pull the relay in, once opened. When the control current is stopped (or reduced sufficiently), the relay opens, and will re-

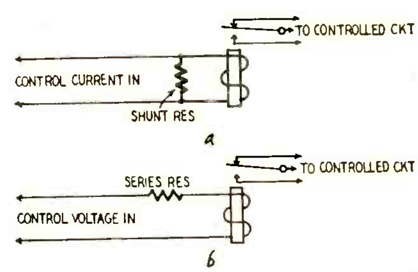

Fig. 2-a—The shunt resistor reduces sensitivity and adapts a low-current relay to a high-current control circuit. Fig. 2-b—The series resistor reduces the sensitivity and prevents voltage breakdown in the coil of the relay.

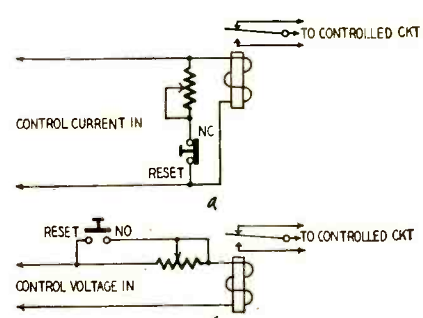

Fig. 3—Self-latching relays. The circuit at *a* is controlled by a change in current; circuit at *b* is controlled by a variation in the applied voltage.

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main opened even though the control current is restored to its normal value, until the RESET switch is pressed to open the shunt circuit and permit the relay to pull in again.

The circuit in Fig. 3-b operates in a similar fashion, except that a series resistor rather than a shunt resistor is used. This circuit is suitable for voltage-controlled relays. In this circuit, the variable resistor is adjusted so the current through the relay is too weak to close the relay but it is strong enough to hold it closed if the armature is depressed manually. Interrupting or reducing the voltage will cause the relay to open. It will not close—even though the normal voltage is reapplied —until the RESET switch is closed momentarily to short out the variable resistor.

Sensitive a.c. relays

Extremely sensitive a.c. relays are not generally available except on special order. The circuit shown in Fig. 4

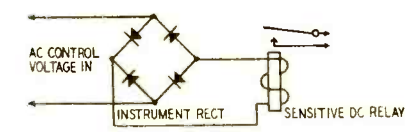


Fig. 4—Instrument rectifier adapts the sensitive d.c. relay to an a.c. circuit.

will give satisfactory results as a substitute for an a.c. unit. A small instrument rectifier (such as used in multitesters) and a sensitive d.c. relay make up the circuit. These small rectifiers cannot deliver more than a milliampere or two (depending on the type employed) and are limited as to maximum voltages. However, sensitive d.c. relays requiring only a milliampere or two are easily obtained at reasonable prices.

Time-delay relays

Three different time-delay circuits are shown in Fig. 5. Each is designed for a different application, and all may be used to give a wide range of time

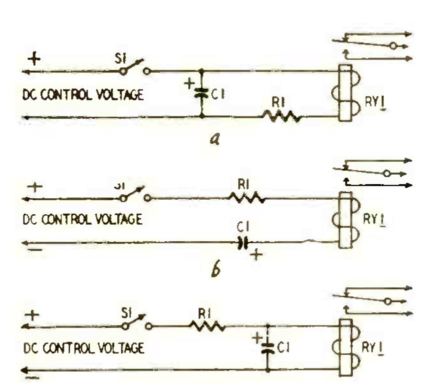


Fig. 5-a—RY1 remains closed for a short interval after opening S1. Fig. 5-b—Relay closes with S1 and then opens automatically after a timed interval when capacitor C1 is charged. Fig. 5-c—Operation of RY1 is delayed on opening or closing control switch S1.

delay. In each case, C1 is generally an electrolytic, with the values of both C1 and R1 chosen experimentally to give the desired time delay. The exact values depend on the resistance of the relay coil, the control voltage, and the delay time. The relay is generally a high-resistance (5,000-ohm to 10,000-ohm coil) unit.

The circuit in Fig. 5-a is designed to hold the relay closed for a given time after the control voltage is removed. In operation, closing S1 charges C1 and pulls in relay RY1. After S1 is opened, the capacitor C1 discharges slowly through R1 and RY1. RY1 stays closed until the discharge current drops below the hold-in current for the relay. In this circuit C1 may be either a paper or an electrolytic capacitor.

When the circuit shown in Fig. 5-b is used, the relay closes immediately when S1 is closed, but opens automatically shortly after, even though S1 remains closed. In operation, closing the switch permits C1 to charge from the control voltage. As long as C1 is charging, current flows through the circuit to pull in RY1 and hold it closed. When C1 approaches maximum charge, the charging current drops, permitting the relay to drop out. If it is desired to open the relay at any time before the end of the delay period, it is necessary only to open S1, in which case RY1 opens immediately.

An electrolytic capacitor is preferred for C1 (in Fig. 5-b) because its internal leakage will permit it to discharge completely between operating cycles. However, a paper capacitor may be used if shunted by a high resistance to provide the necessary leakage.

The circuit given in Fig. 5-c closes the relay at a predetermined time *after* the control voltage is applied. In operation, when S1 is closed, C1 charges slowly from a voltage divider consisting of R1 and the relay coil resistance in series. The current through R1 is the sum of the capacitor-charging current and the current through RY1. The current through RY1 does not reach a level high enough to pull in the armature until C1 is nearly charged.

This circuit also has a slow-opening time-delay characteristic. When S1 is opened, C1 discharges through the relay coil. The relay stays open until after the discharge current has dropped below the relay hold-in value. However, proper choice of components will keep the drop-out time down to a fraction of the pull-in time. Either a paper or electrolytic capacitor may be used for C1 in Fig. 5-C.

Increasing contact current

Very often the problem of controlling an extremely heavy current with a small control current arises in design work. Unfortunately, the most easily obtainable sensitive relays cannot handle large currents because the contact must be small to keep the armature weight as low as possible. In such cases, the usual technique is to use one relay to control another. See Fig. 6. The sensitive relay, RY1, is operated by the weak control current, and, in turn, controls the heavier current required to operate the heavy-duty relay, RY2.

The number of contacts and the contact arrangement may be modified easily in some types of commercially available relays. In others, especially the more sensitive types, changing the number of contacts is difficult. In addition, it may prove next to impossible to obtain a stock relay with the desired contact arrangement. In such cases, two or more relays may be connected in

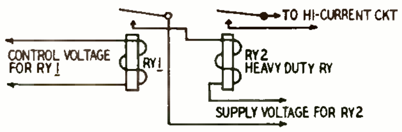
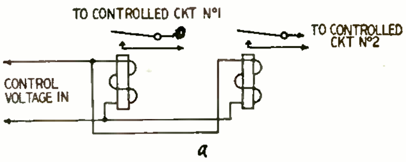


Fig. 6—Sensitive relay RY1 controls coil circuit of heavy-duty relay RY2.

series or in parallel to give the desired circuit arrangement.

Two s.p.s.t. relays are shown connected in parallel in Fig. 7-a to provide the equivalent of a d.p.s.t. relay. In Fig. 7-b a single-pole, normally open and a single-pole, normally closed relay are used together to provide s.p.d.t. action. Although the relay coils have been shown connected in parallel in both cases, they could just as well have been connected in series. The method of connection depends on the control



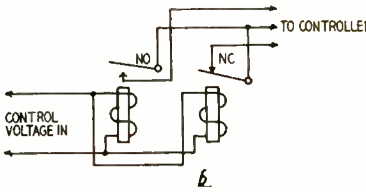


Fig. 7-a—A common method of adapting two s.p.s.t. relays for d.p.s.t. use. Fig. 7-b—Two s.p.s.t. relays (one normally closed) in a s.p.d.t. application.

voltage (or current) available. When using two or more relays together as outlined above, it is important that the relays have similar characteristics (coil resistance, armature tension, and size), regardless of individual contact arrangement. This is necessary if the relays are all to operate simultaneously. There is always a slight variation in pull-in and drop-out time for different types of relays.

Conclusion

While the methods outlined above represent the more basic techniques of adapting existing relays to specialized applications, they by no means represent all possibilities. It is perfectly feasible to combine two or more of the techniques described for special jobs. For example, one of the time-delay relay circuits might be used not only to operate equipment, but also to switch on, in turn, a different type of time-delay relay which is used to control still another piece of equipment. END

The Sphinx Observatory, provisional site for the 200-mc Bern-Lugano radio link, is an almost ideal transmitting site. It is on the Jungfraujoch peak, nearly 12,000 feet above sea level.

WHERE ANTENNAS GO DOWN, NOT UP

By W. KLEIN

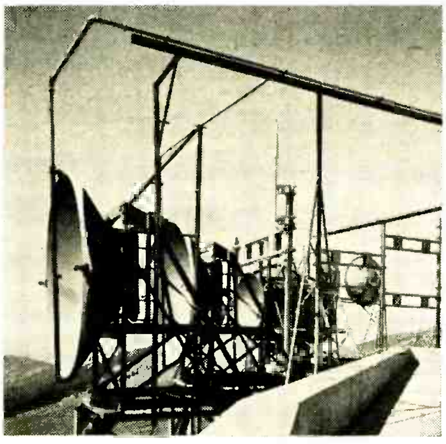
THE Jungfraujoch, long known as a place of general touristic interest and of international scientific research, is the most elevated permanently inhabited location in the Swiss Central Alps. It is accessible the whole year by an electric cog-wheel railway, constructed 40 years ago, which climbs two giant mountains, the Eiger and the Mönch, to a level of 11,333 feet, near the very origin of the Aletsch glacier, the largest in Europe. Here the width of the Alps is at its smallest. It is in this

A close-up of the antenna system seen in the photograph at the top of the page. Antennas are supported on yards extending from the mountain, and held by guys to the rock above. (Antennas extend downward, but the guys go up!)

The tent where equipment for the first 150-mc field tests was housed. The location is on the northeast ridge of the Jungfrau, 12,000 feet above sea level. Sphinx Observatory, present station's site, is above the antenna. Tent is the dark object in foreground.

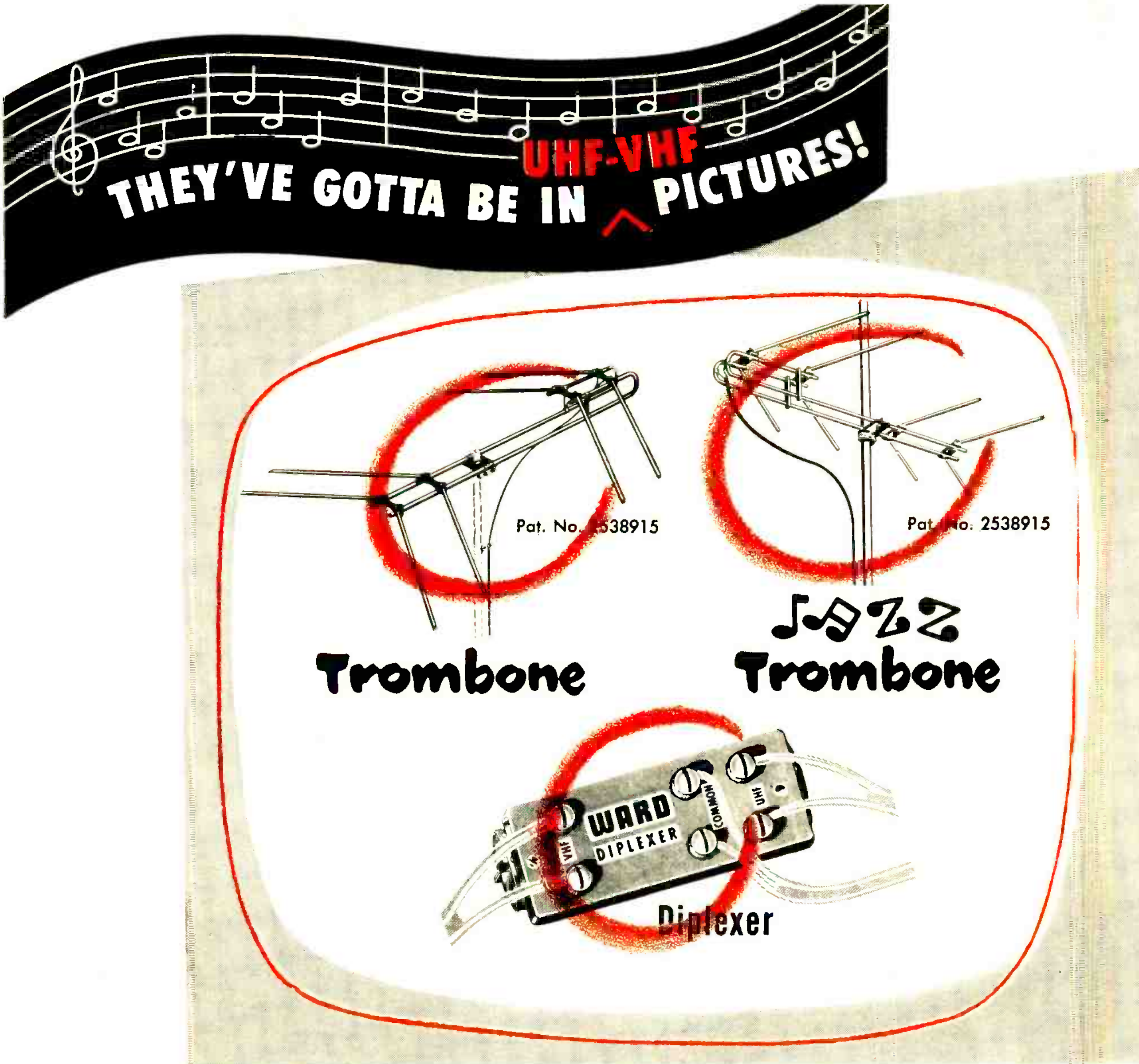
region that a radio link repeater station of the Swiss Telephone and Telegraph Administration is being constructed, on the ridge of the Jungfrau, about half a mile distant from the railway terminus and at a level of 12,100 feet above sea level.

This station is expected to open a new way of communications between parts of Switzerland north and south of the Alps and to adjoining countries as well. The Jungfraujoch will thus be an important intermediate station in a Swiss radio-link network, which will supplement the existing cable trunk-lines that form the basis of public telephone service in the country. This radio-link network may later serve for the exchange of high-quality music and television programs as well.



A battery of high-gain antennas used on the transalpine section of the link, where transmission between stations is not entirely on a line-of-sight path.

At present this network is still at its very beginning. A first attempt to construct and try multichannel telephone radio equipment, based on AM, was made in Switzerland as early as 1938. But it was not until 1947, after some development in the FM field, that the



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first equipment with six speech channels was put into regular public service, with automatic dialing, between Zurich and Geneva. It was of the single-side-band FM type and used radio frequencies between 150 and 180 mc. The two repeaters were unattended and the distances were 3, 70, and 75 miles. On the same path were installed later two 23-channel equipments of the PPM-AM type, both working in the band of 2,000 mc on common aerials. In 1948 studies and field tests were undertaken to find a suitable way of crossing the Alps by radio link, and in the winter of 1949-50 multichannel equipment, again of the SS-FM type, was installed between Bern and Lugano, with one repeater provisionally placed in the Sphinx observatory (11,723 feet) on the Jungfraujoch, and a second repeater on Mount Generoso (5,300 feet) south of the Alps.

This link operates in the range of 200 mc. It has complete standby equipment, and automatic local switchover in case of failure. Path lengths are 37, 65, and 9 miles for the sections concerned.

The Sphinx observatory as a repeater site had to be considered provisional, because there was no convenient repeater site south of the Alps with no obstructions in the line of sight. In the transalpine section of the link in use at present there are two ridges in the theoretical line-of-sight, producing an almost pure diffraction effect, which means a transmission loss of some 26 db over free-space attenuation at frequencies around 200 mc, under normal propagation conditions. This additional loss had to be compensated for by correspondingly large aerials, a measure that might not be generally justified and that turns out to be quite impracticable on the higher frequency ranges or even—with many types of equipment—on certain of the lower frequencies.

The permanent repeater station now under construction on the northeast ridge of the Jungfrau will give all the necessary path clearance on the transalpine section and a wider range north of the Alps, as was proved by the field tests. Supply and other cables for the repeater will enter from the railway terminus through a tunnel, excavated partly in the ice of the glacier. This tunnel will also serve as access for the station personnel. END

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The method is called "statistical prediction," which means simply that the receiver uses the data it has already received to predict that which is to come. The transmitter then merely sends an "error" signal, which is the difference between what the receiver thinks is coming and what the receiver actually gets.

This may not seem to make sense, but is exactly what happens. Let's take an example from something a little easier to understand—the telegraph. The ultimate—and absurd—realization of the prediction system would be to agree that all telegrams would read "President Eisenhower is coming to dinner Saturday night." Then, if the desired telegram should read "Aunt Jane broke her leg Tuesday," the telegraph transmitter would send "error" signals expressing the difference between "President Eisenhower" and "Aunt Jane"; between "coming to dinner" and "broke (her) leg"; and between "Saturday night" and "Tuesday."

In television, as any televiewer will realize, this system would not really be so absurd. Large parts of almost any TV scene are made up of elements exactly like those around them, such as the parts of a sky, a wall, floor, or other large surface. If the transmitter did not have to continue repeating millions of identical cycles just to assure the receiver that it is still receiving the same thing, but could send signals showing only *changes*, only a fraction of the present information would have to be transmitted. Bandwidths could be narrowed, or more detail—perhaps even color—could be transmitted on the same band. It might even be possible to send two or more TV programs, or a combination of television and other services on a single channel.

In our present system of television transmission the *amplitude* of the video signal voltages varies with changes in picture brightness. Unavoidable delays in the video amplifier circuits prevent the signal voltage from responding instantaneously to sudden transitions in the brightness of the scene. This inability to *reproduce* changes in the scene as fast as they occur reduces the definition of the received picture.

In statistical transmission a fixed delay might be introduced in the receiver for all signals, and the picture-tube bias fixed at a normal gray level. During the delay period positive or negative pulses of constant amplitude

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but *varying width* could charge capacitors which would buck or aid the fixed bias when switched into the circuit. Positive pulses would represent an increase in brightness, and negative pulses a decrease. With high-speed trigger-type circuits, the trailing edge of each pulse could be used to discharge one capacitor and switch in the other, in preparation for reproducing the following change in brightness.

There are several prediction methods. In one, the receiver assumes that the signal to be received is the same as the immediately previous signal—that is, the light or shade will remain the same as the point on the horizontal scanning line to the left of what is being received. The kinescope signal-grid bias remains steady till an error signal is received, then varies accordingly and remains at the new value till another error signal comes along. In another system, the receiver believes that the value of light or shade will be exactly the same as the value directly above it—that is, on the same point of the previous line. And in a third system, the receiver bases itself on a combination of the two, seeking to make the illumination on the kinescope screen exactly like that above and to the left.

To do this, the receiver needs a memory to tell it what the signal was like immediately before, what it was at the same point on the last line (63.5 microseconds before) or to remember whatever information the particular system requires. It also needs control circuits to give the spot the required value in the absence of a correction signal. END

HOW NEW IS A TV?

A "new" angle in television gypping is reported from Los Angeles, where a television dealer was lodged in jail for allegedly selling a set which had already been sold several times as a "new" receiver.

The set was sold for $200 to a Mrs. Gertrude Steinberg, who had trouble with it and could not get the dealer to give the 30 days free service her receipt said she was entitled to. (The receipt also stated that the receiver was a 1953 model.) Mrs. Steinberg complained to the deputy city attorney, who referred her to the Council of Radio and Electronic Servicemen. The Grievance Committee of that group investigated and reported to the owner and city attorney that the set was a 1952 model, and that it had been used and repossessed before being sold to Mrs. Steinberg.

Meanwhile the dealer had heard of the investigation and hurried to his customer, offering to return the purchase price and take back the receiver. His manner was so rude, according to his customer, that she refused and went to phone the police. When she came back from the phone she found two $100 bills on the floor and no TV receiver.

Police later picked up the dealer at his shop, booking him on two charges of petty theft and one of illegally making off with stolen property. Meanwhile the "new" set had already been sold again, for $180 this time. Queried, the dealer insisted "Sure, it's still new. A set is new for the first couple of months."

CHICAGO AND TVI

Decision to form a permanent TVI Council to combat interference in the Chicago area was made by a special conference of Chicago service technicians and dealers, radio amateurs, and radio and television manufacturers held February 20.

The conference, which was jointly sponsored by the Newark Electric Co. and the Hamfesters Radio Club, was addressed by Mr. McDonnell of the FCC and Lewis McCoy of the ARRL. Mr. McCoy demonstrated 400 pounds of interference-combating equipment originally used by Philip Rand and described by him in the authoritative book *TVI Reduction*. One of the most arresting topics of the evening was a demonstration of the manufacturer's responsibility for much of the prevailing TVI. Formation of the permanent TVI Council was tentatively set for the next meeting of the Chicago Amateur Radio Club Council.

REPAIRMAN JAILED

A radio service technician, Irving Sammis of Baltimore, has been sentenced to six months in jail for false pretenses. He was found guilty on two counts, one of collecting $76 and one of charging $38 for repairs not made. In addition to the jail sentence, he was fined $1,500.

In passing sentence, Judge Herman M. Moser declared:

"Television is a mysterious contrivance to most persons, who must be able to depend upon the honesty and fair dealing of repairmen.

"Television is part of the daily life of thousands and is as necessary as the table from which they eat, or the beds in which they sleep.

"This man took advantage of his customers in a mean way, exploiting public ignorance for his own profit."

In another case on the same day, a Baltimore radio shop operator was sentenced to eight years in a Federal prison for receiving 90,000 tubes stolen from the Baltimore Signal Depot. A $5,000 fine was levied in addition.

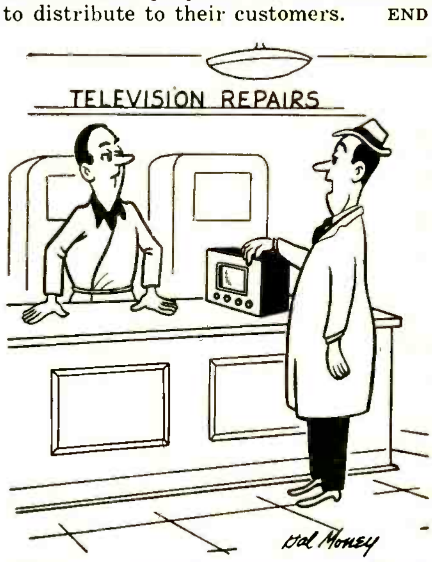
"IMPLIED WARRANTY"

Wisconsin's "implied warranty" bill, under the terms of which purchasers of television receivers would be entitled to a 180-day period of free dealer service, will not be acted on immediately. Instead, according to the State Affairs Committee of the Wisconsin legislature, it will be held up to consider proposed amendments.

The proposed bill, though intended to protect customers from unscrupulous independent service companies, is opposed by many on the ground that it would inflict an undue burden on the small dealer, who would be compelled to maintain a full-scale service organization if he wished to sell sets.

SAN ANTONIO'S OFFICERS

Officials of the San Antonio Radio and Television Association, San Antonio, Texas, are: Al Niehaus, president; A. B. O'Keefe, vice-president; Forrest L. Baker, secretary; and Tom Boyd, treasurer. The organization, which was founded in 1949, announces that it now supplies members with large posters bearings the emblem of the association at the top and featuring its Code of Ethics, as well as cuts of the emblem in several sizes suitable for cards, envelopes, letterheads, and newspaper advertising. A pamphlet called "Interesting Facts about Your TV Set" has also been prepared for the members to distribute to their customers. END



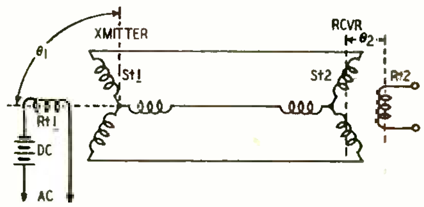
"I'd like to have this set converted to a 21-inch screen"

NEW PATENTS

IMPROVED SERVO SYSTEM

Patent No. 2,615,149
Hershel Toomim, Douglaston, N.Y.

Inertia may cause *hunting* or oscillation in a servo. This invention shows how to eliminate the difficulty. First it provides a greater torque to overcome the slow start due to inertia. Then the torque is reduced so the servo rotor can come to a stop without overshooting. The figure shows a selsyn pair, consisting of transmitter and receiver. Each includes one rotor and three stators. Heretofore, only a.c. was used to energize the servo transmitter. Note that d.c. is used as well in the new circuit. It eliminates the effects of inertia and prevents hunting.



For the moment we will disregard the d.c. Transformer action induces a.c. into St1. This voltage varies with $\theta 1$, the angle between rotor and stator. Power is transmitted to Rt2 which rotates until $\theta 2$ equals $\theta 1$. Unfortunately, inertia holds down Rt2 to a slow start. Once full speed is attained, this rotor cannot stop in time. Therefore it overshoots and must return. Hunting may continue through several cycles.

What happens when the d.c. is added? The current sets up a steady magnetic field around Rt1. So long as this rotor remains stationary, there is no effect on St1 (or the receiver). When $\theta 1$ is changing, flux is cut and voltage is induced into St1. Added torque is available to drive Rt2. Therefore the receiving rotor gets off to a quicker start, despite the inertia. The extra induced voltage is proportional to the speed of Rt1. As the latter nears its final position it slows down and the extra torque dies out. Therefore Rt2 can reach its position of equilibrium without overshooting.

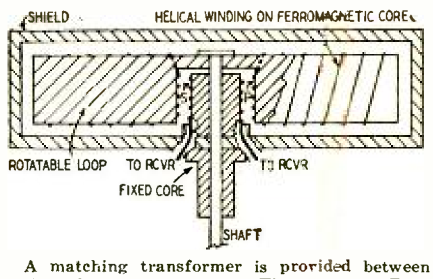
IMPROVED ANTENNA

Patent No. 2,624,004
Wladimir J. Polydoroff, Kensington, Md.

The antenna in many new portable broadcast sets is a compact winding on a special ferrite core. Because of its extra high Q and efficiency it is equal in sensitivity and directivity to an air-core loop of much larger dimensions. This patent describes a method of taking full advantage of the directional characteristics by providing a simple method of rotating the unit and coupling it to a receiver.

This antenna is especially valuable on portable receivers, whose small size makes an air-core loop inefficient. By using a form of faradic shield, the directional qualities are enhanced, and the receiver thus made more selective. It may be mounted firmly on top of the receiver, in portable types which can be oriented for best reception, or made rotatable as shown for larger receivers.

A typical model is illustrated here. It may have the following dimensions: Length 6 inches; height ¾ inch; width 2 inches. When wound with 13 turns it has an inductance of 15 μh. Its pickup is equal to that of an air-core loop 8 inches across.



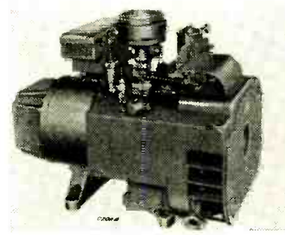
A matching transformer is provided between pickup loop and receiver. The primary P is connected directly to the loop winding and is wound over the rotatable core. Secondary S is placed over the fixed core. The loop is placed in a plastic case and the whole assembly is shielded by metal foil or wire screening. The shield prevents capacitive coupling to ground which would reduce the directional feature.

sweep-frequency generator ranges from 15 cycles to 100 kc, with balanced and linear sweep. The unit has an internal voltage calibrator for peak-to-peak voltage measurement and phasing control of internal line frequency sine sweep. Positive or negative internal, external, or line sync may be selected.

Other features are intensity modulation, external sync inputs, sawtooth and line frequency outputs (all on front panel); internal retrace blanking, and provision for direct connection to C-R tube plates.

ELECTRIC PLANT

D. W. Onan & Sons Inc., University Ave. at 25 St., S. E., Minneapolis, Minn., have developed an air-cooled, gasoline-powered electric generating plant. Its vacuum cooling system uses

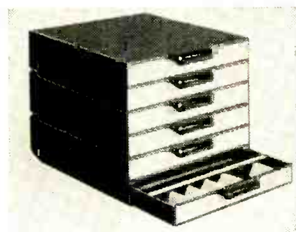


a centrifugal blower which draws cold air through the generator and over the engine, and at the same time discharges heated air out of an 8 x 12-inch side vent.

It is designated the CW model, and is being mass-produced in 5,000 and 10,000-watt capacities.

STORAGE CABINET

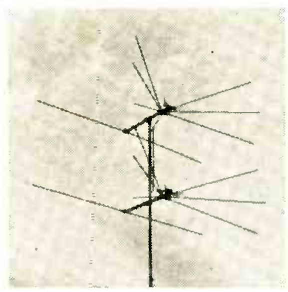
The Equipto Division of Aurora Equipment Co., 422 Cleveland Ave., Aurora, Ill., has announced the *Little Gem* steel cabinet for storage of small parts. The cabinets can be used individually, in stacks, under counters, or on shelving.



The drawer measures 11 x 11 x 1½ inches and accomodates up to 28 adjustable compartments enclosed on all four sides and bottom. An overhang at rear prevents shuffling of items when the drawer is jerked open or slammed shut.

UHF-VHF CONICAL

JFD Manufacturing Co., 6101 16th Ave., Brooklyn, N. Y., has announced its new stacked model JeT283S, combining a conical with a u.h.f. bowtie. The bowtie is built small for less wind resistance and to allow the conical elements to serve as a screen reflector overcoming u.h.f. interference and reflection. The smaller bowtie makes for improved response on the upper section of the u.h.f. spectrum, without diminishing gain on the low end.

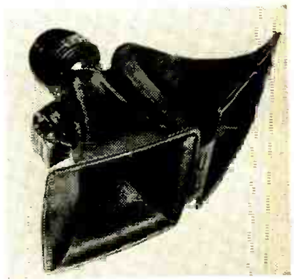


Matching transformers and two couplers are built into the antenna. The couplers are pre-attached to the cross-arms near their dipole ends by bakelite spacers that keep them air-encircled and dust free. Each coupler has 3 sets of terminals, one for the entire v.h.f. band, one for the entire u.h.f. band, and one for the single down-lead to the receiver.

WIDE-ANGLE TRUMPET

University Loudspeakers, Inc., 80 So. Kensico Ave., White Plains, N. Y. has developed a wide-angle trumpet, the Cobreflex-2, which features a pair of exponential horns having twin air columns in a single assembly.

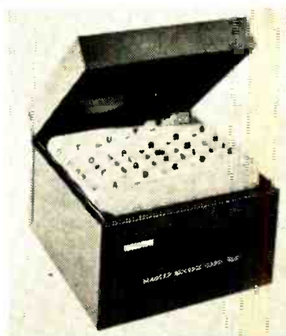
The wave fronts from each mouth form a single, uniform arc that results in a smooth radiation pattern, free from the cancellations that occur in cellular and multimouth horns. Wide-angle dispersion of sound—120° horizontally, 60° vertically—provides greater concentration in the horizontal plane for wider area coverage. Low frequency cutoff is 250 cycles for



maximum penetration of high noise levels without low-frequency masking effects.

CARD FILE

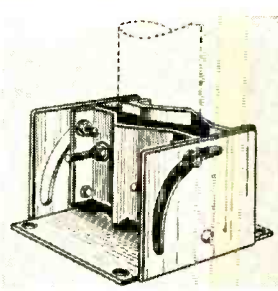
Oelrich Publications, 4135 N. Lawler Ave., Chicago 11, Ill., has designed a *Master Service Card File*, No. 700, for radio-television service dealers, consisting of a metal file box, 500 5 x 8-inch cards, and one set of index cards. Customer information, service details, sales details, warranty and service contract expiration dates are entered on the cards, which have spaces for details of 15 jobs per customer and are printed in brown on buff ledger stock.



MAST BASE

Ward Products Corp., Div. of the Gabriel Co., 1148 Euclid Ave., Cleveland, Ohio, has designed a heavy duty base, model C-34, for telescopic masts.

It is made of 12-gauge cadmium-plated steel and is adjustable to handle mast diameters from 1¼ to 2¼ inches. It can mount on the roof pitch, side of the building, or the ground or other flat surface. A rotatable feature enables an antenna to be mounted to a mast while on the ground, and then raised to a vertical position.



HI-FI UNIT

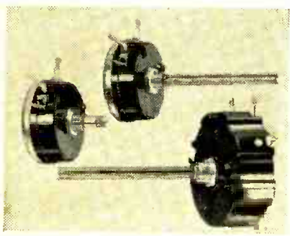
Bell Sound Systems, Inc., 555 Marion Rd., Columbus 7, Ohio, have announced a new 10-watt transcription unit, model 2195. The complete unit contains an amplifier; 12-inch speaker with 25-foot SV cable and plug; 3-speed phono, continuously variable

from 30 to 80 rpm, with a 16-inch tone arm. It measures 17½ x 18 x 12½ inches and weighs 40 pounds.

The amplifier has a power output of 10 watts at less than 3% distortion and a frequency response of 30 to 15,000 cycles ±1 db. Microphone, instrument, and phono have separate volume controls to allow intermixing.

TV CONTROLS

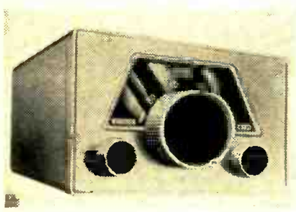
International Resistance Co., 401 N. Broad St., Philadelphia 8, Pa., has announced three new TV controls. Type 4WK is a 4-watt wirewound control, 1¾ inches in diameter, depth behind panel is 1¹¹⁄₁₆-inch, bushing ¼-inch, shaft length 3 inches. Type 4WS, designed for replacement of TV controls mounted at chassis rear or under front panel concealment without shaft alteration is identical to 4WK except that it is equipped with a short, knurled and slotted shaft ⅝ inch long.



Type HV, a 2-watt carbon-element high-voltage control for use in receivers using picture tubes requiring electrostatic focus, also comes equipped with a 3-inch shaft. Its diameter is 2¹¹⁄₆₄ inches, depth behind panel 2⁵⁄₃₂ inch, bushing ¼ inch, and shaft length 3 inches.

NEW PRESELECTOR

Radio Manufacturing Engineers, Inc., 300-302 First Ave., Peoria 6, Ill., has announced a new preselector, the DB23, for coverage of all amateur bands from 3.5 to 30 mc. The unit has three neutralized push-pull stages using 6J6 dual-triodes in selective and wide-band r.f. amplifiers.



The DB23 is self-contained and has its own power transformer, selenium rectifier, and filter system. Input impedance combinations match any standard antenna of 50 to 600 ohms, and output is a shielded line matching any receiver impedance from 52 to 300 ohms, balanced or unbalanced.

The cabinet measures 5 x 7⅝ x 6⅛ inches.

TINY CAPACITORS

General Electric Co., Capacitor Department, Hudson Falls, N. Y., has announced two new lines of subminiature metal-clad capacitors with silicone end seals which provide maximum resistance to thermal and physical shocks and permit soldering up to the bushing without danger of seal damage.

One line of the capacitors has a solid dielectric. These units are for operation from -55° C to +125° C without derating. Their capacitance varies only 1% over the temperature from 0 to 125° C and only 7% over the entire range, -55° C to +125° C. With proper derating, the units can be operated up to 150° C.

The capacitors can be operated at full voltages up to 50,000 feet altitude. Case sizes range from 0.235 inch in diameter and 11/16 inch in length to 1 inch diameter and 2-⅝ inches length.

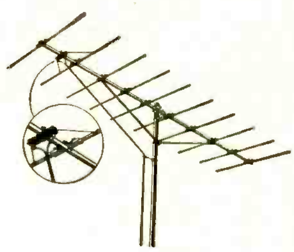
The second new line of subminiature metal-clad capacitors has a liquid dielectric. These units are for operation from -55° C to 85° C without derating, and are 20% smaller than comparable oil-filled units. They are as small as the subminiature wax units,

(characteristic J) recently eliminated from the proposed MIL-C-25 specifications, but have superior life characteristics.

Both lines of capacitors can be supplied in either tab or exposed foil designs in ratings from .001 to 1.0 μf in voltages of 100, 200, 400, and 600 volts d.c. working.

10-ELEMENT YAGI

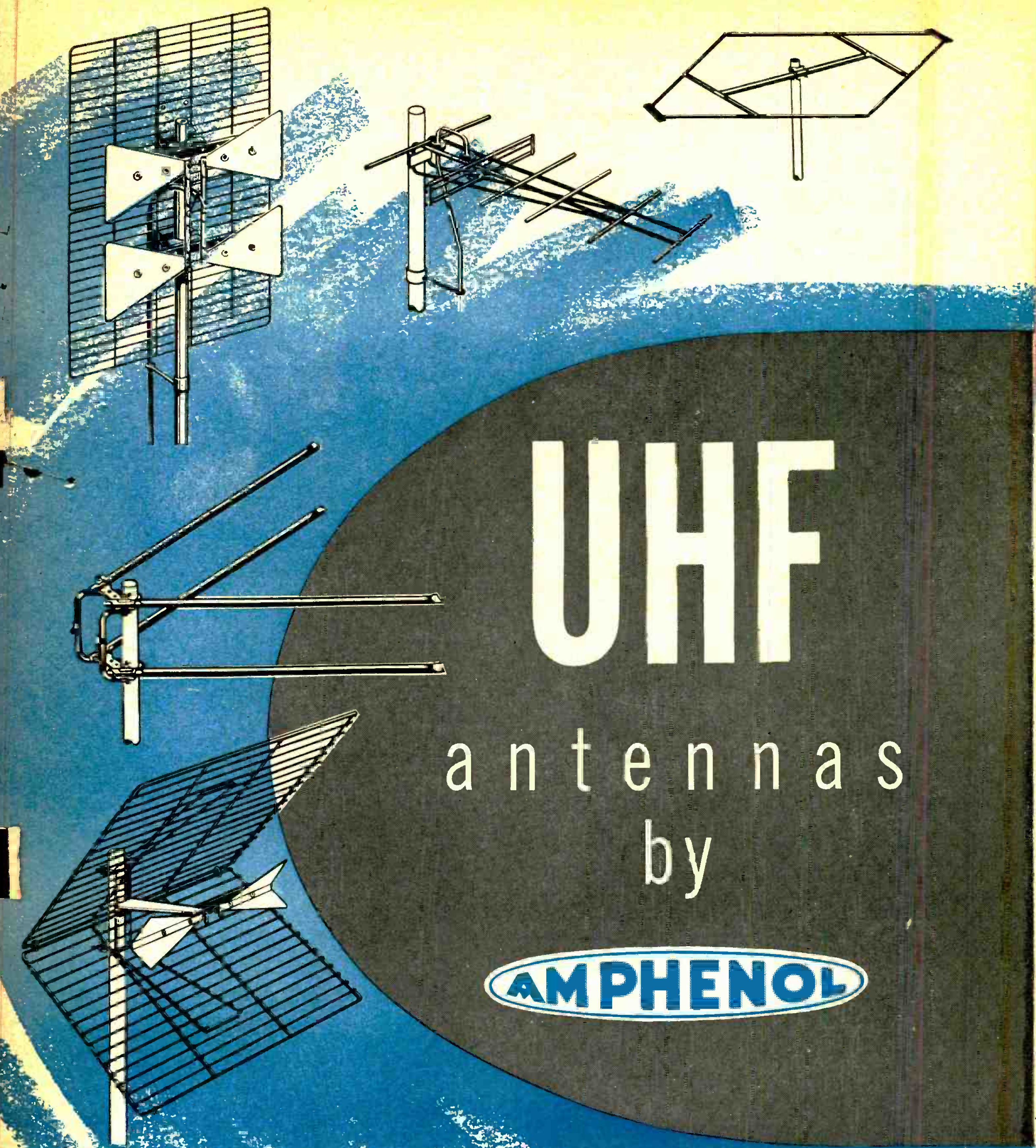
LaPointe Electronics, Inc., 155 W. Main St., Rockville, Conn., has added the Delta X 10-element Yagi to its Vee D-X line. Wide element spacing on the high channels, all-aluminum construction, and boom struts are some of its special features.



OSCILLOSCOPE KIT

Electronic Instrument Co., Inc. (EICO), 84 Withers St., Brooklyn 11, N. Y., has announced the model 470, 7-inch oscilloscope in kit and wired form. It features a boosted vertical sensitivity of 10 mv rms/in. and an extended flat frequency response of 10 cycles to 1 mc (± 2 db). There is a 3-step frequency-compensated attenuator input to vertical channel and cathode follower inputs to push-pull vertical and horizontal amplifiers. There is a wide range of gain control without frequency distortion in both amplifiers.

The wide-range, multivibrator-type



UHF television is an exciting new field for dealers and there is sure to be a growing demand for quality UHF antennas. AMPHENOL has prepared for this with the five UHF antenna designs pictured on this page. At the May Parts Show your distributor will meet with AMPHENOL's antenna experts. They will discuss the values of each of these antennas and their market potentialities in your particular territory. Be sure to contact him for the full UHF story.

AMERICAN PHENOLIC CORPORATION *chicago 50, illinois*

The photo shows the oscillator components removed from the 1¾ x 7-inch metal shell. More than one-half the space is occupied by the crystal in its evacuated glass envelope. The transistor, coil, capacitors, and resistors are mounted on a bakelite frame which may be potted for rigidity. The mercury cell, only about ½ inch deep, is at the base of the assembly and is insulated from the metal shell can by a bakelite shield.

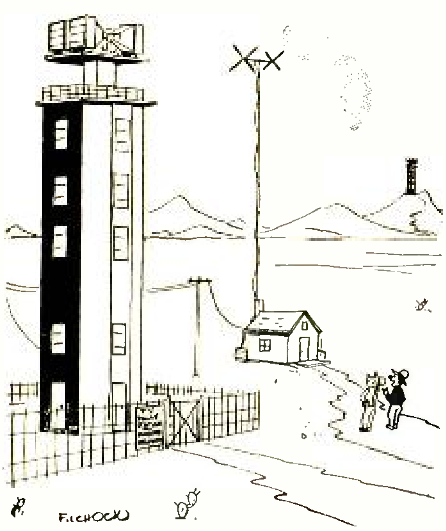
SCOPE MEASURES D.C.

The input to an oscilloscope amplifier usually includes a blocking capacitor, so it cannot be expected to transmit d.c. You may have noticed, however, that if you impress d.c. (or any signal that contains a d.c. component) you get a momentary vertical shift in the trace. Similarly, there is an opposite vertical deflection when the signal is removed or shorted out. Although the capacitors block steady currents, they do pass the square wave generated when d.c. rises and falls.

Nobody seems to have thought of it before, but this simple principle is useful for measuring the d.c. component of any wave. R. Stuart Mackay of the University of California points this out in *Electronics* for December, 1952. He controls a multivibrator to short out the vertical input of a scope during alternate sweeps. His pattern not only traces the *a.c.* waveform of a signal, but it indicates the level of the *d.c.* component as well.

During one sweep, the scope input terminals are shorted out, so the trace is a horizontal line along the zero-signal axis. During the next sweep the short is removed, and there is a quick vertical deflection of the beam proportional to the d.c. component of the signal. The a.c. component is traced above or below the X axis, depending on whether the d.c. component is positive or negative. In other words, the a.c. "rides" a square wave whose amplitude is the d.c. level.

Mr. Mackay shows interesting control circuits and typical patterns obtained by his method.—*I. Queen*



"I'm a thousand miles from the nearest television station, but, Boy, what reception I get."

NBS TRANSISTOR OSCILLATOR

A number of laboratory technicians and independent research workers have been experimenting to produce new circuits and applications for the transistor. Much of this work has been toward the development of oscillator circuits. You will recall that six crystal-controlled transistor oscillators were described in the article "Transistor Oscillators with Crystal Control" in the April, 1952, issue.

Peter G. Sulzer of the National Bureau of Standards has developed a new transistor-type crystal oscillator that is small, portable, dependable, self-contained, and highly accurate over long periods of time. All components, including the power supply, are housed in a metal tube about 7 inches long and less than 2 inches in diameter.

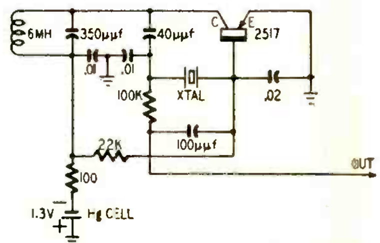


Fig. 1—Schematic of the highly-stable transistor oscillator developed at NBS.

The diagram of the oscillator is shown in Fig. 1. The major components of the unit are a type 2517 junction transistor, a GT-cut precision 100-kc crystal, and a long-life mercury cell. The cell supplies power to the entire unit (1.35 volts at 100 µa) with an active life of five years or more.

The .01-µf capacitors connected to ground from each side of the crystal maintain a constant phase shift in the crystal feedback loop to insure high frequency stability which is maintained by using highly stable components in the balance of the circuit. Amplitude stability is obtained by operating the transistor so that collector-voltage limiting is produced.

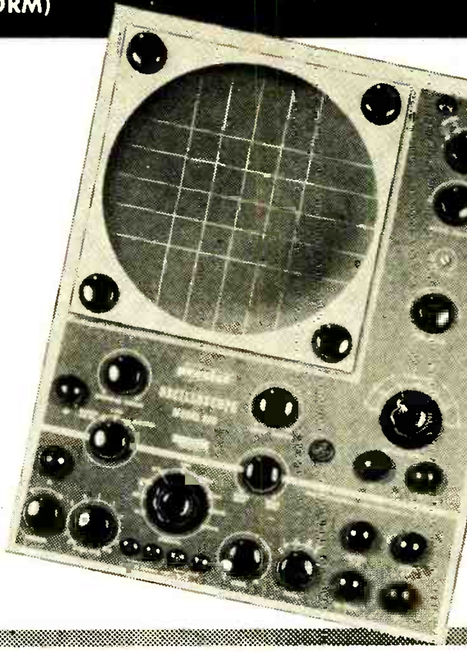
The transistor is operated in a grounded-emitter circuit. It develops 0.8 volt across the tuned circuit connected to the collector. Driving current for the crystal (less than 100 µa) is obtained from a capacitive voltage divider consisting of the 40-µµf and .01-µf capacitors connected in series between the collector and ground.

Measurements of frequency with changes in temperature and voltage indicate that the frequency varies approximately 1 part in 10^8 per degree Centigrade and 1 part in 10^8 per 0.1 volt. Short-time variations are about ± 3 parts in 10^{10}, and long-interval drift indicates changes of about 3 parts in 10^9 per 24 hours.

Oscillator assembly. Glass bulb houses control crystal; mercury cell at right.

NEW... AMAZING... OSCILLOSCOPE by precise

(IN KIT AND WIRED FORM)



SPECIFICATIONS: PRECISE MODEL 300 OSCILLOSCOPE —

VERTICAL — Vertical-flat (3db) DC through 5 megacycles with sensitivity of greater than 10 millivolts push-pull; Push-pull Input immediately converted to single-ended normal or reverse phase; Frequency compensated vertical stepping attenuator; DC amplifiers from input through output.

POSITIONING — Bridge type positioning on vertical and horizontal does not vary tube characteristics.

HORIZONTAL — Push-pull Horizontal out.

BLANKING — Internal (return trace blanked), external (return trace not blanked), 60 cycle or 120 cycle Blanking through Blanking amplifier circuit.

SYNCHRONIZATION — External, Internal Positive, Internal Negative, Internal 60 cycle or Internal 120 cycle synchronization.

SWEEP RATE — Driven or non-driven linear sweeps from 1 cycle to 80KC in five ranges (1-10 cycles uses external C circuit); Trigger potentiometer.

MAGNIFIER — Electronic magnifier and magnifier positioner allows any part of a signal to be magnified up to ten times (equivalent to 70 inches of horizontal deflection).

CALIBRATION — Internal square wave calibrator and potentiometer; Edge-illuminated scale.

OUTPUTS ON FRONT PANEL — Plus Gate output; Sawtooth output; 60 cycle phasing output; 60 cycle unphased output; Calibration output.

FOCUSING — Astigmatism, focus and intensity control.

CRT — NEW 7" Tube, normally supplied is medium persistency type 7JP1 (oscilloscope green trace) — high persistency types available at additional cost.

INTENSITY MODULATION — Z modulation through modulation amplifier.

GENERAL — Low loss components; Over-designed fused power supply for additional circuitry; Deeply etched aluminum panel; New parts from original manufacturers — (NO SURPLUS).

300K—kit form .... **$94.95** 300W—factory wired **$199.50**

PRECISE TEST EQUIPMENT AVAILABLE IN KIT AND WIRED FORM

MODEL 630 RF-AF-TV AND MARKER GENERATOR. For the first time in the history of the industry . SO MUCH FOR SO LITTLE 110 MC on fundamentals. 330 MC on harmonics; Pre-tuned RF (within 1%) head*; AF from 20 to 20,000 cycles; variable % and Ext. Mod.; Cathode-Follower and Constant Z output; Stepping attenuator; Speech Amp.; Xtal Marker with Amp. control; RF and AF Standby; Wien Bridge AF; Colpitts RF; Illuminated Drum Dials; Coax outputs; Separately tuned coils; Filtered AC; Vernier tuning; Separate RF; Shielded; 8" x 11" x 5"; Etched panel.

*Model 630KA $38.95 (pre-assembled head)
Model 630W $53.95 (Factory wired)
Model 630K **$33.95**

MODEL 999 HIGH VOLTAGE PROBE. Designed for high voltage measurements with special emphasis on Safety, Operational Simplicity and Rugged Construction. Exclusive Features: MULTIPLE INSULATION, MECHANICALLY SHOCKPROOF; CHANGEABLE TIPS; SWIVEL connection. Odds are billions of billions to 1 that no breakdown will occur! INTERCHANGEABLE RESISTORS Wired Only **$6.98**

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MODEL 912 RF PROBE. LOWEST PRICED, factory wired Probe in the industry. Individually calibrated at 75 MC for accuracy, impedance and shunt capacity.
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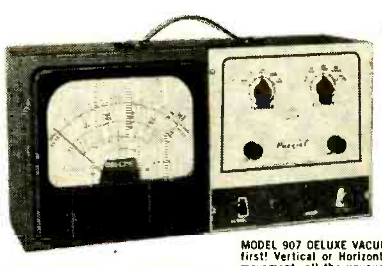
MODEL 960 CAPACITY ATTENUATOR PROBE. Reduces input C. and loading effects of an oscilloscope by 10 to 1. Adjustable for any scope. Lowest priced in the field, but still using highest quality components.
Wired Only **$5.95**



MODEL 610 RF SIGNAL GENERATOR. The lowest priced signal generator in the field offering:—Same RF head as Model 630; 110 MC on fundamentals; 330 MC on harmonics; 60 and 400 cycle AF; Cathode-follower output; Ext. Mod.; Speech Amp.; Individually tuned coils.
Model 610KA $28.95 (pre-assembled head)
Model 610W $39.95 (wired)
Model 610K **$23.95**

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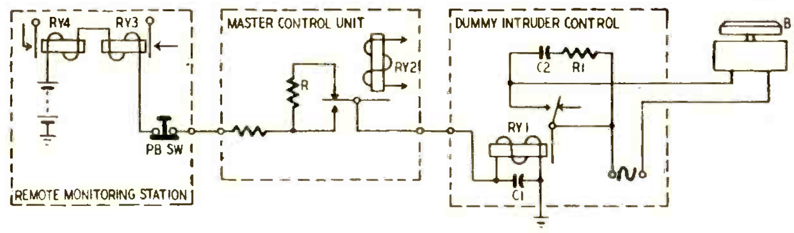
BURGLAR-ALARM TESTER

Patent No. 2,615,970
Samuel M. Bagno, Astoria, N.Y.
(Assigned to Alertronic Protective Corp. of America)

This unit tests ultrasonic burglar alarms. Before discussing the testing unit, we will describe briefly how this type of alarm functions. An ultrasonic generator emits vibrations inside a vault or other room to be protected. The high-frequency waves are reflected at all angles from the walls and furniture so the entire room is saturated. As long as all objects in the room are motionless there will be a pattern of standing waves, and the average energy at any point in the room will be constant. If an intruder enters and moves around the room he will change the wave pattern, and vary the energy distribution. A detector indicates these changes and sets off an alarm. For testing the system a rotating vane under the control of a distant operator is used as a "dummy burglar." When he turns it on, the vane modulates the standing-wave pattern just as if an intruder had entered the room. When the alarm sounds, it notifies the operator that his equipment is in working order.

The testing circuit is shown in the diagram. B is the burglar tester. The a.c. line to the tester motor is normally held open by relay RY1. This relay is energized by the battery at the remote monitoring station. When the operator opens the push-button switch PB momentarily, capacitor C1 discharges rapidly through the relay winding and releases the relay armature. This closes the circuit to the tester motor. The two series resistors in the master control unit prevent the capacitor from recharging instantly and opening the motor circuit when the push-button is released.



RY2 is energized by the ultrasonic detector, and shorts out one of the series resistors, increasing the current in the circuit enough to energize alarm relay RY3. RY4 is an undercurrent alarm relay which operates if the circuit is interrupted or cut deliberately.

At the end of the time interval required to recharge capacitor C1, (usually one or two minutes) RY1 opens the a.c. line and shuts off the tester motor. R1 and C2 prevent sparking at the relay contacts which might affect the operation of the tester.

NEWS SERVICE BY TV

Patent No. 2,623,117
John Hays Hammond, Jr., Gloucester, Mass.

This invention anticipates a demand for transmitting newspapers into the home by TV. It suggests an arrangement whereby the printed matter is received automatically.

A control audio signal precedes transmission of the news sheet. It activates the receiver and prepares it to pick up and record the copy. As the sheet is scanned on the receiver kinescope, a camera photographs it. Further means then provide for automatic processing so the news sheet will be available when the TV viewer is ready for it.

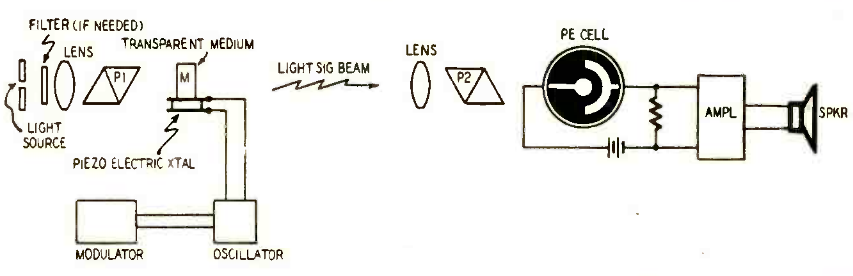
At completion of the newspaper the TV receiver automatically returns to its normal condition for reproducing regular programs when turned on by the viewer.

LIGHT BEAM MODULATION

Patent No. 2,623,165
Hans Mueller, Belmont, and
Robert H. Rines, Brookline, Mass.

Signalling with light beams has been known and used for a number of years. This method permits modulation over a wide frequency range with low noise level and may be used for secret communication over short distances. Either visible or invisible light may be used.

The light source may be a mercury arc, for example. It transmits light through a lens and a M is mounted on a piezo-electric crystal fed from an ultrasonic oscillator. When the crystal is energized, standing waves exist in the glass. These vibrations affect the refractive index of the glass, and as a result the light in M is no longer plane polarized. Consequently, the beam is no longer extinguished by P2, and light falls on the photocell. Actually, the illumination will consist of alternate



polarizer P1. This may be a Nicol prism or piece of Polaroid. The transparent medium M may be glass since we are assuming visible rays. At the receiver, a second lens and polarizer P2 intercept the beam. Output of the photocell is amplified.

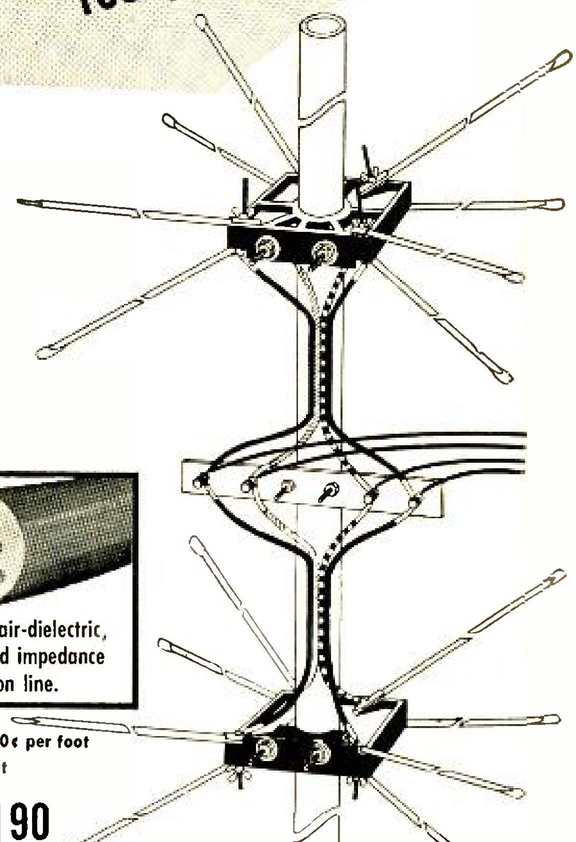
Two pieces of Polaroid can be set to extinguish a light beam which is passed through both. P1 and P2 are oriented so that normally no light falls on the photocell.

light and dark stripes. The dark stripes correspond to standing wave nodes in M. These points do not vibrate and cannot change the polarization of the light waves. The intensity of illumination of the light stripes varies with modulating energy fed to the crystal. If audio modulation feeds the oscillator, the photocell output follows the modulated signal. The audio component is extracted by a detector. END

Concord Radio presents the world's most powerful TV antenna!

22 Db gain over tuned dipole!

motorless all-direction UHF-VHF-FM reception



- Guaranteed 10 times more powerful than stacked 10 element Yagis.
- Receives channel 2-83 from all directions without a rotor.
- Broadband UHF-VHF and FM, motorless all direction reception.
- All aluminum flip-out assembly.

The only TV antenna that instantly beams the television set directly to the signal without a rotor. This antenna brings strong UHF & VHF signals from all directions to weak signal areas instantly . . . with a flick of the nine position switch located near the television set.

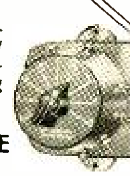
Approx. 300 Ohms between every two of the four conductors.

Four conductor air-dielectric, tubular, matched impedance transmission line.

4 Conductor Tubular Wire 10¢ per foot
$8.90 per hundred feet

$21.90
Dealer Price

Includes Stacked Antenna Array. 9 Position Switch. Completely Wired Stacking Harness. A.I.M.—Automatic. Impedance Matching Coupler.



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ALL CHANNEL ANTENNA CORP.

Woodside, N.Y. under license Pat. No's 2,585,670. 2,609,503. 2,625,655. others pending.

MONEY BACK GUARANTEE To out-perform all other antennas (using rotor motors) on both UHF and VHF, including stacked ten element Yagis, stacked corner and bow-tie reflectors, four bay conicals, etc.

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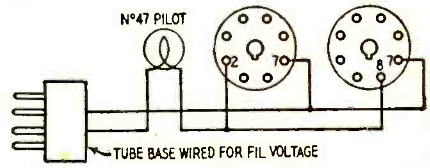
Address______________________________
City____________________ State__________
☐ Check Enclosed ☐ Money Order Enclosed
☐ C.O.D. enclosed please find 25% of total purchase price . . . check . . . Money Order.
☐ Please put my name on your "Special Bargain" mailing list.
( ) Enclosed find $________ in full. Send prepaid.

TRY THIS ONE

TUBE-HEATER CHECKER

The most common trouble in a.c.-d.c. sets is an open or intermittent heater in one of the tubes. Usually we use one of the following time-consuming methods to locate the faulty tube: (1) Test each tube in the tester. (2) Substitute good tubes until we find the bad one. (3) Check each tube heater with an ohmmeter. (This involves holding the tube in one hand while trying to connect the ohmmeter prods to the proper tube pins with the other hand.)

Since the service charge for many of these jobs is limited to the cost of the replacement tube, such jobs must be completed as rapidly as possible. You can speed up the job of locating bad tubes by constructing the tube-tester adapter shown in the diagram. It will locate open and intermittent heaters almost as fast as you can plug a tube into the socket.



I use two octal sockets on the adapter: One for 50L6's and other tubes which have heaters connected to pins 2 and 7. The other is wired for tubes with heaters connected to pins 7 and 8. The plug is wired to tap filament voltage from a vacant socket on the tube tester. I use 12.6 volts to check the heaters of all 12-, 25-, 35-, and 50-volt tubes. The pilot lamp lights to indicate continuity through the tube heater circuit.

Of course, loktal, miniature, or any other types of sockets can be added for checking tubes with these bases.—*Marty Arslan*

ALUMINUM PAINT SHIELDING

Audio equipment operated in the vicinity of an AM transmitter is often subject to a buzzing type of interference caused by a lack of proper shielding. This is especially true of some tape recorders and portable phonographs manufactured for home use. These may be effectively shielded by painting the inside of the case with an inexpensive aluminum paint. The paint must be well grounded to the amplifier chassis. One of the easiest ways of doing this is to fasten a piece of spring brass to the inside of the case and position it to touch the chassis when the unit is assembled.—*Ken Maxwell*

DAMPER FOR V.T.V.M.

Contributors to RADIO-ELECTRONICS have recommended setting the selector switch of a v.o.m. to a high-current range or any other setting which will damp the meter movement while it is being transported. In a v.t.v.m., damping can be applied by replacing the usual s.p.s.t. power switch with a d.p.d.t. The extra section of the switch can be wired in so that it shorts the meter when the meter is turned off.—*Jordan Holtzman*

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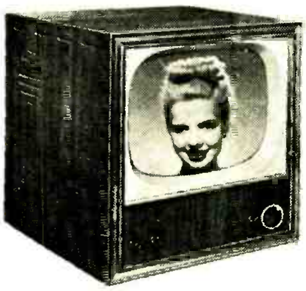

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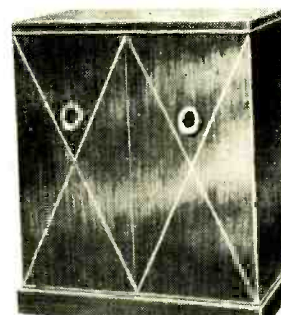

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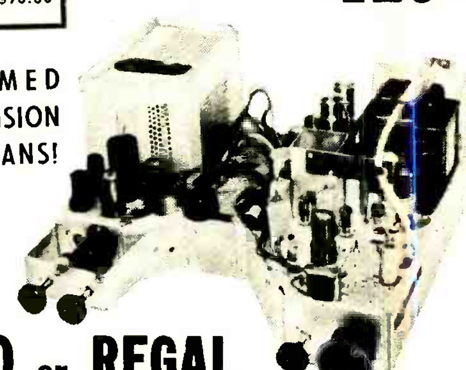

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TRY THIS ONE

THE BUZZING 50L6-GT

Some 50L6-GT's check O.K. but cause a loud buzz from the speaker when used in a set. I had another one of these the other night, and decided to see what I could learn about it. I found that when I placed my thumb directly on top of the tube the buzz was greatly reduced, but when the line plug was reversed in the wall outlet and the thumb again placed on top of the tube, the buzz was worse than before.

Balancing a small chunk of iron on top of the tube had little effect on the buzz. A metal shield over the tube reduced it, but only when the hand did not contact the chassis and while the plug was in the outlet a certain way. By now, it was clear that the matter was becoming quite complicated! Then I spied an Alnico-V slug that I had removed from a small PM speaker and decided to see what effect it would have. Eureka! When the magnet was balanced on top of the tube the buzz disappeared! The buzz was gone for good; it wasn't necessary to touch anything, and the polarity of the power cord made no difference. I immediately formed a coil spring from 18-gauge bare copper wire to hold the magnet securely in position on top of the tube.

What causes the 50L6 buzz, and how does the magnet kill the buzz? I talked to several other technicians and got several different answers, but none of them seemed to know for sure. The guilty 50L6 was checked in a good tube tester but that didn't throw much light on the subject. The tester showed no heater-to-cathode short, but occasionally showed temporary shorts or leakages between various other elements. The 50L6 was tried in several other sets, but each time there was a loud buzz and adding the magnet killed it completely.

It was later learned that the 50L6 buzz was most likely due to Barkhausen oscillation, and that the magnet served the same purpose as the one that is sometimes used on horizontal output tubes. Right or wrong? At any rate, this is a good trick to remember when you run across a similar situation.—*Arthur Trauffer*

HANDY "CHECK" CLIPS

I have a number of small clips which I have marked in pairs with identical codes. For example, I have two A's, two B's, two 1's, two 2's, and so on. These are handy when I disconnect a number of leads or components to get at a defective one or when a component is removed from the chassis for a critical check.

If I remove a component from between two points in the circuit, I use a pair of clips to mark these points. Then, all I have to do is to make a note of the value of the component. In the case of leads which must be disconnected, I fasten one clip to the loose end of the lead and its mate to the end to which the lead connects.—*A. von Zook*

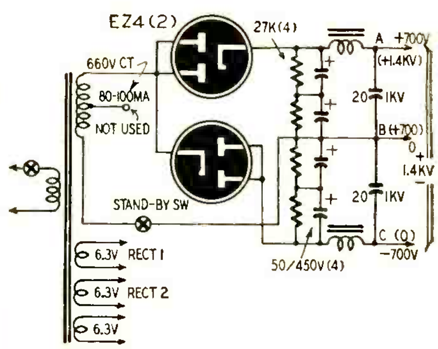
END

ferent power lines where the voltage may vary, this is a considerable advantage.

This circuit was tried out on an Emerson model EB344 receiver. A 6-watt, 117-volt bulb, used for a pilot light, carried the filament current with just enough voltage drop to give 7 volts at the high-voltage end of the series filament string. When the power-line voltage at the receiver was varied experimentally, the filament voltage did not change as much as when an ordinary resistor was substituted in the same circuit.—*Albert Rees*

SCOPE POWER SUPPLY

The design and construction of a high-voltage supply for oscilloscopes often presents a number of problems to the average experimenter or constructor. High-voltage transformers for scopes are rather expensive and are difficult to purchase because many radio parts distributors do not stock them. An Italian amateur, I1CEO, describes in the magazine *L'antenna*, how



he obtained operating voltage for a 7JP4 from a small receiving-type power transformer and a full-wave voltage doubler. The circuit shows how the supply can be used to deliver up to 700 volts positive and negative with respect to a common point, or 1,400 volts positive or negative, depending on which end of the circuit is grounded. The voltages in parenthesis are measured with respect to lead C and the others are measured to lead B. Voltage dividers can be connected across the output terminals to obtain intermediate voltages.

The EZ4 is a European-type full-wave rectifier with an indirectly heated cathode. It is designed for a maximum load current of 175 ma and a maximum of 350 volts per plate. Similar types such as the 6X4, 6X5-GT, and 6AX5-GT may be used in this circuit.

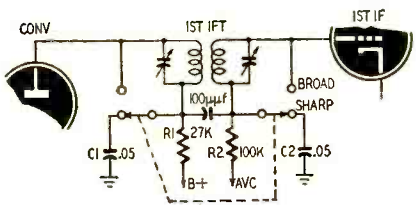
The filter chokes should have an inductance of at least 6 henrys and should be able to handle 80 to 100 ma. The insulation resistance of the chokes depends on the circuit application. If lead A or C is grounded, the choke in the other lead should be insulated for at least 3,500 volts. The choke in the grounded lead does not present any particular insulation problems. If lead B is grounded, the chokes need not be insulated for more than about 1,500 volts.

The filament windings supplying the rectifiers should be insulated for 3,000 volts or more. If the filament windings for the rectifier are on the power transformer make sure that the insulation is adequate or use a separate dual-secondary filament transformer.

VARIABLE SELECTIVITY

The response of a simple superhet receiver can be broadened so that it compares favorably with that of a simple t.r.f. by making an easy modification described by PAØXE in *Radio Constructor* (London, England).

The circuit shows how the coupling between the converter and the first i.f. amplifier is converted from the conventional transformer coupling in the SHARP position to resistance-capacitance coupling when the switch is in the BROAD position. R1 is the converter plate dropping resistor and C1 is the plate bypass capacitor. R2 and C2 make up the a.v.c. filter. A 100-μμf capacitor is connected between the lower ends of the i.f. transformer windings. When the switch is in the BROAD position, the transformer windings are shorted out and R1 and R2 become the plate load and grid resistors, respectively. The 100-μμf capacitor couples the converter plate to the i.f. amplifier grid.



The selectivity switch and the resistors must be mounted close to the bottom of the first i.f. transformer with very short leads between them. This may make it necessary to relocate the resistors and use a wafer type switch with a long shaft protruding through the front panel or the rear chassis skirt. Keep the switch leads well away from the plate circuit of the i.f. amplifier. If the leads are too long or are allowed to run close to the i.f. amplifier plate circuit, feedback is likely to occur in the i.f. amplifier. END

"What did the repairman think of your suggestion, dear?"

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THE EDITOR
RADIO-ELECTRONICS
25 West Broadway, New York 7, N. Y.

STACKING RHOMBICS

? I live in a hilly area about 100 miles from New York City. My problem is the proper installation of a rhombic antenna for TV reception. Since I have only enough space for about two wavelengths (28 feet) in each leg, I would like to know if I can get the same amount of gain by stacking as I would by using a single rhombic with four wavelengths in each leg? If this can be done, what is the minimum height of the bottom antenna and what is the spacing between the two?

Since a rhombic uses the sky-wave to a great degree, I assume that the plane of the antenna should be parallel to the earth. Is this correct?—G. M. A., Kingston, N. Y.

A. A search of antenna handbooks and texts did not turn up any reference to vertical stacking of rhombics, although they have been "stacked" horizontally in some installations. V-antennas have been stacked with a 3-db increase in the gain over that of a single antenna alone, so there does not seem to be any reason why vertically stacked rhombics will not give the results that you desire. Stacking should give a theoretical increase of 3 db. See page 51 in this issue.

The spacing between the two antennas should be one-half wavelength. They should be connected by a half-wavelength matching section consisting of No. 14 wires spaced 10 inches apart. Connect a 300-ohm transmission line to the mid-point of the matching section.

A rhombic antenna may not work out as well as desirable in hilly country or in an area where the forward end of the antenna is close to buildings, heavily wooded areas, or similar obstructions. The land in front of the antenna should be level and free of obstructions for at least one-half mile. Isolated trees and small frame structures have negligible effect on the performance of the antenna. If the antenna site and the area immediately in front are free of obstructions, then the antenna will probably work best with its plane approximately parallel to the earth. In any event, it will be worth while to try lowering the terminated end of the antenna while observing the variations in signal strength.

It may be worth while to try operating the rhombics with the terminating resistors shorted out. This increases the gain by 3 db and makes the array bi-directional.

Do not expect a rhombic or any other wide-band antenna to retain its original bandwidth-gain characteristics when stacked or connected to a transmission line through a matching section.

Quarter-wavelength sections of transmission line have the desired impedance transformation characteristics only at frequencies where the length is an odd number of quarter-wavelengths long. At other frequencies, the poor efficiency of the matching section may cause ghosts and a drastic deterioration in over-all antenna performance.

INTERMITTENT PICTURE

In an Admiral 121K16 receiver I am getting intermittent reception on channels 3 and 6. The other station (channel 10) can be received at any time and is not affected. If I turn the receiver off for a few minutes and back on again, the picture will reappear. If I turn to another channel and back to 6, the picture disappears but the sound remains. If I turn to channel 3 I receive no sound and picture, though repeating the procedure may bring both sound and picture on channel 3. Incidentally, how long will it be before the picture tube can be handled without danger from shock after the set has been turned off?—C. S., Columbus, Ohio.

The fact that the picture will disappear and reappear when changing channels but is always present on channel 10 as opposed to channels 3 and 6 would indicate defects in the tuner. Check the tubes in the tuner and also make sure they are firmly seated in their sockets. Also see if there are loose connections or defective components in the tuner, particularly the channels 3 and 6 coil strips and their contacts. Make sure the coil drum is correctly seated so the coil-strips make perfect contact with the fixed contacts in all channel positions.

If the trouble is traced to dirty contacts, clean them and then install one of the new contact-cleaner strips designed for use in the turret-type television tuners.

There may also be some defect in the a.g.c. circuit, and this should be checked for intermittent capacitors, loose or cold-soldered joints, or poor socket contacts.

The length of time required for high-voltage charges to leak off after shutting off the receiver depends on the type of bleeder network (if any) in the system. Most tubes with outer conductive coatings will hold a charge for some time. Before handling the tube, short the high-voltage contact point to the outer conductive coating with a length of wire. The high-voltage filter capacitor can also be discharged in this manner after the receiver has been shut off.

BRIGHTNESS DELAY

In an Emerson 1951 model using a 17-inch tube there is considerable delay before the picture comes up to maximum brightness. The picture tube is new and I've tried new tubes in the high-voltage circuit but this did not help. Other than the delay the receiver operates perfectly. What would cause this? J. K., Cincinnati, Ohio

As you suspected, the delay in brightness is caused by the slow build-up of high voltage. As you have tried a new horizontal output tube, high-voltage rectifier, and damper, the trouble is probably in the horizontal oscillator circuit. A delay in the output of the horizontal oscillator prevents high voltage from being generated because of the flyback process. Try a new horizontal oscillator tube, and if this doesn't help, check B voltages and component parts.

HV ARCING IN TV

In a Tele-King receiver, Model 616, a loud noise is heard before the picture comes on. I have made tube replacements but it did not help. What could cause this condition? A. M., Brooklyn, N. Y.

The noise you hear when the set is first turned on could be the result of a high voltage arc. After the set is turned on there is a slight interval during which the tubes heat up and there is no load on the power supply. The high voltage potential is at its peak and may arc. After the tubes have warmed up the load reduces the high voltage below the arcing level. Check the high voltage wiring and space all leads carrying the high voltage potential from the chassis. Make sure there are no sharp bends in the high-voltage leads. Also check for sharp points on soldered joints. Inspect the high voltage some one turns the set on to see if you can ascertain where the momentary arcing occurs by the visible flash, or compartment in a darkened room while a bluish haze which denotes corona.

UNSTABLE LINE VOLTAGE

? *The line voltage here is very unstable. It sometimes drops to around 90, remains there for about an hour, then suddenly surges to about 150, slowly dropping again to around 125. These voltage surges cause radio tubes to burn out and other components to fail. Can you recommend an automatic line-voltage regulator which I can use to prevent premature tube burnouts and component failures on a Hallicrafters S-40-B receiver which draws 75 watts from the line? I would like to have something that can be purchased or constructed for around $10.—J. T. K., Yuma, Ariz.*

A. A constant-voltage transformer would probably be the ideal solution to your problem, but one that will handle 75 watts will cost nearly four times the amount you want to spend. The next best bet is a line-voltage ballast like those manufactured by JFD, Clarostat, ICA, Amperite, and others. These units are a great help in protecting equipment against line surges but they are not effective in controlling line voltage that is too low. They are available with different wattage ratings for much less than the sum you are prepared to pay.

TV IGNITION INTERFERENCE

? *I live about 100 feet from a heavily traveled highway and am having trouble with ignition interference on my TV set. Can you recommend a circuit that will make my receiver immune from this trouble?—F. W. L., Richmond, Va.*

A. Ignition interference is most noticeable when the TV signal strength is low. Most interference-elimination measures are aimed at increasing the strength of the desired signal while eliminating or attenuating the interference.

The first step is to overhaul the antenna system. Clean the antenna terminal block to remove all deposits of dirt, soot, and grime. Remove rusted terminal bolts and nuts and replace them with rustproof types. Check the lead-in for breaks and sharp bends, and make sure that it does not run close to any large pieces of metal. Use stand-off insulators to keep it at least 8 inches away from metal gutters, downspouts, flashings, and the like. If you are using ribbon type lead-in that is more than 18 months old, replace it. Twist the lead-in once for each two feet of length. Make a good electrical connection between the line and the antenna terminal block. Carefully orient the antenna for maximum signal pickup. Try raising and lowering the antenna a few feet and moving it a few feet in each direction from its present location. The present antenna may be in a relatively dead spot. A complete relocation of the installation may be desirable to increase TV-signal pickup, and especially to increase the distance of the lead-in wires from the highway.

If interference is still present after overhauling the antenna, much of the trouble may be in the receiver. If the interference is in the form of loss of sync or tearing of the picture, check the tubes in the tuner, video i.f., sync, and sweep circuits. Replace any tubes that are weak. Check components and voltages in the horizontal sync and oscillator circuits against manufacturer's service data. Realign the sync circuit if necessary. Do not undertake this adjustment unless you have the equipment the manufacturer recommends for the job. Check the a.g.c. circuit to see that it is operating properly and that the area selector switch or control (if any) is set to the proper point.

If the interference takes the form of machinegun-like reports from the speaker, the trouble may be in the sound i.f. circuits of the receiver. Replace weak tubes and carefully realign the sound i.f. strip. Feed in a modulated signal at the sound i.f. and check the circuit for AM rejection. If the rejection is not good, check components' values and operating voltages against manufacturer's data.

Some makes and models of receivers are more sensitive to ignition interference than others. You may have one of those which tears or jitters whenever a car passes. If this is the case, try to find out if your neighbors are having the same trouble. If you find that some of them are not having this trouble, it might be advisable to try a set of the same make and model as theirs. END

ager of the Cathode-Ray Tube Division, was promoted to vice-president in charge of manufacturing electron tubes, and **Kenneth C. Meinken, Jr.**, vice-president in charge of equipment sales, takes on added responsibilities as vice-president in charge of equipment and renewal sales.

. . . **Alden R. Joy** and **Roland J. Melanson**, former junior engineers with CLAROSTAT MANUFACTURING Co., Dover, N. H., were promoted to senior engineers.

. . . **W. H. Hazlett**, **R. W. Amos**, and **W. H. Johnson** joined the sales staff of ALTEC LANSING, Beverly Hills, Calif., to help its national distributor, Graybar Electric Co., in promoting sales of Altec products. Hazlett, formerly with Audio Video Products, will be located in New York City; Amos, formerly a sales representative for Altec Service Corp., will have headquarters in Dallas; and Johnson, ex-Webster Electric, will be located in Chicago.

. . . **John Stearns Johnson**, an executive of United States Rubber Co., was elected to the Board of Directors of the NATIONAL COMPANY, Malden, Mass.

. . . **Myron T. Smith**, former sales engineering manager of the GENERAL RADIO Co., Cambridge, Mass., was upped to the post of sales manager. S. W. DeBlois, in charge of export sales, was promoted to export manager.

. . . **Albert F. Watters**, formerly director of personnel for the RCA VICTOR DIVISION, Camden, N. J., was elected vice-president in charge of personnel for the division.

. . . **Harry T. Hagerty** joined the Equipment Manufacturers Sales staff of MAGNATRAN, INC., Kearney, N. J., transformer manufacturers. He had been with Federal Telephone and Radio.

. . . **Herman K. Burgett** was appointed manager of industrial relations at the newly acquired Batavia, Ill., tube plant of the CROSLEY DIVISION of Avco Manufacturing Corp. He was previously assistant to the manager of industrial relations at the Crosley Spring Grove plant, No. 7, in Cincinnati.

. . . **Edward M. Tuft** was elected vice-president in charge of personnel (including labor relations) of the RADIO CORPORATION OF AMERICA. He was formerly vice-president in charge of organization and development of the RCA Victor Division.

END

TV Service Technician

By JEANNE DEGOOD

A man who buys the tubes and tools
With cash from his small revenues,
And works to fix the sets of fools
Who try to pay with IOUs.

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COMMUNICATIONS

CRYSTAL STILL ALIVE

Dear Editor:

I read with great interest the article "DX Crystal Radio Receiver," by Joseph Amorose, in the October issue.

It is gratifying to note that interest in this fascinating hobby has not died. The hobby is still actively pursued by many hams and electronic engineers such as Rufus Turner, Dr. William Grace, and Milton M. Schuman.

M.R.L. Laboratories in California and Amorose Radio in Richmond, Va., supply parts to thousands of crystal hobbyists.

These experimenters, like myself, deplore the fact that so little space has been allotted in electronic magazines to this hobby and we look forward to more articles on crystal sets in yours.

JERRY PAOLA
Baltimore, Md.

CALIFORNIA COMPLAINS

Dear Editor:

I have been a subscriber to RADIO-ELECTRONICS for years, and lots of other technicians feel the way I do—that it's part of the shop.

Well, here's what gripes me and the rest of us out here: Some outfits are offering $2.00 to $2.50 service calls—"Fix it in the home or *no charge*." One chain outfit advertises "Ten TV Services in Your Own Home—All for $1," and some are even making service calls *free!* Now, can you tell me how anyone who wants to be square and honest can stay in business with this going on?

They advertise over the radio: "Just bought a carload of TV sets! We're selling them *below cost!*" (Of course, they don't tell you that these are last year's models—never the newest sets—and most of the listeners don't know the difference.) They even give away free TV lamps, silverware, and a 2-year warranty on sets.

I am not much at writing, but you know how to come back at these practices. There has to be a catch somewhere—they just can't give things away on this scale!

A DISABLED VET
Los Angeles, Calif.

(As we have reported frequently in our column "With The Technician," Better Business Bureaus, local technicians' associations like ARTSNY (New York City) and TISA (Chicago), and dealer organizations, have publicly denounced many of these advertisers, and in several cases have co-operated with law-enforcement agencies in obtaining convictions for fraud and larceny. It is up to reputable technicians to unite and combat these practices with adequate publicity and the establishment of scrupulously fair standards. Unfortunately, large segments of the public are always lured by "bargain" offers, and lack the courage to admit that they have been victimized when a one-dollar service call turns out to be a staggering bill for alleged repairs. One way to help save these people from themselves —and insure the survival of the honest technician—is a campaign of education and the establishment of local complaint bureaus.—*Editor*)

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RADIO CORPORATION of AMERICA

ELECTRON TUBES — HARRISON, N.J.

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