Service Check List for Transistor Radios

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- Speech-Music Discriminator for Music Lovers
- TV Receivers with Remote Controls
- Set Your Checker for New Tube Types

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ON THE COVER
(Story on page 37)
These experimental prototypes of antennas for use in over-the-horizon communications systems are set up at IT&T's Federal Telecommunication Laboratories, Nutley, N. J. Marie Grey, of Federal's drafting department, is studying the construction.
Color original by Dean Price.
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ALL-UHF TV SYSTEM has been proposed by the FCC. Faced with a difficult problem of allocations, the commission has asked for all comments on the proposal by Oct. 1. A major consideration was the usefulness of the lower part of the vhf band to other services.

The FCC report stated, "If suitable means could be found to overcome the difficulties inherent in so major a frequency reallocation as moving television to uhf and if uhf could be sufficiently developed to permit the elimination of vhf channels without loss of service, a number of basic advantages would result. All stations would be able to compete on a much more nearly comparable basis technically ... competitive opportunities would be considerable enhanced ..."

The FCC is also entertaining the advisability of limiting the shift to uhf to the eastern part of the United States.

AIR-DEFENSE COMPUTER designed for use in the Semi-automatic Ground Environment (SAGE) system is about to be installed at McGuire Air Force Base in New Jersey. SAGE represents a supersensitive continental air-defense system.

It starts with a radar ring—on land, Navy picket ships at sea, offshore Texas towers and airborne early-warning planes ranging far out over the ocean. These radars are linked by telephone lines or uhf radio directly to the high-speed computer (see photo). Information about aircraft anywhere within the radar area is relayed continuously and automatically to the computer. The computer digests all the

information plus ground-observer reports, flight plans of friendly planes and weather information as fast as it is received and translates it into an overall picture of the air situation. Hostile planes can be identified immediately and the most effective defense action taken.

The computer automatically calculates for the operator the most effective application of such defensive weapons as guided missiles, antiaircraft batteries and jet interceptors. In the case of intercepting jets, the aircraft is controlled by directions fed by radio directly from the computer to the automatic pilot in the plane. Missiles are controlled similarly. The computer is designed to operate 24 hours a day, 7 days a week.

The first computer, built at Kingston, N. Y., by International Business Machines for later shipment to the air force base, covers 3 acres of ground and contains 58,000 tubes.

INDUSTRIAL COMMUNICATIONS made a revolutionary advance with the opening of the Sylvania Data Processing Center at Camillus, N. Y., June 26. An 18,000-mile telegraph network leased from Western Union connects 45 factories, 19 laboratories, 10 division headquarters, the company’s corporate executive offices, 27 sales offices and 17 warehouse to the data processing center, which will provide complete accounting and statistical services to all 10 Sylvania operating divisions through seventy-one stations in 61 cities and towns.

Data messages from any one of the outlying points contain three data rout-

A bit of the great computer. White bars are handles of plug-in units holding 6-9 tubes. Panel contains about 2,500 of the instrument’s 58,000 tubes.
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4. ABILITY—If you've had any experience in handling a soldering iron or doing simple home wiring, rate yourself 5. If you feel you can follow simple "How-to-do-it" instructions, mark down 3. [ ]
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A small part of the equipment in the new data processing center, which in its entirety contains more than 50,000 square feet of floor space.

ing characters. Thus "DPR" would cause the message to be routed to the payroll section of the data center; "DIC" would send it to inventory control. "D" indicates the message is to go to the data center. The network can be used for administrative messages between any two stations.

Messages arriving at the station are received on perforated tape and are "translated" onto magnetic tape for input to the Univac, 10-ton, 6,000-tube electronic brain of the system. Both punched cards and magnetic tape are used.

The combination of instant communication plus almost instant computation produces formerly impossible results. A complete payroll, including preparation and signing of checks, can be processed in a couple of hours from information sent in by the scattered stations. All checks will be mailed in bundles to the various outlying points, rather than prepared at each one, resulting in a tremendous saving. Engineers can calculate complex technical problems--each of the 19 laboratories has easy access to the large and expensive computer. Production can be geared exactly to inventory through instantaneous knowledge of the quantity of any product on hand. The Data Processing System is, the company believes, "the only existing concept of an entire company tied together communications-wise from a data processing viewpoint, and with that function housed in its own facility."

CERAMIC RECEIVING TUBES recently developed by Eitel-McCullough (Eimac) are the forerunners of a complete line which will meet most receiving requirements with a minimum number of types. The new design permits them to withstand heavy accelerating forces from shock and vibration, and to operate continuously with envelope temperatures of more than 300°C. Tube life is so long that they will be wired directly into electronic equipment, eliminating the need for tube sockets.

The photo shows an exploded view of one of these tubes--an Eimac 33C3A2 dual triode stacked ceramic unit. Its general specifications are: heater voltage, 6.3; amplification factor, 20; transconductance (at 9-ma plate current), 2,600 microhioms. Maximum plate dissipation per section is 2.75 watts; maximum plate current 20 ma. Tube dimensions are 7/8 inch high, 1-1/32 inches in diameter.

Calendar of Events

23d Annual British Radio Show, Aug. 22-
Southern Arizona Hamfest, Sept. 1-3, Fort
Hunchea, Ariz.
RETIMA Conference on Reliable Electrical
Connections, Sept. 11-12, University of Pennsyl-
vania, Philadelphia, Pa.
NATESA Convention, Sept. 14-16, Sheraton
Hotel, Chicago, Ill.
11th International Instrument-Auto-
mation Conference and Exhibit, Sept. 17-21,
New York Colliseum, New York, N. Y.
National Television Show, Sept. 22-29,
New York Colliseum, Sept. 22-30, New York,
Audio Engineering Society Convention,
New York, N. Y. (Radio- Electronics will
exhibit in Room 325 at the High Fidelity
Show.)
Canadian IRE Show and Convention, Oct.
1-3, Automotive Building, Exhibition Park,
Toronto, Canada.
National Electronics Conference and Exhibi-
tion, Oct. 1-3, Chicago, Ill.
35th Convention of Society of Motion Picture
and Television Engineers, Oct. 7-12, Ambas-
sador Hotel, Los Angeles, Calif.
2d Annual IRE Professional Group, Tech-
nical Meeting on Electron Devices, Oct. 26-
28, Shereham Hotel, Washington, D. C.
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MORE ON DO-IT-YOURSELF

Dear Editor:

Mayhaps the fact that I live in the wild West has some influence on my thoughts, although my doubts as to this will be better borne out by any other letters you get in dissent with Mr. Margolis' article, "Dealing With Do-It-Yourself" (April, 1956).

Basically this article points out the selfish and egotistical attitude of many service technicians and one that causes them a considerable loss in volume. I have been bitten by the do-it-yourself bug and I think that it is safe to say that we all tinker a bit with plumbing, wiring, our cars, paint, woodworking, ad infinitum. All these other things could be done by a professional. Yet in our desire to do something by ourselves, and save a buck or two in the process, we all dabble at times.

So let us not climb up on a lofty perch and scream that the soul that tinkerers with his TV set is akin to a leper or should be dealt with severely. He is usually a normal guy. Let me warn you! Treated wrongly by you, he will eventually benefit a TV service technician, but it won't be you if you were the only one within 100 miles.

The do-it-yourselfer figures he is not as sharp as the TV man but he has a lot of time he could waste for that $5 call. And since he has heard how most of his trouble will be a tube, next time maybe he could handle the job, have fun and save the service call.

Here precisely is the point of perhaps no return for some service technician. Bite him, belittle him, cuss him or what, this adolescent period of the TV owner's formative years is very important. He must learn to have, not only confidence in you, but more important: trust. The embryonic set owner has several paths from which to choose at this point and they will mean a difference in money in your till.

Educate him to help with the non-technical problems and he will relieve you of a lot of routine jobs and you will still be in line for that big one coming up. Show him if you can the underside of a set on your bench, show him and demonstrate the easy way he can foul things up so that when in doubt he doesn't experiment. Educate him and win a friend and customer; alienate him and lose all.

ROBERT M. LOHR

Lohr's Electronic Lab
Bridgeport, Wash.

(Careful consideration of some of
(Continued on page 18)
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RADIO-ELECTRONICS (Continued)

CORRESPONDENCE (Continued from page 14)

Dear Editor:

I have been recently spending considerable time studying transistors just to familiarize myself with this important branch of electronics and to be ready when it attains widespread use. I think I now have a good knowledge of the physics and the electronic applications of transistors.

However, what appears to me to be a serious deficiency in this field is the lack of uniformity in classifying transistors as to types. Most companies appear to have their own designation and I have been unable to find a hint suggesting unification. If we consider that we are just at the beginning, throwing good reasons for concern as to how messed up things can get.

Why don't manufacturers agree on some uniform classification, as they have with tubes. For example, they could evolve a system in which the first letter of a transistor type will indicate whether it is p-n-p or n-p-n. A second letter or number can indicate the transistor's function (af, rf, power, etc.). Additional numbers or letters can indicate important parameters such as cutoff frequency.

The entire situation can easily become even more confused if future developments promote transistors that vary widely in basic design, such as triodes, tetrodes, pentodes and other types. Thus, now is the time to set up a system of classification.

This is just a suggestion and most likely a more elaborate scheme can be laid out. At any rate some consideration should be given to the technician who will soon be called upon to service transistorized circuits and will not have transistors of every make nor an elaborate cross-indexing system.

SERGIO CLEMENTI

Caraacas, Venezuela

A HOBBYST'S VIEW

Dear Editor:

I read Radio-Electronics because radio and television is my hobby. I do some repair work and have no dissatisfied customers. In connection with this I would like to voice my opinion against licensing.

I couldn't afford to pay a big fee for a license. In the little servicing I do I seek only to break even and maintain my hobby. I am sure there are others in a situation similar to mine personally. I think that if a service technician is afraid he cannot hold his customers he had better try another occupation.

R. Bailey

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Engineer with Station WHPE

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THE tragic collision and crash of two large airplanes over Grand Canyon, in Arizona, on June 30, with the loss of 128 lives, need never have happened.

For the last few years, many of our pilots time and again have warned our authorities of near collisions, which occur more and more frequently, particularly in the vicinity of our airports.

During a single week, airport control towers operated by the Civil Aeronautics Administration guide an estimated 400,000 outgoing and incoming flights. This is likely to grow to around a million within 10 years.

Ground control said this which dot the land theoretically "guide" all planes by radio, keeping pilots informed along the way. The planes also report their position by "fix postings" over specified points along the route. When, however, a plane is flying blind in an overcast, it is "on visual control" and the pilot must look out for other planes—if he can. During violent thunderstorms he is likely to drift from his course. He was probably was none or very little visibility—tilt it was too late. With the two planes approaching each other—most likely at an angle—at 300 miles per hour each, they must have collided at a combined speed of between 400 and 500 miles per hour—much too fast even after they saw each other—to change direction in a few short seconds.

But a plane flies in a three-dimensional medium. Pilots have only a comparatively small angle within which to make visual observations. They cannot look behind them, far sideways or above, or below them at a steep angle in a heavy overcast. Hence the "visual control" is wholly academic and—under certain adverse weather conditions—absurd.

With greatly accelerated air traffic and with jet planes flying at 750 miles an hour in a few years, drastic changes must be made to make overhaul and modernize our present archaic aviation control.

It is true that the Civil Aeronautics Administration has already under construction an Airways Plan on which $110 million has already been expended. According to a CAA spokesman, the total cost will reach $246 millions for the complete 5-year plan. This plan, according to CAA Administrator Charles J. Lowen, "will give the traffic controller 'radar eyes.' When the plan has been put completely into effect, we will have radar coverage of the entire airspace of the United States at high altitudes."

This would seem to be an excellent plan to keep down collisions, but in our opinion it does not go far enough. Nor can we afford to wait 5 years when we reflect that, since 1950, 65 midair collisions have occurred. Radar control from the ground cannot possibly forestall all collisions during thick weather, violent thunderstorms and black overcast, particularly at night.

Yes, ground radar can warn the planes, but the pilots themselves cannot pinpoint their own relative positions in regard to each other. For all practical purposes, the pilots are blind now. Each can move in six directions—east, west, south, north, up, down. Which shall each choose? The distance is senseless unless we have radar by triangulation, each connected to a fast radio computer—will prove of little use in such situations.

In our May, 1949, issue, we said, under "Airplane Collisions": "Radar on locomotives will prevent not only head-on collisions, but year-end collisions with other trains as well."

Fog, thick weather and darkness, whether at night or in tunnels, do not interfere with radar. What is true of trains is equally true for airplanes, which no longer will collide with other planes in flight nor run into mountains at great loss of life, as at present."

We foresaw most of today's air complexities as far back as 1951 when, in our May issue, we stated editorially: "The new planes, the new radar, the new midair collisions increase. Aerial collisions are by no means a rarity nowadays. They happen right along at great cost of life and property."

It is physically impossible for a pilot to see simultaneously in six directions: up, down, east, west, north and south. The busy pilot has all he can do to look in one direction, perhaps two at times, but that is all.

"In the not too distant future all planes will be equipped with 'television cameras' in such a manner that screen images from a number of directions will be in front of the pilot at all times. Only the great weight and cost of the equipment make this idea unworkable at present."

"It should be possible in the meanwhile, however, to use a six-way modified—or sweep—radar installation, which need not weigh too much if miniature tubes and other miniature components are used. In this case, too, there would be several miniature screens which pilot or copilot could watch and see if another plane was approaching from any direction. When finally this special such a device will prevent many collisions. Such radar installations will be particularly advantageous during night flying and while flying in overcast weather when the visibility is extremely poor or nil."

This does not exhaust the subject even remotely, but we do maintain that we have sufficient electronic talent in this country to bring into life an Anti-Airplane Collision Crash Program, now necessary if we cannot compete for the CAA ground radar, no matter how well it is perfected. By itself it may never prevent all collisions, particularly when jet planes flying at 750 miles per hour move in on each other at 1,500 miles an hour, 25 miles in a single minute, or over 4 miles in 10 seconds! From this it would appear that planes soon must be required to carry their own collision alarms, in addition to supervision by modern ground radar devices.

We are certain that American ingenuity can devise a reasonably safe collision warning device on board all planes that will be light and unobtrusive.

A comparatively simple instrumentation comes to mind that might be evolved from means in existence now. Let each plane be equipped with one or more automatic revolting direction finders. Every plane will have a high-frequency transmitter, which emits a special type of signal (or a plurality of signals) assigned only to planes. This signal should not carry farther than 100 miles. The receiver is peaked on this special signal only, which can be made to heterodyne with its own signal when another plane moves into its field. As the planes approach each other, the intensity of the received signal rapidly increases in proportion to the diminishing distance between the planes, and the pilot is alerted by visual and aural alarms.

In time it should be possible to evolve an instrumentality whereby the pilot or navigator can read not only the exact distance between two planes in miles, but he will see the vertical or horizontal angle of the approaching plane, too. By radiophone, both pilots then take the proper steps to change course, thus avoiding collision, no matter what the weather.

If a system such as this, or a similar one is evolved, the nightmare that now continuously frays pilots' nerves and puts thousands of passengers on edge daily, will, we hope, become a bad dream of the past—soon. —H.G.
TELEVISION

Remote Controls for TV

By HENRY O. MAXWELL

During the past 7 years or so manufacturers have sporadically introduced and then discontinued remote controls in some of their TV receivers. In any one year hardly more than two or three brands had this feature. Now it looks like 1956 will be remote-controlled TV's big year. Almost every major manufacturer offers it in some form.

The control systems may be divided roughly into three basic types: electromechanical, electronic and split-chassis. The electromechanical system has a motor-driven tuner for channel selection and may or may not include remote control of volume, brightness and fine tuning. The electronic type includes those systems that permit controlling the set from a remote point without running wires or cables from the receiver. The split-chassis type has the tuner, and possibly if circuits, on the remote-control chassis along with other controls that may be needed. The electronic and electromechanical types are described in this article. Further electromechanical, and the circuitry and novel features of several split-chassis types will be discussed in subsequent ones.

The Zenith Flash-Matic

This system enables the viewer to control the TV receiver with the beam of light from a small flashlight. Four cadmium-sulfide photocells are mounted behind bezels in the four corners on the front of the TV cabinet. A momentary flash of light on the lower-left photocell turns the power on and off, on the lower-right one mutes the sound. The cells in the upper left and right corners turn the channel selector counterclockwise and clockwise, respectively. Thus, by turning the motor to the left you can flip immediately from channel 2 to 13 or from 5 to 4 without having to switch through all other channels. A large illuminated numeral on the manual channel selector shows the channel in use.

The circuit of the Flash-Matic is shown in Fig. 1. Its functions can be broken down into on-off and motor-control operations.

Cadmium-sulfide photocells are a resistive type in which the resistance varies inversely as the light intensity. In the absence of light the resistance may be as high as 100 megoohms; in bright light it may drop to around 25,000 ohms.

The power supply in the control unit supplies 117 volts ac for the plates of the 68X7-GT motor-control tube, 145 volts ac for the plates of the 2D21 thyatrons controlling the on-off and audio-mute circuits and -25 volts dc bias for the 68X7-GT and 2D21's.

The basic thyatron control circuit is shown in Fig. 2. The grid of the

Fig. 1—Schematic diagram of Zenith's Flash-Matic remote tuner. Unit triggered by light falling on four photocells.
2D21 is biased to cutoff by a negative voltage from the power supply. The plate is supplied with 145 volts ac through the solenoid coil and the grid is supplied with ac through the photocell. The ac voltages on the plate and grid are in phase. The amplitude of the ac voltage on the photocell is determined by the setting of the MANUAL SENSITIVITY CONTROL (Fig. 1) and the ac on the grid is determined by the light on the photocell.

When light of sufficient intensity—as from the flashlight—strikes the cell, its resistance drops and applies a high ac voltage to the 2D21 grid. If the positive peaks of the ac voltage are high enough to override the negative grid bias, the thyratron conducts and the solenoid operates the switch. This switch is a latching type. One operation of the solenoid throws it in one direction and the next operation returns it to its original position. The 2D21 cuts off on the next negative half-cycle of the line voltage after the flashlight is turned off.

When the MANUAL-AUTO switch (Fig. 1) is set to AUTO (for remote control), the switch operated by the solenoid in V2's plate circuit is in series with one side of the speaker voice coil. Similarly, S1, controlled by the solenoid in V1's plate circuit, breaks or makes one side of the ac line to the main power transformer. The second set of contacts on S1 and S2 interlock V1 and V2 so that they fire only in sequence.

There is a possibility that the TV set will be turned off manually when S1 is in the off position or S2 is set to MUTE. With S1 off, the line voltage does not reach the primary of the TV power transformer and with S2 thrown to MUTE, the speaker circuit is open. To avoid having to use the flashlight to reset S1 and S2, a reset switch is ganged to the MANUAL SENSITIVITY CONTROL so that, when it is turned momentarily to its extreme counterclockwise position, the switch closes and applies a 117-volt ac pulse to the thyratron grids. This pulse overrides the bias on the 2D21’s and returns S1 or S2 to the desired position.

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**Fig. 2**—The thyratron control circuit.

**Fig. 3**—Zenith motor control circuit.

**Fig. 4**—Basic motor control circuit.

**Fig. 5**—Schematic diagram of the RCA Magic Brain TV control system. Unit is typical electromechanical control.
The motor control circuit

A 117-volt induction type ac motor drives the channel-selector shaft of the tuner. Its direction is controlled by V3. The motor has two series-connected windings with one side of the ac line tied to the junction. The ends of the windings are connected to the other side of the ac line through the contacts of RY1 and RY2 in the plate circuits of V3-a and V3-b, respectively.

In Fig. 4 the basic motor control circuit, V3 is biased to cutoff by a voltage supplied through the motor sensitivity control. When light strikes the photocell, its resistance drops and applies an ac voltage to the grid, causing the tube to conduct on positive half-cycles. The relay pulls in and remains closed as long as the light beam is on the photocell.

Two cam-operated homing or interlock switches insure that the motor always stops with the tuner centered on a channel. One switch is across clockwise relay RY2 contacts, the other across counterclockwise relay RY1 contacts. The homing switches are operated by two index cams that make one revolution per channel. The cams are positioned so both switches are open when the turret is exactly on a channel. Thus, a short pulse of light will start the motor and the homing switch keeps it running until the cam breaks the circuit.

Electromechanical control

Sets with electromechanical control have the control box or head connected to the chassis through a multiconductor cable. Controls on the box permit the viewer to select channels and adjust volume, brightness and fine tuning. Like the Zenith, the tuner's channel selector is driven by a small motor. The circuit is shown in Fig. 5. S1 is the channel selector on the control box and S2 a n switch that rotates with the tuner shaft driven by the motor.

When S1 is moved to any new position, the circuit to the motor is completed through the corresponding contact on S2. The motor runs until the wiper on S2 moves around and breaks the circuit. In this basic arrangement, the control cable would have to have 13 conductors for the channel selector alone and additional conductors for the other circuits.

In practice, the number of conductors needed for channel selection is greatly reduced by using a more complex switching system like that shown in Fig. 5 of the RCA Magic Brain TV Control. S1 is a rotary switch ganged to the tuner shaft and S2 the remote channel-selector switch on the control head. These switches are shown in the channel-2 position and the motor circuit is open.

Rotating S2 right or left to another channel completes the circuit to motor relay RY1 and starts the motor. The channel-selector shaft on the tuner rotates to the desired channel, breaking the circuit through S1 and S2 and releasing RY1 and stopping the motor.

Volume control

A simplified circuit showing the method of controlling volume from the remote panel is shown in Fig. 6. The dashed lines indicate wiring and components added to the KCS96 chassis to adapt it for remote control. The dpdt switch is actually made up of parts of RY2 and RY3 (Fig. 5). The switch section labeled on-off is a part of RY2 and the remote-local section is a part of RY3.

One section of this switch opens the circuit to the arm of the master or local volume control on the TV set and connects the high side directly to the grid of the first af amplifier. The other section connects the remote volume control between ground and the screen grid of the sound if amplifier.

Brightness and fine tuning

In Fig. 7 the contacts of RY3—shown as an spdt switch—are used to return the picture tube from the arm of the local brightness control to the arm of a similar control in the remote-control head.

Fig. 8 is a simplified circuit of the vhf oscillator in the tuner and its connection to the remote fine-tuning control. Added components are shown in dashed lines. In this arrangement a 4.7-muf capacitor and NE-2 neon lamp are in series across the fine-tuning capacitor in the tuner. A positive voltage, tapped off the fine-tuning potentiometer, is applied to the neon lamp through an R-C filter network. The neon lamp acts as a capacitor whose capacitance increases as the current through it. Thus, the oscillator frequency can be controlled within limits by varying the voltage on the lamp.

The lamp may also be considered as a variable resistor in series with the fixed capacitor. When the applied voltage is low, the lamp resistance is high and the 4.7-muf capacitor has little or no effect on the oscillator frequency. Increasing the voltage decreases the resistance and raises the effective circuit capacitance. Regardless of the method of circuit analysis, the oscillator frequency decreases as the lamp voltage and current increase.

Power on-off circuit

When the receiver is modified for remote control, the 24-volt transformer in the relay unit feeds power across the ac line. To operate the receiver remotely, the local fine-tuning control is turned clockwise to throw the local—remote switch and apply 24 volts to the coil of RY3. Closing the on-off switch on the control head applies 24 volts to the coil of RY2 to switch the volume-control circuits and complete the circuit to the primary of the power transformer in the TV set.

References

ROUND-THE-WORLD television network sounds fantastic—at first. Of course, most of us are already sophisticated enough to know that the Atlantic is a big lake only until one decides to travel via Canada, Greenland and over the edge of the world. And the occupation of Attu during World War II jolted us into the knowledge that the Pacific isn't so wide either.

But if these bodies of water don't impose an impassable barrier to TV transmissions, the question “Who will pay for the broadcasts?” does. TV stations must be sustained. More than one American TV broadcaster has had to cease operating—and the failures weren't all in the uhf band!

A TV network's economic problems would be much more serious if it had to pick up its programs on one continent and broadcast on another. True, some important events (such as the Olympic games) might pay commercial sponsors handsomely. Coronations, important diplomatic conferences or historic UN sessions might also justify commercial sponsorship, if the governments concerned did not care to broadcast them. The Voice of America could no doubt use the network for some broadcasts and some governments would probably want to sponsor regular programs. But the sum total could not add up to a self-sustaining system. Here—one would think—is the impassable barrier.

Economic aspect
The plain fact is that television wouldn't have to pay for the system—any more than it pays for our transcontinental “television” microwave relay routes. These are broad-band circuits paid for and occupied mainly by telegraph and telephone services, with TV occupying only a portion of the band part of the time.

A transworld relay system would also serve for general communications as well as TV and would thereby fill a genuine need. A single broad-band trans-Atlantic service would in fact be able to carry more traffic than the present cable and radio routes combined.

Engineering problem
Then what of that other difficulty—spanning the oceans between us and Europe on the one side and Asia on the other? The greatest single water gap—as Fig. 1 indicates—is the 290-mile jump between Iceland and the Faeroe Islands. Two other gaps—from Baffin Land to Greenland and from Greenland to Iceland—can be bridged with 275-mile jumps, and all other distances between practical station sites are shorter. The problem, then, is to maintain reliable communication over a maximum distance of 290 miles.

Conditioned by our own experience with TV broadcast reception we may think of 290 miles as almost as bad as the whole Pacific, as far as sending and receiving TV is concerned. But we have recently been hearing more and more about beyond-the-horizon transmissions. The August, 1955, issue of RADIO-ELECTRONICS gave a detailed...
account of experiments in which signals from the Bell experimental transmitter at Holmdel, N. J., were picked up regularly at MIT's research station at Round Hill, Mass. Experiments made in Newfoundland for a period of 5 months in 1954 (Bell Labs Record, February, 1956) proved that reliable communication can be maintained over a path of 290 miles (from St. Anthony to Harbour Main).

Just such long-distance communication has actually been working in commercial service for several years, though little may have been known of the underlying theory when it was first installed. The French Compagnie Générale de TSF has been operating a broad-band transhorizon radio link between Grasse, on the French mainland, and Calenzana in Corsica, since 1947. Frequencies are in the order of 100 mC and the distance is 127 miles. The antenna at Grasse is 1,900 feet above sea level and at Calenzana 1,050 feet.

A still longer jump is that between Mt. Cavo, near Rome, Italy, and Mt. Serpeddi, Sardinia, operated by the same company. A 14-channel telephone service is operated over a 242-mile range, with antennas approximately 3,200 feet high at both ends.

Both these systems are low-power. The French transmitters are rated at 100 watts and operate with 10-db gain antennas, and the Italian system uses 500-watt transmitters and 20-db-gain antennas. These distances could be increased enormously with the power—measured in thousands of kilowatts—used in recent American experiments.

Indeed, a number of spans are now being covered with moderate power. The antennas on our cover are prototypes of those to be used in the Puerto Rico-Dominica system now under construction by the International Telephone & Telegraph Corp. These antennas, mounted on the roof of the Federal Telecommunication Laboratories, a division of IT&T, Nutley, N. J., have been in regular communication with Southampton, Long Island, N. Y., for the last year and a half. Distance is 91 miles; power 500 watts.

IT&T intends to use the same power for the Dorado, Puerto Rico, to Ciudad Trujillo, Dominica, link, as well as for a 240-mile span between Sardinia and the Spanish island of Minorca. Both these systems are relatively narrow-band (6 voice channels) and the Sardinia-Minorca link will use 60-foot dishes. On the other hand IT&T is using 10 kw on a system that will carry 1 TV and 120 voice channels between Florida and Cuba.

Broad-band tropospheric radio is also being used in our northern defense network—the famous DEW line. Detailed information on the number of stations and path lengths is, of course, not available, but it is understood that distances of at least 175 miles are being spanned.

Engineers have no doubt that bridging the longest gap in a world-wide communications service is simply a matter of power plus right antennas.

Beyond the horizon

What is this method of transmission that makes such distances possible? It is based on three fundamentals: recognition that a method of transmission not covered by traditional theory does exist; very high power; directional high-gain antennas.

That such a method of transmission exists has been known for some time. Shortly after the Grasse-Calenzana circuit opened, the Annales d'Electricité printed a report showing the fantastic spread between the calculated and actual signal strength—a spread of thousands of times. In 1950, a paper by Booker and Gordon in the Proceedings of the IRE announced that it was possible to communicate over greater distances with vhf and uhf than had formerly been believed possible. The paper further suggested that waves may have been reflected or scattered by discontinuities or turbulence in the troposphere or ionosphere.

The effect has been compared to that of a searchlight projecting its beams through foggy, dusty or smoky air. It is possible to see the area illuminated by the beam at distances far over the horizon, due to reflections from airborne particles, though the source itself may be well below the line of sight.

This "scatter" theory falls short in explaining a number of points and for some time other theories were sought. Recently, however, two Bureau of Standards bulletins have supported the turbulence idea very strongly, not even mentioning other possible hypotheses.

Incidentally, there are two types of beyond-the-horizon transmission—the tropospheric scatter we have been discussing, and an ionospheric type that operates best at distances of more than 600 miles. Because of multipath reflections, the ionospheric type is of greatest value for narrow-band transmissions and apparently is not applicable to broad-band systems.

All agree on two necessary factors
TELEVISION

Did You Ever? . . .

By H. A. HIGHTSTONE

GET confused over which tubes belonged to the customer and which were yours, after solving a case of TV trouble by mass tube substitution? A 15c bottle of nail polish will help end such snafus. Use it to color sealoff tips of seven- and nine-pin miniatures. In the case of octals, color the bottom of the key.

. . . groan when some thrifty customer confronted you with a shopping bag filled with small tubes to be tested? Next time, after inserting a tube in its test socket, briefly jump the heater voltage to the next higher setting on the tester. With only a little practice you can check tubes about as fast as they can be popped in and out of the tester.

. . . get beaten on a poor-sound complaint? I nearly did a while back. A last-ditch hunch saved me when I investigated the speaker itself. Everything was OK after removing half a teaspoon of iron filings lodged between the voice coil and magnet pole-piece. (If it’s a direct-coupled amplifier you’re fighting, a variation as small as 0.75 volt in the firstaudio cathode voltage can be the difference between crisp, clean sound and an effect reminiscent of a loudspeaker filled with mush.)

. . . forget to discharge a picture tube and get a sharp bite while rassling it around, removing it from a chassis? Then visualize yourself getting such a bite while the tube is suspended in midair, and dropping it. I used to forget and get bitten at intervals, but never after setting up my foolproof double-check system, like this: Discharge tube. Tape triple thickness of cardboard over second- and third-cone connection, using Scotch Brand Tape No. 33 (10-kv insulation). I probably still occasionally forget to discharge tubes, but it doesn’t matter any more. Might have already saved me the price of a glass eye.

. . . give up on a case of vertical jitter? Before you do, give the gain (contrast) control a short snort of standard cleaner-lubricant first. That’s all a Mercury chassis recently required, although I got stuck for a callback in discovering the cure. The control was glazed; extremely loud bursts of sound from the speaker jarred it open momentarily, causing jitter which sometimes went to the point of frame-jumping. It never showed up in the shop where speakers ordinarily run in low gear, but in a customer’s home only, intermittently.

. . . blister your thumb and/or forefinger pulling some superheated rectifier or short-circuited small tube? Buy a few 10c hotpads next time you’re in a dime store. Not even a slight search around here since thinking up this uncomplicated trick.

END


for beyond-the-horizon transmission—high power and directive antennas. The antenna on our August, 1955, cover was able to pack its 10-kw signals into a beam only 0.25° wide at 4,000 mc and broadening out to only 2.5° at 400 mc. Such quantities of power (or even greater ones) and such antennas are the solution to the engineering aspect of world-wide television.

Practical approach

Unlike many “global” projects, world-wide television is a thoroughly practical proposition. It does not depend on some stupendous combination of finance and engineering which would lay down a global system all in one piece. It can operate in pay-as-you-go stages, first from America to Europe, then to near Asia and so on to its point of origin.

Chief proponent of world-wide TV is William S. Halstead of United, Inc. An old-time communications engineer, he has in the past not hesitated to depart from the more hidebound methods for a reliable communication system (See “Communication by Induction,” RADIO-CRAFT, January, 1945).

Mr. Halstead has worked out a method for a feasible and practical system of communication around the world. The route would follow the course of Fig. 1 from North America to Europe, would branch off to the south and go eastward along the Mediterranean, through Turkey, the Near East, India, Pakistan and Indonesia to the Philippines, thence north through the Japanese archipelago and on to the Aleutians by coaxial cable (Fig. 2). The connection between Asia and North America can then be made with even shorter jumps than along the Iceland-Faeroe Islands route from North America to Europe.

The plan was proposed some years ago, but has gained in interest greatly within the past year because of our increasing knowledge of beyond-the-horizon transmission, its reliability and its possibilities. Development of area networks which could form portions of the world-wide system has also helped demonstrate the idea’s feasibility. Notable among these are the Mediterranean net, of which the French and Italian stations already mentioned form a part, and a Japanese system, in the design and installation of which Halstead played a prominent part.

We will not be at all surprised to see instantaneous TV from Europe within the next 4 or 5 years. And—since past success breeds greater success—it may not be many more years before our screens show a presidential inauguration in Manila or a person-to-person visit to the home of the Emperor of Japan.


SEPTEMBER, 1956

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EVER wonder why transformerless power supplies rarely use the once popular (and much-to-be-desired) full-wave doubler circuit? I say “rarely” because now and then an equipment manufacturer will take a chance on it—usually to his subsequent sorrow. True, some trade literature still displays the full-wave doubler along with series heaters. But today no tube manufacturer will honor a warranty when such a circuit is used.

Fig. 1 shows a conventional full-wave voltage doubler as used until a few years ago. It can be seen that point A rides at a positive potential of 150 volts with respect to chassis ground. Since one end of the heater string connects to point A and since all cathodes are effectively tied to the chassis, a sizable heater-cathode strain will appear along the entire string.

Because this dc potential on the heaters is a static thing, unflowing, there can be no voltage drop. Consequently, 150 volts will appear across the heater and cathode of every tube. The stress or strain will not diminish as you go down the series string.

This force, incidentally, is in addition to that exerted because of the ac potential which also appears across the cathodes and their respective heaters. The ac strain, however, does diminish as you go down the string since ac flows through the heaters.

Thumb through any tube manual now and observe the bad news. Most tubes are rated at only 90 to 100 volts, heater positive with respect to cathode. And that, precisely, is what killed the full-wave doubler circuit for use in transformerless power supplies.

It took some time for tube engineers to catch up with this one. Sylvania was one of the first to recognize the necessity for placing the present ratings on heater-cathode stress. However, shortly after these became standard in the tube industry, abnormal failures ceased.

Then the trend back to half-wave doublers began with, of necessity, larger filter chokes and electrolytics. Some manufacturers even returned to the transformer type chassis rather than contend with the lower ripple frequency of the half-wave doubler.

In Canada, where 25-cycle power is found in large sections of Ontario, the bad news hit hard. A ripple frequency that low is murder to filter out. With the now-condemned full-wave doubler, the resultant 50-cycle ripple had been difficult enough to smooth. It meant a switch to “brute” filtering—or the transformer type chassis.

When management abruptly announced that we were about to enter the Canadian television market, this problem of heater-cathode strain became a pressing one. Among our various chassis requirements was a 25-cycle vertical model (see photo) employing a doubler circuit and series heaters. True, we could have used an isolation transformer to block the dc from the heater string, but that would have lifted the chassis out of the “transformerless” classification—not to mention the fact that there was no room to mount a big 25-cycle transformer on the little chassis. Unless it were well shielded and kept an appreciable distance from the picture tube, its 25-

By GEORGE C. CHERNISH*

* Senior liaison engineer, television design, Sylvania Electric Products.
cycle magnetic field would play havoc with the beam.

It appeared, therefore, that we were forced to turn to the half-wave doubler and brute filter. Using such a circuit, it soon became obvious that to obtain a high-quality picture, very large filter chokes would be required for 25-cycle operation. Even so, there was also the problem of wobbly interlace caused by the proximity of heater wiring to the neck of the picture tube—passing as it did through a hole in the chassis.

Fig. 2 shows a circuit developed by the author to overcome this problem of heater-cathode stress in full-wave doublers. Born of sheer necessity, it has been used for some time in the vertical chassis manufactured by Sylvania in Canada. It makes possible, for the first time, a high level of picture quality in 25-cycle television receivers employing series heaters. Here at home, it also imparts a higher degree of quality to those sets using a series string.

During that half of the input cycle when X is positive with respect to Y current will flow through the selenium rectifier RECT 3 charging capacitor C1. One end of the heater string, point B, will assume a polarity which opposes the 150 volts at A. The net positive potential (with respect to chassis ground) depends on the value of C1, and can be made very small. In the Canadian design, point B measured +9 volts.

During the next half of the input cycle, while X is negative with respect to Y, RECT 3 does not conduct, thereby effectively blocking the 150 volts at A. However, X also carries this static dc potential developed at A, for somewhere, either on a pole outside or in a near-by substation, there is a distribution transformer winding linking X and Y. We e it not for dropping resistor R1, we would be back where we started on the problem of heater-cathode stress.

Resistor R1 performs two functions. First, it serves in its conventional role as a current-limiting resistor to protect the heater string. Second, it reduces the injurious static potential developed at A which now must flow, because of this special circuit, and dissipate itself to some harmless level through extraneous circuitry linking X and Y. The value of R1 will depend, therefore, not only on the amount of current limiting required, but also on the desired reduction of the injurious potential at C.

Capacitor C1 also plays a dual role. In addition to providing a constant opposition voltage at B, it acts as a dc filter for the pulsating current supplying the series string. Its value depends on the total voltage required by the heaters and the level to which it is required to reduce the damaging potential at B.

As for RECT 3, conventional radio-television stacks may be used. There is nothing special or off-standard about any of the components. RECT 1 and RECT 2 are the same as in Fig. 1. In both cases, these may be vacuum tubes.

Two other important advantages are gained with this circuit: heater-induced hum is drastically minimized; in tele-

![Fig. 2—Circuit developed by author.](image)

vision receivers whose supply frequency is less than 100% stable, where heater wiring runs near the picture tube—as in vertical chassis—there is far less likelihood of trouble from asynchronous operation.

Anyone owning a transformerless radio or television set manufactured prior to the clampdown on heater-cathode ratings may greatly prolong tube life with this protective circuit. The first step would be to verify that the full-wave doubler is used therein. Then, a rectifier one size larger than normal heater current calls for should be selected for RECT 1. For example, if the series string draws 300 ma, choose the 350-ma size. This is to allow for possible increase in line voltage from time to time.

Next, determine the value of electrolytic capacitor required for C1. After the rectifier has been wired in, start with 40 µf, shunting with other capacitors until rated current flows through the string at normal line voltage. Then a single unit may be selected and installed permanently.

If no dropping resistor is presently used in the series string, one must be inserted. However, when the first tube in the string is, say, a 25Z5, which has a high heater-to-cathode rating, R1 may not be necessary. The trick in any event is to make sure there is enough resistance between the first tube of low heater-cathode rating (less than 150 volts) and the line at X, so that R1 will function as explained earlier. The greater the resistance required, the larger the value of C1.

Measure heater-to-cathode voltage on a vtvm. The reading will be an approximation only, particularly in TV receivers where pulses on the cathode of the damper tube influence polarity at its end of the heater string. However, unless checking a new design in the lab, more elaborate equipment and test procedures are not needed for checking.

Circuits have a peculiar way of growing on us. Sometimes, while designing a conventional series string, we run out of line voltage. Perhaps we would like to use five 25-volt tubes. Or maybe a proposed tube complement in a TV chassis requires more than 117 volts for its heaters. In either case, we have, as it were, too much voltage for a split string—yet not enough for a single string. This problem is quickly eliminated with the circuit of Fig. 2 since, by merely increasing C1, we can obtain an effective dc potential higher than the rms value of the ac line.

Because it lends itself so readily to miniaturization, this new circuit is currently finding favor with manufacturers of airborne and other portable communications equipment. Although it was developed to fill a specific need here at Sylvania, the reader may think of many applications undreamed of by the inventor.

END

SEPTEMBER, 1956

TELEVISION

In RADIO - ELECTRONICS October issue—

UNDERGROUND ANTENNA
A TV signal distribution system that gets away from disadvantages of aerial cables

TV ANTENNA ADJUSTMENTS FOR ELIMINATING INTERFERENCE

LONG-TAILED CASCODE PAIR AMPLIFIER
FLEA-POWER TRANSISTOR TRANSMITTER

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TELEVISION

When picture and raster are normal, any defect in the sound that cannot be corrected by replacing audio tubes or varying switches and the audio amplifier calls for alignment of the sound if section. This includes all circuitry from the sound takeoff point to the output of the ratio detector. The defect can include anything from weak or no sound to drift, distortion and oscillations. Sometimes oscillation causes patterns to appear on the screen.

Sound if alignment is comparatively simple because only one frequency is involved—4.5 mc. Test equipment requirements are few and the basic work consists of skipping the sound if stages for maximum output and balancing the ratio detector for zero output at 4.5 mc.

A highly accurate 4.5-mc signal generator is necessary. The best source is a television signal where the video and sound carriers are transmitted precisely (crystal-controlled) 4.5 mc apart. When a TV signal is not available, a signal generator—checked against a crystal calibrator or some other frequency standard—may be used. Accuracy should be within 1 kc at 4.5 mc.

In general, it is a good idea to check the alignment of the video if stages before going on to the 4.5-mc sound. This is especially true where the picture appears degraded. However, where trouble appears limited to the sound section only, with the picture strong and sharp on all channels, video if alignment may be bypassed.

While the circuitry of the ratio detector will vary slightly from set to set, the fundamental operation remains the same. Thus, while space permits a discussion of a limited number of circuits only, the alignment procedure may be applied to virtually all ratio detectors used in today’s television receivers.

Fig. 1 shows the sound if section of the Motorola TS-402 chassis. When aligning with a TV signal, use the fine-tuning control and detune the signal slightly until you can measure from about 5 to 8 volts from the positive side of stabilizing capacitor C56-b to chassis. This procedure will permit operation below the limiting level of the FM driver tube and provide sharp tuning.

If a signal generator is used, tune it exactly to 4.5 mc, adjust its output to approximately 5,000 microvolts and short the antenna input terminals or remove the antenna lead-in. Connect the hot side of the unmodulated AM signal generator output to pin 2 of the third if transformer T3-the cold side goes to chassis. From this point on, the alignment procedure is the same whether a TV signal or generator is used.

From the positive side of C56-b, a 10-µf electrolytic capacitor, connect a dc vtvm or other high-impedance voltmeter (at least 20,000 ohms per volt) to chassis through a decoupling resistor of about 10,000 ohms. The first tuned circuit after the point of sound takeoff is C52-L65; tune L53 for maximum reading (parallel resonance). Interstage trimmer C66 should also be tuned for maximum reading.

During alignment, as adjustments are tuned to resonance and the 4.5-mc signal strength is reduced the signal generator output or TV signal input to the receiver to prevent overloading and to get sharper peaks and nulls. It is often advisable to insert an attenuation pad at the antenna input.

The ratio detector primary (top core in this chassis) is now tuned for maximum reading on the meter. In tuning this and the secondary circuits of the ratio detector there will usually be two tuning points. Only one is correct—the point at which the cores are farthest out of their windings (minimum inductance). The inner position produces improper bandpass.

For balancing the secondary, connect a matched (1%) pair of 100,000-ohm resistors across the ratio detector load resistor R62 and connect the ground side of the meter between the resistors. The high side of the meter is connected to the output of the de-emphasis network (junction of R63 and C74).

Now vary the ratio detector secondary for zero response on the lowest range of the meter. Make sure the slug is tuned to the outside of the coil winding—this corresponds to the crossover point of the detector curve. The symmetry of the curve may now be checked by tuning the signal generator for 25 kc above and below 4.5 mc and observing the plus and minus voltages obtained, reversing the meter connections as necessary. The voltages should be approximately equal. If not, repeat the entire alignment procedure for the ratio detector tube. Repeat the process for maximum accuracy.

Fig. 2 shows the sound if system of the Admiral 20Y4H chassis. Here again, either a TV signal or generator may be used. Tune to a strong station or connect the high side of the generator to the junction of L304-L305 (in series with an isolating resistor or, better still, a 0.01-µf capacitor) the generator cold lead goes to ground. Connect the vtvm from the negative side of C206 (4 µf) to chassis.

With the vtvm set on a low dc scale and the generator tuned to exactly 4.5 mc, vary L201 and the primary of the ratio detector transformer for maximum indication on the meter. Keep reducing generator or signal strength so the meter reading does not exceed a few volts.

To adjust the ratio detector secondary, move the ungrounded lead of the vtvm to point A and vary the secondary core for zero reading on the meter. It will be between a positive and negative maximum. If available, use a vtvm having a zero indicator to pick up the peak.

To touch up the ratio detector secondary using TV signal, vary the core for best sound with minimum buzz. Make this adjustment carefully since only a very slight rotation will usually be necessary. The correct alignment point will be between the two maximum bands peaks that are generally obtained by turning the slug back and forth about one-half turn.

While manufacturers’ alignment instructions vary slightly, the above indicates the general process; align all sound if circuits up to and including the ratio detector primary for maximum output across part of the entire stabilizing capacitor (the voltage developed here acts as sort of an ave indicator or signal strength). Align the ratio detector secondary for zero output (balance) at 4.5 mc with the vtvm connected between the electrical center of the secondary and the output of the de-emphasis network.

Sound buzz and oscillation

A peculiar condition occurs in an RCA RCS-82 chassis. An intermittent oscillation can be clearly seen on the screen. At other times this trouble disappears and there is a strong buzz in the sound with an accompanying beat around on the meter. The customer said both defects occurred about the same time, but it seems unlikely that one component would cause both symptoms.

I have replaced all rf and if tubes, both video and audio, without improvement. All voltages appear as per RCA schematic and, while I have noted changes in the sound signal during the trouble, I have been unable to clear up the defects.—T. L., Richmond, Va.

Ordinaril, from the information furnished, I could only suggest a thorough check of all components in sound if section together with alignment. However, in this chassis the probability is very great that the trouble is due to a defective dual capacitor Cl-a and Cl-b. (Fig. 3). It is used as a series and cathode bypass capacitor in the first stage of amplifier.

When Cl-b decreases in capacitance, as it often does, this stage oscillates at about 2 mc or so and will generally produce the buzz and beat pattern you
Phases reversal in picture

The picture on a General Electric has practically no contrast range and could be considered a monochrome. The set, model 810, shows very little change when the contrast control is varied. In fact, it would be correct to say that the picture is reversed—whites where the blacks should be and vice versa.

At first I took it to be the picture tube, but a new tube had no effect. I also noted that synchronization was very poor. The trouble could not be a weak signal because there is no snow in the picture. I then aligned the video amplifier. This produces a slight change, but not very much. All if and video amplifier tubes have been replaced with no luck.—B. S., Houston, Tex.

From your description, the trouble seems almost surely to be in the video amplifier section. Often many effects are mistakenly called a phase reversal.

However, if you clearly see a black-white reversal of tones, accompanied by very little contrast and a faint signal, the cause is an inoperative video amplifier stage. With this the video signal could feed through the internal grid-to-plate capacitance of the 12A7U (Fig. 4). The usual 180° phase reversal would be missing, causing the black-white reversal. In addition, with sync pulses of the wrong polarity, synchronization would be virtually destroyed, depending on how close to 180° the phase reversal was.

So check for plate voltage on the first and second video amplifier stages. Watch out especially for R39, as unreliable a resistor as any. It often opens and cuts off that stage. Also replace C27 regardless of what your checker indicates. If this does not help, check all components shown in Fig. 4. Most likely, the trouble will be, not an off-value part, but one completely open or shorted.

Fig. 1—Sound if circuits in Motorola television chassis type TS-102.

Fig. 2—Admiral 20Y4H sound if strip.

Fig. 3—The first sound if amplifier stage in the RCA type KC883 chassis.

Fig. 4—Video amplifier in G-E 810.
THE noninterlaced pulse generator of a closed-circuit television system forms line-rate (horizontal) and field-rate (vertical) timing pulses. These two pulse-generating circuits are not locked together, as they must be in an interlaced system, but run freely with respect to each other. Consequently, the noninterlaced pulse generator forms a sequential line structure instead of an interlaced one. When a standard television receiver is synchronized by the pulses from a closed-circuit camera using a noninterlaced pulse generator, a 60-frame raster is formed having some 250 scanning lines. If the pulse generator were of an interlaced type, a 30-frame raster with some 500 lines would result.

The noninterlaced generator is frequently used in closed-circuit cameras because of its circuit simplicity—it requires no counter chain nor phase-comparison circuit.

The pulse and sweep systems of the Dage 60-B closed-circuit camera are shown in Fig. 1. The frame-rate 60-cycle pulse is derived directly from the 60-cycle power line. A 60-cycle high-voltage sine wave is taken from a winding on the power transformer and applied through resistor R1 to a rectifier diode and the grid of V1.

The sine wave is clipped by the selenium rectifier and then fed to a differentiating or sharpening circuit consisting of C1 and R2. This circuit shapes the clipped sine wave which must excite the discharge-tube grid.

The shaped 60-cycle wave applied to the grid has a very high amplitude and drives the tube between cutoff and grid conduction. In fact a major portion of the applied grid waveform is below cutoff and therefore holds the tube cut off for a long interval. During this time a sawtooth trace is formed across capacitor C4. As this capacitor is charged toward B plus through resistor R3, a sharp positive swing of the grid waveform causes the discharge tube to conduct for a short interval. Now the C4 voltage is discharged because of the shunting of the conducting tube.

This portion of the cycle on the capacitor constitutes the retrace segment of the generated sawtooth wave. Hence the sawtooth wave generated in the plate of the tube can be used as a driving sawtooth for application to the grid of the camera vertical output tube. The output tube develops the deflection energy for the vertical deflection coil of the Vidicon camera tube.

Actually, the grid of the discharge tube is driven so far positive that it draws grid current and charges capacitors C2 and C3 to a high negative value. This action limits the extent to which the grid can be driven positive and prevents excessive plate current flow. The negative capacitor charge and the now-swinging negative portion of the grid waveform carry the tube way beyond cutoff. Once again capacitor C4 charges to begin another frame scanning cycle.

Note that the discharge tube conducts for only the short interval that the grid waveform (Fig. 2) swings positive. However, during this time the cathode-plate current is high and develops a sharp positive voltage across cathode resistor R4. This positive voltage is in the form of a pulse because, as soon as the tube is driven quickly to cutoff, the plate current ceases and no voltage is developed across the cathode resistor. The pulse developed across R4 coincides in time with the discharge period of the sawtooth wave developed across capacitor C4. The retrace time of the sawtooth constitutes the synchronizing and blanking periods of a television system. Hence the pulse developed across the cathode resistor can be used for synchronizing and blanking functions because it does coincide with the retrace period of the deflection waveform.

This is an important fact in understanding the operation of a closed-circuit system. During the retrace interval of the deflection waveform the scanning beam of the Vidicon is in retrace. Thus the camera itself must be blanked during this period. The blanking pulse is, in fact, the pulse developed in the cathode circuit of the discharge tube. Furthermore this very same sync-blanking pulse is also inserted into the video signal and, at each television viewer, will cause the picture-tube beam to be blanked during vertical retrace.

This very same pulse in a closed-circuit system can be used for synchronization. At the viewer the pulse is also applied to the vertical synchronization and sawtooth-generating circuits. As with standard TV receivers the synchronizing pulses start the retrace periods of the sweep waveforms. In other words, the retrace period of the viewer vertical sweep waveform has been made to coincide with the retrace period of the camera vertical-deflection waveform. In effect the vertical motion of the viewer picture-tube scanning beam corresponds with the similar motion of the Vidicon camera beam.

The frame rate is set at 60 cycles and framing thus follows in frequency and phase the variations of the power-line frequency. The close lock-in between frame rate and power-line frequency minimizes many of the hum and synchronizing disturbances to which a television system can be subject. It does so because any 60- or 120-cycle hum field produces a stationary disturbance on the scanning raster because the scanning rate itself follows in frequency and phase the troublesome hum activities.

The sawtooth wave developed across capacitor C4 is properly spiked by resistor R5 before application to the grid of the Vidicon vertical output tube. This step insures a linear change of current in the vertical deflection coil. A low-impedance coil is used and, consequently, it can be driven by a cathode-follower output stage. During the trace portion of the sawtooth wave applied to the grid of the vertical output tube the current rises linearly in the vertical deflection coil to produce a linear motion of the scanning beam. The cathode potentiometer permits linearity control by setting the output tube bias at a correct point.

Horizontal pulse formation

The horizontal pulse generator is a combined horizontal output tube and cathode-coupled multivibrator. To in-
sure stable operation of the multivibrator at the high horizontal frequency, a stabilizing tuned circuit consisting of inductor L1 and capacitor C5 is inserted in the grid circuit of the first section. The multivibrator frequency is also controlled in this grid circuit by regulating the B-plus value toward which the grid circuit discharges during the nonconducting period of the first section. During a long cutoff period of this tube, capacitor C6 charges toward B plus to form the trace portion of the deflection waveform. When the feedback cycle drives the first section into conduction for a short interval, this capacitor discharges quickly because of the shunting influence of the tube, forming the retrace period of the horizontal deflection waveform.

The horizontal sweep waveform excites the grid of the horizontal output tube. In so doing it produces a sawtooth current in the horizontal deflection coil located in the cathode circuit. Inasmuch as the second section conducts for a longer period than the first, the current in the deflection coil rises linearly to produce the horizontal trace period of one line.

The dc required by the focus coil also flows in the horizontal-output cathode circuit. The cathode of the first section is linked through capacitor C7 to the cathode of the second section to form the necessary cathode-coupled feedback link to sustain relaxation oscillations.

The width control is in the plate circuit of the first section. It regulates the B plus toward which capacitor C6 charges during the trace interval. Therefore it regulates the amplitude of the deflection waveform applied to the grid of the second section.

The second section of the horizontal cathode-coupled multivibrator conducts for a long interval. Consequently, a long positive pulse is developed at the cathode during this period. When the tube is nonconducting, the cathode waveform drops to zero. However, if we notice the cathode waveform closely (Fig. 3) we can see that in effect it can be considered a short-duration negative pulse. This negative pulse coincides with the horizontal retrace period. Again we have developed a useful pulse output that coincides exactly with the timing of a horizontal retrace interval. Thus we can use this pulse as a combined horizontal sync-blanking pulse for synchronizing the horizontal sawtooth-forming circuits of the viewer and to supply blanking for the picture-tube scanning beam of the viewer.

The functional block diagram of Fig. 1 demonstrates the simplicity of the synchronizing methods employed in closed-circuit television. The pulse generator is really a combined pulse and deflection waveform generator. By proper choice of circuits the sync-blanking pulses, as formed, can be made to coincide with the retrace intervals of the camera-tube vertical and horizontal deflection waveforms. Therefore the system can be synchronized and viewer and camera tubes blanked coincidentally with only a few tubes.

The number of pulse-generator controls is surprisingly few. The vertical circuit contains linearity and height controls only. No vertical frequency control is necessary because of the direct link with the 60-cycle power frequency. The horizontal circuit contains frequency, width and linearity controls.

The horizontal frequency control is adjusted to lock in the picture on the viewer. In many cases the viewer is a standard television receiver which has been adjusted previously to the correct horizontal frequency by tuning in a standard telecast station. The horizontal frequency of the camera is then adjusted until it too produces a locked-in picture on the receiver screen.

The linearity and size adjustments are generally set correctly at the factory. However, if adjustments are necessary a standard test chart is provided by the manufacturer. The chart is placed in position in front of the camera at a prescribed distance and the linearity and size controls are set to produce a linear and full-size picture on the viewer screen.

The next article will be on an interlaced pulse generator for closed-circuit television.
TEST INSTRUMENTS

VTVM servicing is not so simple!

Recognize the limitations when servicing with this instrument

By ROBERT G. MIDDLETON *

The VTVM appears to be an easy-to-use service instrument and, in general, this is so. Nevertheless, perplexing situations arise in practice. Some of these are discussed and analyzed here.

A good VTVM will always indicate the same resistance value, no matter which range is used, provided the resistor under test is linear. However, not all resistors are linear. Consider, for example, the filament of a small receiving tube. It has a higher resistance when hot than when cold (Fig. 1) and hence exhibits rated resistance only when rated voltage is applied to the terminals. But the voltage applied to the filament varies with the range which is used.

Consider, for example, a VTVM with a 1.5-volt ohmmeter battery (see photo) used to measure the filament resistance of a 1N34A crystal diode and tube filament.

<table>
<thead>
<tr>
<th>Range</th>
<th>Ohms</th>
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<tbody>
<tr>
<td>RX1</td>
<td>24</td>
</tr>
<tr>
<td>RX10</td>
<td>10</td>
</tr>
</tbody>
</table>

Since the 1N34A is rated to draw .05 amp at 1.4 volts, its rated filament resistance is 28 ohms. Hence it appears that the rated resistance was approached on the RX1 range, but was not approached on the RX10 range.

Consider a picture-detector crystal diode. The diode has a nonlinear characteristic, like a tube filament. Fig. 2 shows the difference between a linear and a nonlinear detector. The apparent resistance of a crystal diode on various VTVM ranges is as follows:

<table>
<thead>
<tr>
<th>Resistance (ohms)</th>
</tr>
</thead>
<tbody>
<tr>
<td>R×1</td>
</tr>
<tr>
<td>R×10</td>
</tr>
<tr>
<td>R×100</td>
</tr>
<tr>
<td>R×1,000</td>
</tr>
<tr>
<td>R×10,000</td>
</tr>
<tr>
<td>R×100,000</td>
</tr>
</tbody>
</table>

The varying resistance values are easy to understand by observing Fig. 2. The varying E/I ratio implies a different resistance value at different applied voltages. Thus, a rated front-to-back ratio for a crystal diode is meaningless, except at a specified voltage.

High-frequency measurements

To measure high-frequency voltages, a detector type probe, such as shown in Fig. 3, is often used. This probe provides an indication of the peak values of unmodulated high-frequency voltages when the output from the probe is applied to the dc input terminals of a VTVM. It also indicates the peak value of the carrier voltage in a modulated wave. The probe indicates the rms value of the modulating voltage in a modulated high-frequency voltage when its output is applied to the ac input terminals of a VTVM. Indication of the rms value is the result of passing the modulating voltage as an unrectified and unfiltered component in the probe output voltage, and the calibration of the ac ranges of the VTVM in rms values.

Just as the crystal diode is a nonlinear device, so is the demodulator probe. The practical result of this nonlinearity is that when voltage values of less than 1 are measured, the scale indication is somewhat less than the actual value of the voltage. And as

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* Field engineer, Simpson Electric Co.

Fig. 1—Voltage-current characteristics of crystal diode and tube filament. Dashed lines indicate voltage-current ratio at opposite ends of the curves.

Fig. 2—Detector characteristic types.

Fig. 3—Circuit of detector probe—measures peak of high-frequency voltages.
smaller and smaller voltages are
applied, the error becomes proportion-
ately greater. To avoid this difficulty
it is necessary to provide an auxiliary
scale for the probe when small volt-
gages are to be indicated. The probe
scale is cramped at the low-voltage
end, as is required by the diode char-
acteristics.

Some care must be taken when appli-
cing the output from a high-frequency
probe to the ac voltage ranges of a
vtvm because some service vtvm's do
not have a high-impedance input for
ac, but provide only a copper-oxide or
selenium type ac circuit which has a
low input impedance of 1,000 or 5,000
ohms per volt. Unless the input imped-
ance is much higher, the probe will
not operate satisfactorily. The input
resistance of the instrument shown in
the photo is 270,000 ohms on the ac
volts range.

Test points must be avoided which
apply excessive input voltage to the
crystal probe, as loss of sensitivity or
complete burnout will result. If a 1N34
crystal is used, probe manufacturer
usually rate the maximum input volt-
age as approximately 20. Test points
which have a high impedance must also
be avoided, since the loading effect of a
demodulator probe is appreciable.
Thus, signal tracing in the if circuits
of a TV receiver with a vtvm and
demodulator probe is a questionable
procedure because the input capacit-
tance of the probe detunes the circuit
under test and impairs the measure-
ment. Sometimes the indication is only
attenuated, but sometimes the shunt
capacitance throws the circuit into
oscillation and the indication is
enormously increased. Since the lower volt-
gages which can be read on a vtvm
scale are useful only at the last if
stages, signal tracing by this means is
largely impractical.

Testing with weak batteries
A linear resistance will appear to be
nonlinear when tested with a vtvm
which has weak batteries in the omm-
eter circuit. For example, a 100-ohm
composition resistor gave the follow-
ing apparent readings when tested
under this condition:

<table>
<thead>
<tr>
<th>Range</th>
<th>Ohms</th>
</tr>
</thead>
<tbody>
<tr>
<td>R×1</td>
<td>50</td>
</tr>
<tr>
<td>R×10</td>
<td>90</td>
</tr>
<tr>
<td>R×100</td>
<td>100</td>
</tr>
</tbody>
</table>

The variation in apparent resistance
is caused by the varying current drain
in the ohmmeter circuit on the various
ranges and the great increase in inter-
nal resistance of the ohmmeter battery
on the heavy-current ranges. A fresh
battery has a practically constant inter-
nal resistance in the ohmmeter circuit.
It gives correct indications on all
ranges.

Tracing ac signals on dc range

It is sometimes not clearly understood
how an ac signal can be traced through
some sync circuits; for example, using
the dc voltage ranges of a vtvm. How

this is possible is shown in Fig. 4. The
applied sync pulse is an ac voltage
waveform which is partly positive and
partly negative. There is just as much
positive electricity in the waveform
as there is negative, so that the zero-
volt level in the waveform exists at
the point which divides the waveform
into equal positive and negative areas.
(“As much” electricity means current
×time. Zero-volt line is a time axis.)

Fig. 4—Developing grid-leak bias.

The positive excursion drives the
tube to grid current flow in a circuit
using signal-developed bias. The grid
current flow traps electrons on the grid
coupling capacitor, which then have
a limited rate of escape through the grid
leak. The end result is the buildup of a
negative dc voltage on the grid when
a signal is present. This dc voltage
from grid to ground can of course be
measured on the dc ranges of a vtvm.

To obtain a clearer understanding
of the voltages in a capacitively coupled
circuit, refer to Fig. 5. Here the sync
pulse is superimposed on the dc plate
voltage on the plate side of the couple-
ing capacitor; the voltage here is pul-
sating dc (which never goes negative)
and consists of an ac voltage super-
imposed on dc. The capacitor will “con-
duct” the ac voltage but blocks the dc.

Test Instruments

Fig. 5—Voltage relationships on plate
and grid sides of coupling capacitor.

When the ac function of a vtvm is
used to check the voltage on either side
of C, the same value is indicated. This
equality results because the ac func-
tion of the vtvm itself utilizes a block-
ing capacitor whereby only the ac com-
ponent of the voltage is passed into
the meter circuit.

When the dc function is used to check
the voltage on either side of C, different
values are indicated. This inequality
results because the dc voltage on the
plate side of C is determined by the
value of B plus; the dc voltage on the
grid side of C is determined by the
amount of grid current drawn by the
tube in response to the applied ac signal.

Daughter of Necessity

FORCED to do a minimum amount of
lifting due to a bad back, I con-
structed what I believe to be an inter-
esting and unusual workbench arrange-
ment. This setup (see photo) has been
in use for 4 years with no changes
except the addition of antenna outlets.

For these, I installed Blonder-Tongue
equipment composed of channel strip
amplifiers for channels 3, 4, 12 and 13,
using an eight-outlet distribution am-
plifier to feed my workbench.

The bench is approximately 40 feet
long, with National Trolley rail mounted
overhead. From this I have all my
test equipment, as well as the tele-
phone, suspended on rollers so that it
can be rolled to any location on the
work bench. The telephone line travels
on pulleys from one side of the rack
with the ac power (to test equipment)
traveling on the opposite side.

This arrangement permits me to
work my entire bench with one set of
test equipment by rolling the instru-
ments to any position.—Jack Wise
AUDI0 SIGNAL GENERATOR

Resistance-tuned instrument is small, light, safe and versatile

By LYMAN E. GREENLEE

A SIGNAL source was needed for checking audio equipment. The basic requirements were: small size, light weight, adequate isolation from power lines, complete frequency coverage, provision for monitoring the signal with a scope and enough power output to check loudspeakers without additional amplification. No low-priced commercial equipment available met all the above requirements, so I designed and built my own audio signal generator. It is rugged and reliable, and anyone interested in working with sound equipment may find it a tool well worth the time and cost of construction.

No chassis is used or needed—all parts are mounted directly on the front and back covers of a standard 6 x 6 x 6-inch utility cabinet (see photo). Although the front and back panels are permanently wired together, they can be easily removed from the cabinet for service by turning the back panel at an angle so it will slip through along the diagonal.

The power supply, which is built on the back panel, uses a small filament transformer combined with an output transformer for isolation from the power lines, a necessity for successful operation of test equipment. This power supply has proved very satisfactory. Since the normal plate drain of the two tubes is about 5 ma, the transformers do not even get warm. This power supply is easily adapted to other test equipment and is much lighter than most supplies using conventional power transformers.

A 12AU7 miniature dual triode is used as a resistance-tuned audio oscillator. With the values shown in Fig. 1 the tuning range should be from about 75 to more than 30,000 cycles; the upper range extends well beyond the limits of the human ear. The output voltage is uniform through the audible range but will fall off rapidly as the ultrasonic limit is approached. The top and bottom frequency limits will depend somewhat on the characteristics of individual tubes and the tolerances of the various parts.

The values of C1 and C2 have a considerable effect on the frequency coverage of this generator. The combination of .002 and .005 µf, respectively, provides a usable range from 75 to 35,000 cycles. Using .007 and .01 µf, the range goes from 50 to 25,000 cycles; .012 and .015 permit a range from 25 to 15,000 cycles. Thus, increasing the values of C1 and C2 gives a lower frequency response at the expense of reducing the high-frequency coverage.

There is a slight shift in frequency as the feedback control is varied. To calibrate the dial accurately, a fixed setting of this control must be marked on the front panel. This point may be ignored for most applications since we are not always too concerned about the exact frequency when checking speakers or audio amplifiers.

The feedback control should always be set at the lowest point which will produce satisfactory oscillation. This adjustment should be made while observing the waveform on an oscilloscope so that the waveform will have minimum distortion. If excessive feedback is used, the output will contain highly distorted pulses. Actually, owing to the stabilizing effect of the 3-watt bulb in the cathode of the 12AU7, very little change in the feedback control is necessary while tuning from one end of the dial to the other. By monitoring the output on a scope, the distortion can be held to a minimum and a very pure sine wave will result. The waveform is of little concern unless checks for distortion are being made.

The signal generator is useful for making distortion checks when used with an electronic switch and scope so that input and output waveforms can be viewed simultaneously. I found it convenient to monitor the output on a small scope, using a larger scope as a signal tracer to observe the waveform at various points in the amplifier being checked. This method is faster and involves no difficulties in the way of feedback, crossed wires and haywire hookups, bound to occur if a single scope is used with the electronic switch for signal tracing. For an overall check the electronic switch may be preferred because a direct comparison of waveforms can be made on the same screen.

The 12AU7 feeds a 6C4 miniature triode used as the output amplifier. A low-voltage high-current signal is thus available for checking speaker voice coils. However, since some distortion is introduced by the small output transformer, a direct output connection from the 6C4 plate is also provided. This connection may be used when making checks with the scope for distortion or for any application where higher voltage output is needed. Although the distortion from the output transformer cannot be detected by ear, it is easily visible on a scope.

 Provision is made for connection to the 6C4 grid through a pin jack and 0.1-µf capacitor. This input connection may be used to mix another audio sig-
nal into the 6C4 grid while calibrating the instrument or it may be used for low-amplitude audio output directly from the 12AU7. A calibration chart should be made for the signal generator. The most convenient way to do this is to use another audio generator as a reference source. Couple them together and tune to zero beat to locate fundamentals or harmonics. A cathode-ray oscilloscope is a useful zero-beat or null indicator.

A cathode connection to the 6C4 provides a signal 180° out of phase, useful whenever a phase inverter is called for (checking push-pull amplifiers, etc.). The cathode connection may also be used to monitor the waveform on a scope. These features are extremely worth while when a critical analysis of amplifier performance must be made, yet they are missing from most commercially built instruments.

**Generator construction**

The two miniature tube sockets should be fully wired before they are fastened to the panel. They are slipped over 1-inch 6-32 screws and soldered fast. Very little actual wiring is required, as most connections are made with the capacitors and resistor leads.

The 3-watt lamp in series with the 750-ohm cathode resistor is mounted in a socket salvaged from a candelabra panel-light assembly. Since one side of the lamp (G-E 3S6) is grounded, the socket can be bolted directly to the front panel, the bolt making the center contact.

Different transformers from the ones specified may give an unsatisfactory dc voltage, so a preliminary check should be made to ensure the voltage is within the 120–150 range. (Up to 250 volts could be used on the plates of the tubes, but this is too high for the filters and selenium rectifier in the power supply.) To operate the 12AU7 on 6 volts it is necessary to connect its two heaters in parallel by joining pins 4 and 5 together at the socket. Total heater drain for the two tubes will be 450 ma. Certain parts have been specified by manufacturer's name and part number to enable the constructor to duplicate the generator more easily. Other items are standard and require no particular care in their selection.

Fig. 2 shows an alternate output circuit that may be used when an output transformer is not used in the plate circuit of the 6C4. The circuit is a cathode follower and delivers a surprisingly uniform output voltage over the usable range of frequencies. The output voltage shown is the minimum average over the entire range.

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Fig. 1—Schematic of the resistance-tuned af signal generator with three output terminals. Fig. 2—Alternate output circuit eliminates transformer.

**Parts for audio generator**

- Resistors: 2–510,000 ohms, 1/2 watt, 5%; 1–47, 1–500, 1–560, 1–750, 1–1,500, 1–5,100, 1–25,000, 1 watt; 1–35,000-ohm carbon potentiometer (Ohmite CU251 or equivalent); 1–600,000-ohm dual potentiometer (Ohmite CCVP256 or equivalent); 1–100,000-ohm potentiometer (Ohmite CU140 or equivalent).
- Capacitors: 1–C1 and C2 (see text): 1–0.01, 1–0.05, 1–0.1 µf, 400 volts; 1–20-25 µf, 150 volts, electrolytic.
- Miscellaneous: 1–12AU7; 1–6C4; 1–F-pin, 1–F-pin.
DELAY and TIMING GENERATOR

By TOM JASKI

For the great majority of service tasks and the most frequently encountered experimental work commercial oscilloscopes in the low- and medium-price ranges are adequate. A compromise between versatility and economy, they are designed for a specific and, in some respects, limited field of work.

With new high-speed films generally available and with a greater interest in pulse techniques applicable to the growing uses of electronic control, the prospects of observing and photographing cathode-ray tube patterns become more feasible and attractive.

However, this type of work brings with it certain demands not readily met in the average oscilloscope. Observing transients, for example, requires close control of the scope sweep so that the trigger producing the transient can be made also to place the transient waveform in the proper position on the screen. Or, it may happen that a certain sequence of events has to take place ahead of the desired trace observation. Fairly long delays may be needed; relay sequences could be such a case.

It is possible to use a camera with shutter-operated flash contacts, allowing these contacts to trigger the event. This places a somewhat serious limitation on the delay, generally fixed at some convenient values such as 5 or 20 milliseconds. In photography these delays are short, but in oscillography we work in microseconds and delays measurable in milliseconds are enough to waste a good deal of film and effort.

There is another class of work not readily performed with standard oscilloscopes, excluding again those in the higher price bracket: the observation of very slow or very fast voltage variations. The very fast phenomena put another demand to the scope, generally requiring special vertical deflection amplifiers which are connected directly to the vertical deflection plates.

The limitation of the scope amplifier is not so much the frequency response, as often advertised, but the rise time, not so much emphasized. A real problem in industry, the requirements are rarely as severe for the average experimenter. No such limitation is encountered at the other end of the scale—the low-frequency waveforms. Virtually all scope amplifiers are usable to 1 cycle or lower, and all we need then is a slow enough sweep to scribe our pattern.

To solve my problems of observing and photographing transients and low-frequency waveforms, a separate sweep generator was built to supply a sawtooth waveform of excellent linearity, as slow as 1 cycle and up to almost 1 megacycle. For a 4-inch deflection this works out from 0.25 second per inch to 0.25 microsecond per inch (if the horizontal amplifier will permit).

The generator also furnishes sweep...
delays from 2 seconds to 1 microsecond and supplies externally a delayed pulse and a blanking pulse at the end of the sweep. The sawtooth wave can be repetitive or triggered. The repetitive sawtooth can be synchronized with an external input.

Fig. 1 shows the complete circuit diagram of the generator. This can be divided, for discussion, into four parts: the power supply, the pulse selector and shaper, the delay univibrator and the phantastron sawtooth oscillator with blanking pulse discriminator. The power supply needs no discussion, except that the better the regulation, the greater the accuracy of the sweeps and the greater the stability. If very high accuracy is required, more effective regulation should be considered. Excellent voltage-regulated power supplies have been described in RADIO-ELECTRONICS (August, 1952, page 47; April, 1952, page 66).

Pulse selector and shaper

The function of the selector and shaper is as follows: A signal of any waveform or a pulse of any polarity is applied to the grid of the triode half of the 6U8 through the .01-µf capacitor. The signal then appears at the cathode of the triode in the same polarity as the input and at the plate with opposite polarity. The trigger polarity switch is used to select the negative polarity trigger always. Thus at the plate of the pentode a positive signal appears. The pentode always conducts, but conducts less when the trigger signal is impressed on the grid. The amplitude (and with certain waveforms, the pulse shape) is regulated by R1, which alters the bias on the pentode. If the trigger is a sine wave, the signal from the pentode will contain both a negative and a positive peak. Since a positive peak only is required to trigger the delay univibrator, the trigger is next sent through a diode, one half of a 6AL5, which effectively eliminates the negative peaks. The 6U8 is coupled to the diode through differentiating network C1-R2, which further sharpens the pulses. The positive trigger is applied through coupling capacitor C2 to the univibrator. The coupling capacitor is needed since otherwise the cathode of the diode would be biased and the signal would be blocked.
Fig. 2-a shows the resultant pulse when a sine wave is applied to the pulse shaping circuit.

**Delay univibrator**

There are many circuits which can provide a variable delay. For example, a phantastron similar to the one described here as sawtooth and blanking generator is frequently used. All that is required, basically, is a monostable circuit which, after a period of time, returns to the rest condition. However, the univibrator has certain advantages: the pulse output varies only very little with different delays; it is a relatively simple circuit and very easily controllable over a very wide range.

The univibrator was described in the October, 1954, issue of *Radio-Electronics*.

The first triode is normally cut off; the second triode conducts. A predetermined bias is placed on the grid of V3-a, set by potentiometer R3. When a positive pulse arrives from diode V2-a, V3-a conducts and charges capacitors C3-C8, selected by the delay time switch.

The current of V3-a lowers the voltage at the plate and also on the grid potential of V3-b until it is cut off. This causes a sharp rise in potential at the plate of V3-b (see Fig. 2-b) and the grid of V3-a coupled to it through resistor R4. Triode V3-a conducts more vigorously, charging the delay capacitor through R5 and R6 and finally reaching the point where the grid of V3-b has sufficient voltage on it to once more make it conduct. The resultant drop of V3-b plate voltage coupled back to V3-a cuts off the latter and the original condition is restored. The off period of V3-b corresponds to the delay time, forming a square wave of that length. Through differentiating network C9-R7 this appears as a pair of pulses, one negative and one positive. The negative pulse only is passed on through diode V2-b to the phantastron. Potentiometer R8 is adjusted to prevent the univibrator from running free without a trigger. With trigger applied and trigger amplitude full on, set R8 to allow the univibrator to trip at the trigger frequency.

**The phantastron**

For the sweep oscillator the phantastron circuit was selected because of excellent linearity and wide frequency range. It is also suitable for repetitive (free) running (Figs. 2-c, d) and for trigger operation (Fig. 2-e) and can be changed from one type of operation to the other by merely changing the bias with potentiometer R8.

The phantastron is made up of two tubes: a 6BH6 (V4) and a cathode follower which is one half of a 12AU7 (V8-a). Basically the phantastron is a transitron type of oscillator. But when triggered, the transitron characteristics are not used as the circuit operates here. The plate resistor in the V8-a plate circuit can be ignored in the
discussion of function for it was put there only to provide a takeoff point for the blanking pulse amplifier.

At rest position the voltages at the tube elements are:

<table>
<thead>
<tr>
<th>Pentode</th>
<th>Cathode Follower</th>
</tr>
</thead>
<tbody>
<tr>
<td>plate</td>
<td>plate</td>
</tr>
<tr>
<td>suppressor grid</td>
<td>control grid</td>
</tr>
<tr>
<td>suppressor</td>
<td>cathode</td>
</tr>
<tr>
<td>cathode</td>
<td>control grid</td>
</tr>
</tbody>
</table>

The apparently lowered plate voltage on the plate of V4 reaches 180 because V5-a is drawing grid current through the 470,000-ohm plate resistor.

At rest position the voltages on the V4 voltage are cut off by the negative voltage on the suppressor grid. The triode conducts heavily and keeps the timing capacitor charged. The screen of V4 also draws current. When a negative pulse arrives on the plate of V4 and grid of V5-a, grid current drops and the plate will momentarily conduct a part of the total cathode current. Since the control grid remains at equilibrium, the total cathode current will be the same. The screen will draw less current, allowing the screen voltage to rise sharply.

Through voltage divider R9-R10-R11 the suppressor will be brought up to almost 0 and the plate continues to conduct, lowering still further the plate voltage on V4. This eventually falls to about 18. The lowering plate voltage on V4 reduces the voltage applied to the cathode, and at the time the plate voltage is cut off, the cathode, and also, considerably below the cathode voltage, and cuts off V5-a for the time being.

The charging capacitor selected discharges the so-called "rundown" at a rate determined by the values of divider network R9-R10-R11 and also by the position of sweep-time potentiometer R14, which determines the equilibrium point for the grid. These resistors are so arranged that with increasing plate current the grid becomes more rapidly less positive, thus restoring equilibrium and allowing a linear rundown.

When the capacitor contains no further charge, V4 is very near cutoff for the very low plate voltage then present. At this point the energy stored in capacitor C10 is sufficient to kick the suppressor grid negative and cut off V4. It remains cut off until another negative pulse arrives on the plate. The sudden jump in plate voltage results in plate cutoff and V5-a to conduct heavily and rapidly recharge the timing capacitor. When continuous operation is desired, the bias on the suppressor grid is so arranged that, when the timing capacitor contains no further charge, there is not sufficient energy to restore the plate-cutoff condition and the cycle repeats itself—when V4 momentarily cuts off altogether and allows V5-a to recharge the capacitor.

Blanking amplifier

The frequency range of the sweep generator is determined by three factors: potentiometers R8, R14 and R16.

Potentiometer R16 sets the upper limit, R14 the lower. These pots interact to a certain extent since changing either affects the relative value of R15 and the other. The following shows the approximate range in each position:

- 1-5 cycles: 5.0-4.0 kc
- 2-25 cycles: 6.0-25.0 kc
- 3-120 cycles: 7.25-290 kc
- 4-80-650 cycles: 8.180 kc-1 mc

The above cover about a 1-to-8 frequency range. By resetting R8 a frequency ratio of 1 to 10 can be obtained with a minimum frequency down to 1/4 cycle. Thus, if a calibration scale is desired, it must be made with R8 in one certain, repeatable position.

The blanking amplifier is supplied with a sawtooth signal from the plate of the phantastron cathode follower through differentiating network C11-R17. The small capacitance and the high bias on the tube (V5-b) allow only the very highest peaks of the sawtooth wave to be amplified, resulting in a sharp negative pulse (Fig. 2-h). These pulses are of the correct polarity for direct connection to the grid of a cathode-ray tube. The blanking pulse (Fig. 2-f) voltage obtained is about 15 volts peak, depending on the setting of the cathode bias on the blanking amplifier triode. This is usually sufficient to do an adequate blanking job. Potentiometer R18 varies the shape of the blanking pulse, generally close to tube cutoff.

The output voltage of the sawtooth oscillator is approximately 40 volts peak in the free-running condition. This again depends on the bias setting in this case of the suppressor grid bias. The output voltage in the triggered operation is somewhat less, primarily because a greater bias must be applied to prevent free running. The output voltage of the delayed pulse (Fig. 2-g) is a sawtooth waveform. This pulse is always of very short duration. Any device to be operated by the delayed pulse will generally require some intermediate amplifier or triggered relay, such as a 5823. The narrow pulses have been used successfully to trip a 5823 cold-cathode relay tube.

Construction

A compromise between etched circuits and wiring has been used. See Fig. 2-e. It has been possible to use a larger printed circuit which could contain the screwdriver-adjusted potentiometers, or even the capacitors mounted on the range switches. Or a single circuit board could be used with some intermediate generation or generator chassis. For those who wish to use etched-circuit techniques to build this generator, see "Making Printed Circuits Is Easy," September, 1955, and "Making Phototetched Circuits," December, 1956, Radio-Electronics, p. 1156. The boards in the photos can be used as guides, but it would not be practical to copy them exactly unless it is first established that parts of exactly the same dimensions are available. I had some thick, short 15,000-ohm 5-watt resistors and designed the power supply board accordingly. More length may well be required, unless a miniature 5-watt type is available. The generator board, however, is designed with entirely standard parts.

Those desiring to use wire construction will find the wiring not particularly critical. The univibrator will not trigger on anything but a positive signal, and the phantastron must have a negative signal. However, it would do well to keep the input trigger circuit wires away from those connected to the univibrator input and the phantastron trigger input to prevent false triggering. The phantastron sockets and connections must be kept clean and the tubes used of good quality for leakage discharge of the capacitor might start a rundown without a trigger, no matter what the bias setting is.

Operation

If a repetitive trigger is supplied to the univibrator delay circuit, the delay setting must be less than the space between triggers. If this is not observed, triggers will be missed and the operation will become erratic. Similarly it is not possible to operate with a sweep time greater than the space between triggers. If such a setting is made, the phantastron will simply trigger on alternate pulses or will operate on some other multiple or submultiple of the trigger repetition rate.
TEST INSTRUMENTS

Setting Your Checker For New Type Tubes

Checking the latest tubes, or, what to do until the new roll chart arrives

By BASIL C. BARBEE

NEW tube types are appearing at the most rapid rate in electronic history, making it quite a problem to keep tube-tester data up to date. A new type need not be any better than its predecessor; all that is required is that it be different, if only in some minor respect such as a slight change in basing. How can the technician test a new type he has never even heard of and cannot find listed on the roll chart of anybody's tube tester? Here is the procedure I developed during the testing of some hundreds of thousands of tubes over a period of years. It may not be the best approach, but it is one that has worked for me.

The oldest and simplest way of determining whether a tube is defective is to substitute a known good one of the same type and note whether the performance of the set is improved. This method is sometimes useful even when a tube tester and up-to-date chart of settings are available. For instance:

A tube may test good yet may oscillate in its circuit due to an open screen or other internal shielding.

A tube may test good yet may fail to perform in a high-frequency oscillator circuit due to small changes in interelectrode capacitance as a result of misalignment of the tube elements.

A tube may test good yet not work satisfactorily in a TV horizontal oscillator or sync-clipper circuit due to its being used in the circuit under conditions other than those for which it was designed and tested.

The substitution method fails under certain conditions:

When no known-good tube of the same type is available for substitution. Having a new tube on the shelf is no guarantee that a good tube is available; new tubes, particularly of a new type, may be defective, usually due to interelectrode shorts. A tube which has performed daily for a year is a far better bet than a new one fresh from the distributor.

When the equipment in which the tube is used is not at hand, as when a customer brings in a tube for test.
When there are one or more faults in the set in addition to the suspected tube.

Data-compilation method

The first step in this method is to understand your tube tester. Read the instruction book thoroughly and find out just what connections of the controls on the panel is for and how it works. Study the schematic so that every time you turn a switch or dial and push a button you visualize what is happening inside the instrument.

The second step is to accumulate every scrap of information on the characteristics and base connections of every new tube type that comes out. A subscription to one of the looseleaf tube-data services offered by the leading tube manufacturers will pay for itself several times in a year in time saved. Better still, subscribe to two or more such services since a new type will sometimes be announced first by one company, sometimes by another.

Take sample sheets from each looseleaf stock and stack them. If you buy a sheaf of blank sheets to match one of them. Then order an extra looseleaf binder from the tube manufacturer (if you want it to match the others) and make up a volume of new and unusual types from clippings from RAY-ELECTRONICS and other magazines by pasting the clippings to the blank sheets. When these types are covered by the printed supplements issued for the looseleaf manuals, the homemade sheets may be thrown away.

The third step is to identify the new tube with a similar type which appears on the roll chart of the tube tester or to make up the test settings for a unique type. A complete and up-to-date interchangeability chart will frequently be helpful in determining kinship of tube types.

"There is nothing new under the sun" is almost always true in new tube types. Usually a new type will be simply a well-known one with different cathodes or heater ratings or a combination of two or more single-purpose tubes in one envelope. If the electrical characteristics and base connections of the new type are at hand, it is an easy matter to find a similar type whose test settings are given on the chart of the tester—unless the new one has unusual base connections, in which case a knowledge of the workings of the tube tester, as recommended above, will be necessary. When comparing published characteristics, the interelectrode capacitances are of no importance and may be neglected since the testing will be done at 60 cycles.

In most tube testers one heater pin, the grid pin, a suppressor pin (if any) and any other elements other than grid, plate, and screen of the section of the tube being tested are grounded. (In emission type testers, suppressors are not necessarily grounded; with triodes, of course, there is no screen.)

Which pin goes to the heater supply is selected by a switch or by plugging the tube into the proper one of two or more sockets. The heater voltage is selected by another switch which may or may not be calibrated in volts. If it is simply labeled with consecutive numbers, the number in terms of voltage may be determined by referring to the settings on the chart for tube types of known heater voltage. If the tube has a tapped heater, it is essential that the tap be ungrounded. Some of the more flexible of the tube testers make it possible to test centertapped heater tubes with the two halves in either series or parallel. In the parallel case, both ends of the heater are left grounded, with heater voltage applied to the tap. A third switch usually selects the plate load resistance for the tube under test. One position will be for all ordinary amplifier tubes, another for rectifiers, a third for diode detectors and perhaps other positions will be provided for pentagrid converters, transistors, triodes of unusual transconductance and other tubes of special characteristics. This switch may take the form of a series of pushbuttons.

Grid, plate and screen pins are selected by other switches or pushbuttons. (In emission testers, usually all elements except the cathode are connected together and tested as a diode plate.) A variable resistor is used as a fine adjustment of plate load resistance or as a sensitivity control in the meter circuit. The setting of this control will vary roughly as the plate resistance of the tube type under test and may be estimated fairly closely for a new type of known characteristics from a knowledge of the characteristics of tube types listed on the chart.

Another control (except in emission testers) is used to adjust the ac excitation applied to the control grid. Settings of this control will vary roughly inversely as the amplification factor of the tube and may be estimated by comparing characteristics as in the case of the plate load or sensitivity control. On a transconductance tube, sharp-cutoff tubes may be differentiated from remote-cutoff (variable-mu) types by noting the manner in which the meter needle indicates the grid excitation control is varied.

Inspection method

Suppose the questionable tube is so new that no published data are available, either in the tube manuals or in the magazine clippings? Most new types are glass miniatures with the aid of a magnifying glass the base connections may be determined by visual inspection, particularly if you have ever handled similar tubes and studied their structure.

By drawing your diagram of base connections, don't forget that the pins are numbered clockwise looking at the base of the tube, whereas you will be looking from the opposite direction since the button of a miniature tube is not very transparent. Be sure also not to overlook any "built-in shorts" (where two or more pins are connected together internally) as frequently found in high-frequency tubes. Otherwise, you may discard a perfectly good tube by mistaking a "shorted" connection as a fault.

An easier method of determining the base connections is by noting the small numbers around the tube symbol on a schematic, if one is available, or by inspecting the connections to the socket underneath the chassis in which the tube is housed. Visual inspection of the tube geometry (relative spacing of elements, pitch of grid windings, cathode area, etc.) and by comparison with tubes of known characteristics.

Heater ratings may be estimated by inserting the tube in the tube tester (after having first identified the heater pins) and slowly raising the heater voltage from the lowest tap until the color of the cathode changes. A single-looking tube operated at normal heater voltage. If desired, the heater current may now be determined with an ammeter (with normal voltage, as determined above, applied to the heater). When working with tubes taken from a series-string set, it may be simpler and quicker to adjust the heater voltage till the ammeter reads the correct heater current. Then it should be operating at the nominal voltage and the heater should look normal. If the tube is in series with others of known characteristics, its correct heater current is known. Similarly if a tube is in parallel with others which are known, its heater should appear normal at the heater voltage which that tube demands.

Knowledge of the heater current is useful in estimating the other characteristics of the tube inasmuch as the transconductance is roughly proportional, all else being equal, to the heater power (voltage times current).

Characteristics estimated in the manner described, while not highly accurate, are sufficiently so for all practical purposes in tube testing. In combination with a thorough short check, a tube's condition can be determined on the basis of data arrived at by inspection will tell whether or not a given tube could have caused the operational fault of which it is suspected. This data are therefore valuable enough that you would be willing while to record them on a looseleaf sheet to be filed in the extra tube-manual binder until the manufacturer's data arrive, and to add the test settings derived from them to the supplementary test data chart.

Even though the type number on a tube may be illegible, the inspection method will still yield the approximate data. If the tube test bads, you have the data to help find a replacement for it; if it tests good, all you have to worry about is how to file the data sheet.

SEPTEMBER, 1956
THE LABORATORY

By JOSEPH MARSHALL

Part II—Adding variable damping; construction and adjustment

As pointed out in the first part of this article, the Laboratory Golden Ear has gone through many modifications and has not yet reached its final form. (Nor will it do so in the foreseeable future.) Fig. 1 is a basic diagram showing the features which have been more or less preserved throughout the various evolutionary steps. In its present form, the amplifier is used experimentally in testing tubes, transformers, etc., and for other purposes. It is therefore fitted with an assortment of pots by no means necessary for normal use. The photo (Part I) shows an assortment of inputs and outputs not needed by the average user.

Neither schematic nor photo is therefore intended as a model for exact duplication. They are offered as basic ideas to be modified to suit the requirements of the advanced audiophile. The amplifier portion can be built on a 7 x 12 x 3-inch chassis with room to spare. I recommend a separate chassis for the power supply; hum is minimized and low-level intermodulation held down to the vanishing point. Aluminum chassis material is recommended.

Layout is completely noncritical if separate chassis are used. I recommend using Vector turret sockets for the twin-triode portion of the circuit. Better yet are the Vector turret decks; the No. 8-4N-64-2 is a four-socket unit. Completely wired it will hold all the components except the large capacitors and occupy a space a little over 5 inches long, 1 1/2 inches wide and just under 3 inches deep. The deck can be wired completely before mounting on the chassis. All interconnections with the rest of the circuit will come into easily accessible lugs on the bottom of the deck. If you cannot obtain this item from your dealer, Vector Electronic Co., 3352 San Fernando Rd., Los Angeles 65, can supply it direct for about $2.30 plus postage. The pots can be mounted on one end of the chassis. The output-stage components are few and can be mounted from socket to socket. Ceramic or mica-filled sockets are recommended because of the high voltages applied to adjacent plate and screen pins.

Run a common bus bar of No. 18 or larger wire from the input jack to the center terminals of all turrets, or the turret deck, and return all circuit grounds to this bus. Be careful not to ground one of the filament lugs. The filaments are biased about 50 volts; grounding the loop will remove the bias. This may not be noticeable in increased hum but it will increase the IM at low levels.

The power supply (Fig. 3) uses readily available components. If the amplifier is to use a single pair of KT66's, a simpler and cheaper supply with a single 5U4-G and capacitor-input filter can be used (see parts list). With two tubes the no-signal current will be less than 125 ma and maximum-signal current about 175 ma. With four tubes the no-signal current is around 225 ma and maximum under 300.

Variable damping

This amplifier was designed primarily, as its name implies, to serve as a laboratory-grade piece of equipment that can be used for measurements. For this reason, variable damping was not included in the original. However, due to the current popularity of this feature, I did some experimenting with variable-damping circuits and

![Fig. 1—Schematic diagram of the Laboratory Golden Ear—less power supply.](image_url)
came up with a modification (Fig. 2) that works well. The feedback circuit now includes switching so the variable-damping feature can be put out of action when using the amplifier for measurements.

The variable-damping arrangement follows the principle used in Bogen's amplifiers. Due to the choice of values, the adjustable current feedback is effective only at frequencies below about 200 cycles. Adjusting the 25-ohm pot provides a choice of either positive current feedback for increased damping or negative feedback for decreased damping. When the 1-ohm 10-watt variable resistor is correctly set, the 25-ohm unit provides continuous adjustment over a range of about ±10 db. The 100-μf electrolytic capacitor restricts the current feedback to the low frequencies. The 1-ohm resistor will rob the speakers of some power, but audibly the loss is insignificant.

Adjustment

When the amplifier is finished, check for continuity and shorts with an ohmmeter. When you are sure all is well, adjust as follows:

1. Insert only the 12BH7 with the output bias pot about half on. Connect a vtvm from one cathode to ground and adjust for a reading of minus 38 to 40 volts. (It is possible to obtain positive bias, so be sure the polarity of the vtvm is right.)

2. Insert the KT66's and readjust the bias to obtain a total cathode current of about 100 ma for a pair and 200 ma for four KT66's.

3. Balance the output tubes with the output balance control in the cathode leg of the output tubes. Use a voltmeter connected from plate to plate and adjust for zero voltage difference.

4. Insert the other tubes (with power off). Connect the vtvm from cathode to grid of one section of the 12AX7 driver tube. (Be sure it is the same section.) Adjust the driver bias pot for a bias of 2.25 volts.

5. Throw the balance switch to balance (which ties both input grids together and disconnects the feedback loop). Feed in any signal and adjust overall balance in the input tube circuit for a null or minimum output.

6. Set the balancing switch in its center position and feed in a sine-wave signal; adjust the input to provide an output reading of 1 volt.

7. Throw the balance switch to operate. If variable damping is used, inactivate it by throwing its switch to off (contacts closed). Observe the reading on an output meter. It should be about 18 to 20 db down from the 1-volt reading between 0.1 and 0.11 volt. If the reading is higher, reduce the value of feedback resistor R1 (Fig. 2) slightly; if lower, increase the value slightly. If you have a scope and square-wave generator, check the appearance of a 20- or 30-kc square wave; it should be quite vertical and with little or no trace of ringing. If the ringing is excessive, add small capacitances in parallel with phase-shifting capacitor C1 which shunts the feedback resistor. If there is rounding of the leading edge, replace C1 with a smaller capacitance. The values given should be satisfactory unless the capacitor used is way off its rated value.

8. If using variable damping, throw the damping switch to the on position. If you have a square-wave generator and a scope, set the generator for 200
AUDI0—HIGH FIDELITY

In a word, the key to the use of the damping control is the idea of constant damping. The essential point is the use of constant damping control. If you have no square-wave generator and scope, set the control about half on. Now, with the speaker you are going to use with the amplifier adjust the damping control for critical damping. The best way to do this is with a step-transient input and a scope across the speaker line. A 1.5-volt cell keyed momentarily into the amplifier input will provide the step transient. For best results the scope should have a triggered sweep. Set the sweep for its lowest rate. Key the 1.5-volt cell and observe the trace. What you want is the nearest approximation to traces indicating critical damping. The traces at a in Fig. 4 are those obtained by Tomicki (Radio-Engineering, January, 1956) with the speaker in an infinite baffle and those at b were obtained with the speaker in a large bass-reflex enclosure. You will probably get a slight bounce or hangover, but in any case adjust the control for the smallest bounce or the straightest line.

The adjustment can also be made with the square-wave generator. Again set the generator for 200-cycle square wave and adjust the damping control for flattest top and squarest wave, an indication that the voltage developed across the speaker voice coil is as flat as possible. The adjustment can also be made by ear. Alternately feed 500- and 50-cycle notes to the amplifier and adjust the damping control so both are about the same volume. When adjusting by ear keep the volume as loud as you can stand without endangering the speakers, to make the adjustment at a point where your ear is fairly flat; if you adjust at low volume levels, you will underramp. The damping control should not be used to obtain a bass boost; it should be used merely to flatten the speaker peak and to damp speaker hangover. The critically damped point is not the point of maximum bass response. If the constants in the feedback loop are adhered to rigidly, adjustment of damping will have only the slightest effect on distortion (raising it from 0.5% to perhaps 0.35% at the most). It is possible for the damping control to produce subsonic oscillation at one extreme or the other with some speakers. This can be verified by watching the inside of the KT66's through the top of the envelope. Oscillation will produce periodic ionization. It may also cause the speaker cone to move slowly, and can be measured by meters with good response below 20 cycles.

If you have an IM meter, the final touching up can be done with extreme accuracy. Take an IM reading at a level of about 10 watts. Leave the IM meter on and adjust OVERALL BALANCE for minimum IM. If you like, you can increase the level to just under maximum output and readjust the driver bias control slightly for lowest IM. When adjusting be careful to obtain minimum IM without reducing output more than a fraction of a watt. The OUTPUT BALANCE can be used as a vernier for OVERALL BALANCE. It is possible that using it this way you may sacrifice a watt or so of maximum output, but you can obtain a more complete balance at lower outputs.

There will be some tendency for the adjustments to drift until the tubes are aged. In the early period OVERALL BALANCE can be reset about once a month by the null-output method. After tubes are aged, the adjustments will hold good for long periods.

LISTENABILITY

An amplifier such as this could be expected to produce good listening and the expectation is realized. The reserve power is reflected in unusual cleanliness in peaks. The definition is exceptional and actually is limited almost entirely by the speaker system. The most notable difference from home type amplifiers is the remarkable ability to handle low frequencies. Given a preamplifier with sufficient stability, the low end can be brought up by bass boosting to provide startlingly realistic reproduction of high-level bass—especially bass drums and tympani. With a smooth bass boost and speakers capable of taking and dishing it out, it is possible to bring these instruments up to true concert-hall level with all their floor-shaking awesomeness. Similarly, the crash of cymbals can be reproduced cleanly, assuming they are recorded with anything like proper dynamic balance. There is never any sense of strain. I have applied as much as 80 db of boost at 20 or 30 cycles (including equalizer boost) and the amplifier takes the bass peaks in stride and with no tendency to break up.

At ordinary home listening levels, however, the improvement over Milady's Golden Ear is so slight that except for record reviewers and others requiring the most complete definition, the much higher cost would probably not be justified. Moreover, the full capabilities are realized only with the very finest speaker systems. But for those who, like myself, chase the phantom of perfection, whether or not it has any practical worth when caught, the Laboratory Golden Ear may satisfy far beyond the added money and time expended.

TRANSISTORIZED EXECUTIVE DESK SET

O LD-TIME radio readers may remember a "construction article on 'The Executive' radio-clock desk set. That set, which included a clock radio almost a foot long, 8 inches high and about as deep, remained on Hugo Gernsback's desk for some years. It has now been replaced by this set, which occupies a fraction of the space and has styling far more in keeping with the transistor age. The portable radio is bolted to the desk-set base. There is a hint here for the office-supply manufacturer or even the technician with the right kind of clientele—more than one businessman might like a similar desk set.

END
Hi-Fi doesn't have to be loud! It can be soft and sweet—just like "Lo Fi" or "Mid Fi"—provided the distortion is low, the overall response is smooth and pleasantly balanced at low levels. Of course, the reproduction must not be marred by buzz, hum, rumble, hiss, pops, ticks and other inharmonic, nonrhythmic, buzzing, or humming noises which jar the listener's nerves and callous his senses.

One of the important links in the chain of hi-fi components is the preamp, a link which often becomes the limiting factor in the quest for low distortion, low hum and freedom from microphonics. Insofar as balance is concerned, the preamp-equalizer is almost always the sole controlling element.

So the preamp is worthy of review, especially in view of components available today which promise to make performance improvements possible. Transistors alone offer freedom from certain hum sources and microphonics common to tubes. Generally speaking, transistors are more linear than tubes.

But enough about transistors. This is a story of a hi-fi preamp which features low distortion, low hum and low noise, plus the advantages of continuously variable tone controls. With a bass boost ranging from flat to 20 db up and a treble-control range of 10 db up to 10 db down, more or less, lows and highs can be balanced as well for low-level relaxation music as they can for high-level exhilaration sound.

Take the output stage (see diagram), for example. Here a 2N109 is used in a common-emitter circuit which is analogous to a grounded-cathode tube hook-up. The signal from the preceding stage is fed to the base; there is collector load resistor R21; an emitter resistor R22 and a base-bias network R18 and R20.

The emitter resistor provides a degree of degeneration which reduces distortion and, of course, stabilizes against the effects of temperature changes. It also helps the circuit accept a range of transistors with considerably different characteristics. However, at this stage of the art (or science) some transistors may still require individual circuit adjustments—and this can be done by increasing or decreasing the value of either or both of the resistors in the bias network. The bias adjustment is for obtaining a voltage at the collector which is about 40 to 50% of the collector supply voltage. Thus the collector voltage should be about 6 to 7 for a 15-volt collector supply. This principle applies to the first and second stages (both of which use 2N109's) although only one 2N109 out of a dozen tested required a change in the bias network.

The first stage will be recognized as either a common-emitter or common-base circuit. Actually, it is either, as desired—the switch not only selects the input but applies it to either the base or the emitter. The selector switch has two other functions: it connects or disconnects the components which convert a constant-velocity to a constant-amplitude characteristic (R6 and C13); it inserts series load resistors (R23 and R24) where needed to match the input impedance to a particular source.

Sound-source positions

The Mike position connects a low-impedance microphone to the emitter of the transistor in a common-base circuit. The output of the transistor is attenuated by R6, R25 and C12, but in a nonfrequency-selective manner. This input circuit is for sources with output impedances of approximately 12-200 ohms and may be used with low-level lines as well as mikes.

The radio position connects the output of an AM-FM tuner to the base of the transistor in a common-emitter circuit. The input signal goes through R23 which attenuates it to the level of a phono pickup and at the same time increases the input impedance of the preamp as "seen" by the tuner. The output of the transistor is attenuated the same as for mikes input.

The tape-phonon position connects the output of a tape reproducer head or a low-impedance phono pickup (like Fairchild or Elector-Sonic) to the emitter of the transistor in a common-base circuit. The output circuit of the transistor (R6 and C9) converts the velocity curve to an amplitude curve.

The phono (Hi-Z) position connects the output of a high-impedance magnetic pickup (G-E variable reluctance) to the base of the transistor in a common-emitter circuit. R24 is a series load resistor—a higher value will accentuate highs, a lower value lows. The transistor output is converted from a velocity to an amplitude characteristic as in the tape-phonon position.

Many variations are possible. For example, high frequencies can be further accentuated in the radio and phono positions by connecting small capacitors (in series with resistors of 1,600 ohms or so) between the unused contacts of the middle switch section and ground. Or a dynamic microphone with a high-impedance transformer can be connected to the radio position (series resistor R23 might have to be reduced to about 50,000 ohms or so for

Preamp power supply is at the rear.
Schematic diagram of high-fidelity preamp—unit uses three 2N109 transistors.

maximum gain to be developed.

Resistors R1, R30, R26 and R27 simply maintain capacitors charged at proper levels so that there will be no switching "plops." Should there be a switching plop when going to RADIO position, it will probably be due to a capacitor with no ground return in the tuner. Correction can be made by connecting an 820,000-ohm resistor between the capacitor and ground, either in the tuner or the preamp.

Looking now at the output circuit of the first stage, the treble control stands out as a very simple but effective circuit. Highs are picked off the collector by C5 and adjusted in level by R7. At the other end of R7, highs are bypassed to ground by C4. R8 and R9 are simply isolating resistors which prevent objectionable circuit interaction.

The second stage is the bass booster. In the position where R11 is shorted out, C5 is also short-circuited. Thus, there is negative feedback at all frequencies between the collector and the base, by way of C7 (a dc blocking capacitor) and R10. But when R11 is rotated clockwise, the negative feedback is removed for the lower frequencies which cannot "get through" C5, and a bass boost results. R17 is ganged with R11 as a complementary control. In its maximum-resistance position it increases the effectiveness of the C11-R19 feedback circuit and reduces the gain of the amplifier except at the bass-note frequencies. It works in conjunction with R16, the result being a fair degree of self-compensation with changes in the loudness-control setting.

Finally, the power supply. After long seeking, a suitable power transformer was located—a familiar TV vertical blocking oscillator transformer, readily available at low cost. Hooked up "backward," it provides the necessary step-down ratio for a transistor power supply.

Preamp construction

The entire preamp is built on a 1 ½ x 9 x 5 ½-inch chassis with a bottom plate. The power supply is mounted on the rear apron (see photos) to simplify the assembly and guard against hum pickup. This leaves more than enough space inside to mount the resistors, capacitors and transistors, point-to-point, on four eight-point terminal strips.

Electrically, a ground bus is used and connections to it are made progressively from the output stage to the input stage to the input end where the bus goes to chassis ground. The ac line enters the case at the "output end" of the chassis, going to the power switch. A point of novelty is the three-way ac receptacle to which other components in the system may be plugged. Thus the preamp power switch may be used to turn the entire system on and off.

Tests on the model produced very gratifying results. Distortion was measured at 0.25%. Maximum voltage output was over 3 rms. Hum was inaudible at normal levels, as was noise (hiss) produced by the transistors. There was plenty of gain, with adequate reserve for all the sound sources listed.

Consideration was given to provision for compensation (turnover and roll-off) to match the several recording characteristics. This complication was abandoned, however, when experienced ears failed to recognize an improvement over results obtained by adjustment of the bass and treble controls for most pleasing reproduction. END
The Shure WC10 ceramic cartridge is intended as a universal replacement for various crystal, ceramic and even magnetic cartridges. Shure makes no extravagant claims for it and it is highly probable that its excellent performance has been overlooked.

As indicated by Fig. 1, taken directly off the cartridge into the 1-megohm load of a Heathkit ac vtvm, it has a reasonably smooth response under this relatively low load. The response at 5,000 cycles is only 1 db down from that at 1,000 and at 10,000 cycles only 5 db down. Response rolls off pretty sharply beyond that.

The most gratifying thing is the low-frequency response, which is plus 2 db at 50 cycles and 0 db at 30. Most crystal and ceramic cartridges require a much higher load to achieve such a bass response. Indeed, the WC10 delivers an excellent response even into the normal 500,000-ohm input of most amplifiers. The 4-db dip between 1,000 and 6,000 cycles is much less serious to the ear than it looks to the eye. As a matter of fact, the WC10 produces a highly pleasing sound with most of today's recordings. Because of the sharp rolloff beyond 8,000 cycles, it actually sounds cleaner on most pop records than magnetic cartridges of flatter response because most pop records are still much overcut and the spectrum above 8,000 cycles has more distortion than worth-while high highs.

The cartridge is particularly felicitous at 78 rpm on old shellac recordings, which it reproduces with very low scratch and—given a little judicious bass boost—surprisingly good tonal quality. It can also be fed into the lower resistance input of magnetic preamps and works acceptably well with magnetic equalizers—though there is some possibility of overloading modern high-gain preamps. Distortion is very low. All in all, this is one of the best of the piece cartridges. While it does not come up to the finest (and most expensive)Mad of today's magnetics, I am confident that most people will be hard put to tell it from some of the magnetics. Its higher output, lower susceptibility to hum and lower price are advantages which should give it wider application in the high-fidelity field.

Elac Miratwin cartridge

The Miratwin, the product of the same mechanical ingenuity which produced the Miracord changer, presents along with first-class performance several innovations.

Performancewise the Miratwin ranks with the finest available cartridges. Under optimum conditions my sample delivered a response (Fig. 2-a) flat within 2 db to 19,000 cycles at 33 rpm, to 22 kc at 78 rpm (into a pentode preamp, very low-capacitance input, short three-wire cable). Fed into a good equalizer with a 50,000-ohm triode input, through 3 feet of shielded cable, it delivered the response of Fig. 2-b. It is not only indifferent to load, both resistive and capacitive. Decreasing load resistance or increasing capacitance produces a quicker rolloff at the high end, but the capacitance has to be very high to produce a peak and even then it is broad and results in no serious deterioration of audible quality.

The response to the square waves (Fig. 3) on the Folkways test record is very good. The distortion with a pressure of 8 grams is among the lowest I have registered. The tracking ability is very fine, even when the cartridge is used in a changer rather than an expensive independent arm. The output is among the highest but not high enough to overload a good preamp. The cartridge is very well shielded and this, along with its low impedance and high output, results in an extremely good hum figure when used with low-hum turntables.

The listening quality is very satisfying; the highs especially are clean and sweet. Furthermore, the needle chatter is phenomenally low—almost nonexistent on the best modern classical records—and this seems to make the highs even cleaner. It is one of the two or three wide-range cartridges I have used which seldom requires any rolloff and can, in fact, stand considerable boost above 10 kc. Its wide response therefore, is really useful.

One innovation, long overdue, is that every Miratwin is numbered and tested for response by an independent laboratory and comes with a pen recorder chart of response at 10 frequencies. The frequencies are not specified but the overall curve can be inferred easily.

The mechanical design also has some very commendable points. The cartridge consists of two independent movements (similar in appearance to the Pickering 240 series) fastened back to back in a turnover mount. The cartridges can be removed from the mount without any tools and the mount could therefore be used in even the cramped arm with a minimum of inconvenience. The mount has a grounding lug so that it and the arm to which it is attached can be grounded—if they are not already grounded on the turntable.

An admirable feature is the needle. It can be changed in seconds with only the fingers; this should encourage more frequent change. There is no gap in which dust can clog and spoil compliance. The needle can be wiped of dust with a brush without any danger of removing damping material. The price is moderate—under $25 with sapphire needles.
A commercial killer that works!

SPEECH-MUSIC DISCRIMINATOR

By EDWARD E. PREDMORE

A commercial electronic device to discriminate between speech and music (Fig. 1) was described in the August, 1955, issue of Radio-Electronics. Unfortunately, the unit fell considerably short of my expectations. After spending considerable time on the circuit, as explained in my letter of January, 1956 (Correspondence, page 16), I was able to obtain excellent results.

The device can be made to work in 1 minute by changing tubes V3 and V4 to type 12AX7. As soon as I did this, it differentiated between a singing commercial and Jimmy Durante "singing" a song. It let 100% of Durante through and rejected 80% of the singing commercial. I believe these are the tubes for which the gadget was originally designed, as the 10,000-ohm threshold resistor is then the optimum value if operated as a fixed resistor.

I now wish to apologize to Genius R. C. Jones, who invented this, for the doubts concerning him expressed in my letter in the January, 1956, issue. It would be very interesting to have Mr. Jones tell how the difference between speech and music was discovered, if he happens to read these lines.

The block diagram shown is the same as the original circuit, made by the Vocatrol Corp., Cambridge, Mass. The circuit (Fig. 2) is the revised one. I used Music Appreciation Record MR18A Analysis of Beethoven's Fifth Symphony as a convenient controlled repetitive source of alternate speech and music. It gives an excellent speech-to-music ratio as measured by the voltages across the 2-pf integrating capacitor C1.

Adding the .001-pf capacitor from the cathode of V2-a to ground improves the speech-to-music ratio about 10%. This ratio is further improved by having the threshold resistor as a variable control, as shown. The threshold bias rejects pulses whose peak is below the selected voltage and clips the base off larger pulses. The table shows the performance of the device with various threshold control settings, using miniature tubes. The output is flipped when the voltage across integrating capacitor C1 passes 2.8 volts.

Thus, using maximum possible threshold and full sensitivity gives the best speech-to-music ratio. For the 10,000-ohm setting it works but barely. For 15,000 ohms the speech voltage is too high and takes too long to die out after voice ceases, thus losing too much of the following music. Reducing the sensitivity corrects this but raising the threshold to 30,000 ohms does likewise and gives a greater margin for error. This margin is greatly desired for speakers who do not talk crisply and for singers. The performance using 15,000 ohms corresponds to that of about 12,000 ohms using the slightly lower-gain 6SL7 tubes.

Unfortunately, although these changes improve the ratio of voltages developed between speech and music, they do not improve the gadget's IQ very much, for it still has some trou-
ble distinguishing between some girl "pop" singers and a singing commercial. Also, I ran across one cornet solo which the gadget insisted was speech, or to put it more correctly, the envelope of this music contained a 10-cycle component large enough to activate the gadget.

Circuit description

The theory of operation given in the August, 1955, issue seems correct and complete. I'll go through the discriminator, making operational and adjustment comments.

The input should have peaks between 1 and 3 volts. This is what the detector of my Craftsman RC10 tuner puts out on both AM and FM, so this is convenient.

Input stage V1 is a bandpass amplifier, rolling off at 300 and 1,500 cycles. V2-a is a simple detector or half-wave rectifier giving the positive half envelope of the audio-frequency voltage.

V3-a, the logarithmic amplifier, can be explained as follows (with the help of Vocotrol Corp.): Consider just the grid and cathode as a diode. A positive pulse from the detector V2-a causes the grid to draw current. The positive pulse is then divided between the series grid resistors and the dynamic grid resistance of the tube, the resultant grid voltage being approximately proportional to the log of the applied positive voltage. This is amplified by V3-a as a triode. It certainly needs amplifying at this point, for the grid attenuates the peaks several hundred to one.

The plate circuit of V3-a is a lowpass filter rolling off at 8 cycles. The coupling to the next stage passes above 3 cycles as do the following coupling circuits. The 0.1-pf coupling capacitor in the plate circuit of V3-a differentiates each word pulse, giving a short positive pulse for the start and a short positive pulse for the end of the word pulse. This capacitor seems a bit large for this job but I have not been able to show that a smaller one (0.03 or 0.05 µf) works any better; less works worse.

V2-b is another rectifier used to select only pulses due to the stopping of speech syllables. Positive pulses applied to the plate of V2-b cause the diode to draw current and thus pass these positive pulses. The negative pulses simply cut the tube off further and are lost completely. The threshold resistors—the 10,000-ohm resistor and the 20,000-ohm pot—act as a voltage divider along with the 1-megohm fixed resistor to apply a positive bias on the cathode of V2-b. The positive pulse must rise above this bias (plus contact potential) before it causes the tube to conduct and thus pass the pulse. In this way the bias cuts off the base of a large pulse and eliminates small positive pulses.

Speech generates large pulses and noise and music generate small pulses. I find that for orchestral music I keep the threshold at 25,000 ohms and sensitivity at maximum. This works practically perfectly . . . but some popular female vocalist will flip it at this value (and some announcers who slur their speech will not). Announcers connected with classical music seem to talk crisply, and on a classical music program the speech-music discriminator can be set and forgotten. On a popular music program the controls require adjustment to match the music and the announcer.

V4-a is a simple amplifier which inverts the pulse. This negative pulse applied to diode-connected V3-b causes it to draw current, producing a negative voltage on the 2-µf integrating capacitor. This voltage builds up sharply with each pulse as it is charged through the relatively low-impedance path of V3-b and V4-a. It discharges slowly between pulses as it can only discharge through the two 2-megohm resistors in series, and takes 8 seconds to lose 63% of any voltage left on it.

This voltage is direct-connected to and amplified by V4-b, whose plate is direct-connected to V5, the flip-flop stage. As the plate of V4-b goes more positive, due to the negative voltage on C1, it causes the left side of V5 to conduct and the right side to cut off. The 1-megohm resistor from the grid to plate helps this action to be more abrupt.

Underchassis layout of discriminator.

Fig. 3—Circuitry for receiver connection—relay control stage may be used.
As the right side cuts off, its plate voltage rises and this rise partially passes through the 1-megohm resistor to help left side conduct. The current of the left side conducting passes through the common cathode resistor and the voltage generated tends to cut off the right side. This works in reverse when the voltage across C1 passes -2.8 volts going toward zero.

The output bias varies from zero to -75 volts. There is not much left of this after it passes through the 22-megohm isolating resistor (Fig. 3). It is enough to cut off a 12AX7 in the radio if it has a 2.2-megohm grid resistor. For a 12AU7 the isolating resistor must be greatly reduced.

My hi-fi rig already has a commercial killer that responds to those stations broadcasting 20 ke and 35 ke before and after the commercial and this operates a 1.5-ma plate relay (Fig. 4) across the input to my Williamson type amplifier. I disconnected its coil and low impedance so the voltages do not vary with the load or the load should be made constant. The latter is done when adding the relay control stage.

The power supply was made with parts on hand. A 350-volt transformer would be better as it would permit the dropping resistors to be reduced to the few ohms needed to limit the peak rectifier current and would reduce the power supply impedance. Capacitors C2 and C3 must be separate from C1 and the negative side insulated from ground. I ran the 6X4 heater on the 5-volt winding as my 6.3-volt winding was loaded to capacity, and it does not take much heat to boil out the 4 ma this thing uses for B plus (including relay tube and bleeder). As my line uses 6 volts on the heaters. And thinking of heaters, note the 5 volts on the 12AU7 in the vtm attachment (Fig. 6). This was adapted from the circuit given in the RCA tube manual, which uses 10 volts on the 12.6 connection. The manual uses a 290-µa meter.

Adjustments

As a vtm is absolutely necessary to measure across C1 (Fig. 2), I include the adapter made for my Triplett 630 meter. You can see the ac pulses with a scope on the cathode of V3-b, but it is the resultant integrated voltage across C1 that is of prime interest.

The cathode resistor (Fig. 6) was chosen so the 5,000-ohm pot adds only a few ohms in series with the meter. The circuit shown gives 0.6, 12 and 72 volts for full-scale deflection, the 0.6 being direct connection to the grid with the 3.3-megohm resistor disconnected. The other two are through the 22-megohm isolating resistor to the top and bottom of the 3.3-megohm resistor, respectively. If you use a multimeter for this, before disconnecting it from the circuit, switch it off the microamps scale. And when setting it up, switch it on this scale the last thing. This is so much easier than straightening out a horrible bend in the meter pointer.

Building this device is a real pleasure for there is not a thing critical about any of the circuits in it, and it uses only standard parts. There is not a single tuned circuit or inductance except the relay, and a ±20% tolerance is more than adequate for any of the circuit elements. Placement or length of leads is almost completely unimportant as V1 is a midrange amplifier with highs and lows not wanted, and the rest of the circuits are designed to pass 10 cycles. The only construction caution is to keep the 2- and 10-megohm resistors close to the grid terminals and the high voltage ac leads away from them to reduce 60-cycle pickup at these high-impedance points.

The cabinet

Some time ago I picked up a small discarded table-model radio from a trash can. Its wood cabinet was in fair condition and its 8 x 5 x 2-inch chassis just about holds the components used. The two pots use the original tuning and volume control holes. I covered the speaker cutout on the chassis with a piece of metal from an oil can. It could easily be removed by the chassis is mounted in the center of it (see photo). The 6X4 is visible and replaceable through the hole in the front of the cabinet, formerly used by the tuning dial. It is backed up by a piece of black paper and makes a good-looking, out-of-the-ordinary pilot light (and saves buying one).

Parts for discriminator (with power supply)

- Resistors: 1/4-watt 100, 1000, 1 meg, 5000
- Capacitors: 10, 1μf, 0.1μf
- Miscellaneous: 1-4AU6, 1-4AL5, 1-22AU7, 1-12AL7, 1-6X4, tube, 3-6.3 polar mini-mini sockets, 1 transformer (see text), 1-chassis, approximately 8 x 5 x 2 inches, 1-cabinet.

Parts for relay control stage

- Resistors: 164,000, 12,000, 1100, 1 meg, 2.15 megohms, ½ watt; 8-4000 ohms, 1 watt, resistors; 1-P6-µf capacitor; 1-12AU7, 1-µf miniature socket; 1 relay, 1.5 ma, 5000 ohms, spst; 1-Set of male and female connectors.

Parts for vtm adaptor (Fig. 6)


I have enjoyed my speech-music discriminator for the past several months, particularly when my favorite station was in the throes of its "American Music Festival" most of which I consider to be music. I was forced to another station with good music but many commercials, some of which were highly objectionable. The SMD works perfectly and gives me many pleasant hours of music interrupted by periods of silence rather than by the blasting of commercials. It also frees you from the necessity of listening to the same five minutes of news every hour on the hour.
HEATHKIT ETCHED CIRCUIT, PUSH-PULL

5" Oscilloscope Kit
COLOR TV

The previous Heathkit oscilloscope (Model O-10) which was already a most remarkable instrument, has been improved even further with the release of the Heathkit Model O-11. It incorporates all the outstanding features of the preceding model, plus improved vertical linearity, better sync stability, especially at low frequencies, and much-improved over-all stability of operation, including less vertical bounce with changes in level. These improvements in the Model O-11 circuit make it even more ideally suited for color TV servicing, and for critical observations in the electronic laboratory. Vertical response extends from 2 CPS to 5 MC without extra switching. Response only down 1 1/2 DB at 3.58 MC. The 11-tube circuit features a 5UP1 cathode-ray tube. Sync circuit functions effectively from 20 CPS to better than 500 kc in five steps. Modern etched circuit boards employed in the oscilloscope circuit cut assembly time almost in half, permit a level of circuit stability never before achieved in an oscilloscope of this type, and insure against errors in assembly. Both vertical and horizontal output amplifiers are push-pull. Built-in peak-to-peak calibrating source — step-attenuated input — plastic molded capacitors and top-quality parts throughout — pre-formed and cabled wiring harness — and numerous other "extra" features. A professional instrument for the servicing shop or laboratory.

**1** FEWER DOLLARS BRING MORE REAL QUALITY.
- Factory-to-you sales eliminate extra profit margin.
- "Build-it-yourself" eliminates labor charge.
- Heath purchasing power cuts component costs.

**2** PERSONAL SERVICE ASSURES CUSTOMER SATISFACTION.
- You deal directly with the manufacturer.
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HEATHKIT ETCHED CIRCUIT, PUSH-PULL

5" Oscilloscope Kit
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5 BIG REASONS WHY
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**3** PROVEN DESIGNS MEAN RELIABLE PERFORMANCE.
- Research and development efforts concentrated on kits only.
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- The world's largest manufacturer of electronic equipment in kit form.
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**5** EASY TIME-PAYMENT PLAN TO FIT YOUR BUDGET.
This new and improved oscilloscope retains all the outstanding features of the preceding model, but provides wider vertical frequency response, extended sweep-generator coverage, and increased stability. A new tube complement and improvements in the circuit make these new features possible. Vertical frequency response is essentially flat to over 1 mc, and down only 1 ½ DB at 500 kc. The sweep generator multivibrator functions reliably from 30 to 200,000 CPS, almost twice the coverage provided by the previous model. Deflection amplifiers are push-pull, and modern etched circuits are employed in critical parts of the design. A 5BP1 cathode-ray tube is used. The scope features external or internal sweep and sync, one volt peak-to-peak reference voltage, 3-position step-attenuated input, adjustable spot-shape control, and many other "extras" not expected at this price level. A calibrated grid screen is also provided for the face of the CRT, allowing more precise observation of wave shapes displayed. The new Model OM-2 is designed for general application wherever a reliable instrument with good response characteristics may be required. Complete step-by-step instructions and large pictorial diagrams assure easy assembly.

HEATHKIT LOW CAPACITY PROBE KIT
Oscilloscope investigation of high frequency, high impedance, or broad bandwidth circuits encountered in television requires the use of a low-capacity probe to prevent loss of gain, circuit loading, or waveform distortion. The Heathkit low-capacity probe may be used with your oscilloscope to eliminate these effects. It features a variable capacitor, to provide correct instrument impedance match. Also, the ratio of attenuation can be varied.

HEATHKIT ELECTRONIC SWITCH KIT
This handy device allows simultaneous oscilloscope observation of two signals by producing both signals, alternately, at its output. It features an all-electronic switching circuit, with no moving parts. Four switching rates are selected by a panel switch. Provides actual gain for input signals, and has a frequency response of ± 1 DB from 0 to 100 kc. Sync output provided to control and stabilize scope sweep. Will function at signal levels as low as 0.1 volt. This modern device finds many applications in the laboratory and service shop. It employs an entirely new circuit, and yet is priced lower than its predecessor.

HEATHKIT SCOPE DEMODULATOR PROBE KIT
Extend the usefulness of your oscilloscope by employing this probe. Makes it possible to observe modulation of RF or IF carriers found in TV and radio receivers. Functions much like an AM detector to pass only modulation of signal, and not the signal itself. Among other uses, it will be helpful in alignment work, as a signal tracer, and for determining relative gain. Applied voltage limits are 30 volts (RMS) and 500 volts DC. It uses an etched circuit board to simplify assembly.

HEATHKIT VOLTAGE CALIBRATOR KIT
This entirely new voltage calibrator produces near-perfect square wave signals of known amplitude. Precision 1 ½% attenuator resistors assure accurate output amplitude, and multivibrator circuit guarantees good, sharp square waves, as distinguished from clipped sine waves. Output frequency is approximately 1000 CPS. Fixed outputs selected by panel switch are: 0.5, 0.1, 0.3, 1.0, 3.0, 10, 30, and 100 volts peak-to-peak. Allows measurement of unknown signal amplitudes by comparing to known peak-to-peak output of VC-3 on an oscilloscope. Will also double as a square wave generator at 1000 cycles for determining gain, frequency response, or phase-shift characteristics of audio amplifiers. Equally valuable in the laboratory or in radio and TV service shops.

New HEATHKIT ETCHED CIRCUIT
5" Oscilloscope Kit
* Brand new model with improved performance specifications.
* Full 5" scope for service work at a remarkably low price.
* Attractively styled front panel in charcoal gray with sharp white lettering.
* Easy to build from step-by-step instructions and large pictorials. Not necessary to read schematic.
HEATHKIT Etched Circuit
Voidmeter Kit

The fact that this instrument is the world's largest-selling VTVM says a great deal about its accuracy, reliability, and overall quality. The V-7A is equally popular in the laboratory or service shop, and represents an unbelievable test equipment bargain, without a corresponding sacrifice in quality. Its appearance reflects the performance of which it is capable. A large 4½" panel meter is used for indication, with clear, sharp calibrations for all ranges. Front panel controls consist of a rotary function switch and a rotary range selector switch, zero-adjust, and ohms-adjust controls. Precision 1% resistors are used in the voltage divider circuits and etched circuits are employed for most of the circuitry. This makes the kit much easier to build, eliminates the possibility of wiring errors, and assures duplication of laboratory instrument performance. This multi-function VTVM will measure AC voltage (rms), AC voltage (peak-to-peak), DC voltage, and resistance. There are 7 AC (rms) and DC voltage ranges of 0-1.5, 5, 15, 50, 150, 500, and 1500. In addition, there are 7 peak-to-peak AC ranges of 0.4, 14, 40, 140, 400, 1400, and 4000. 7 ohmmeter ranges provide multiplying factors of X1, X10, X100, X1000, X10K, X100K, and X1 megohm. Center-scale resistance readings are 10, 100, 1000, 10K, 100K ohms, 1 megohm, and 10 megohms. A DB scale is also provided. The precision and quality of the components used in this VTVM cannot be duplicated at this price through any other source. Model V-7A is the kind of instrument you will be proud to own and use.
HEATHKIT NEW AUDIO VACUUM TUBE

Voltmeter Kit

* Brand new circuit for extended frequency response and added stability.
* Ten accurate ranges from 0.01 to 0.300 volts.
* Modern, functional panel styling. "On-off" switch at both extreme ends of range switch.

MODEL AV-3
$29.50 Shpg. Wt. 5 Lbs.

HEATHKIT AUDIO WATTMETER KIT

This instrument measures audio power directly at 4, 8, 16, or 600 ohms. Load resistors are built in. Covers 0-5 MW, 50 MW, 500 MW, 5 W, and 50 W full scale. Provides 5 switch-selected DB ranges covering from -10 DB to +30 DB. Large 4½" 200 microampere meter and precision multiplier resistors insure accuracy. Frequency response is ± 1 DB from 10 CPS to 250 kc. Functions from AC power line. Use in the audio laboratory or in home workshop.

MODEL AW-1
$29.50 Shpg. Wt. 6 Lbs.

HEATHKIT AUDIO ANALYZER KIT

This multi-function instrument combines an AC VTVM, an audio wattmeter, and an intermodulation analyzer into one case, with combined input and output terminals and built-in high and low frequency oscillators. The VTVM ranges are 0.01, 0.03, 0.1, 1, 3, 10, 30, 100, and 300 volts (RMS). Wattmeter ranges are 0.15 MW, 1.5 MW, 15 MW, 150 MW, 1.5 W, 15 W, 150 W. 1M scales are 1%, 3%, 10%, 30%, and 100%. Provides internal load resistors of 4, 8, 16, or 600 ohms. A valuable instrument for the engineer or serious audiophile.

MODEL AA-1
$59.50 Shpg. Wt. 13 Lbs.

HEATHKIT HARMONIC DISTORTION METER KIT

The HD-1 is equally valuable for the audio engineer or the serious audiophile. Used with a low-distortion audio signal generator, this instrument will measure the harmonic content of various amplifiers under a variety of conditions. Functions between 20 and 20,000 CPS, and reads distortion directly on the panel meter in ranges of 0-1, 3, 10, 30, and 100 percent full scale. Built-in VTVM for initial reference settings and final distortion readings has voltage ranges of 0-1, 3, 10, and 30 volts. 1% precision resistors employed for maximum accuracy. Features voltage regulation and other "extras". Meter calibrated in volts (RMS), percent distortion, and DB.

MODEL HD-1
$49.50 Shpg. Wt. 13 Lbs.

HEATHKIT AUDIO OSCILLATOR KIT

Producing both sine waves and square waves, the Model AO-1 covers a frequency range of 20 to 20,000 CPS in three ranges. An extra feature is thermistor regulation of output for flat response through the entire frequency range. AF output is provided at low impedance, and with low distortion. Produces good sine waves, and good, clean square waves with a rise time of only two micro-seconds for checking square wave response of audio amplifiers, etc. Designed especially for the serviceman and high-fidelity enthusiast. A real dollar value in test equipment.

MODEL AO-1
$24.50 Shpg. Wt. 10 Lbs.

RADIO-ELECTRONICS

www.americanradiohistory.com
Audio Generator Kit

This particular audio generator is "made to order" for high fidelity applications. It provides quick and accurate selection of low-distortion signals throughout the audio range. Three rotary selector switches on the front panel allow selection of two significant figures and a multiplier for determining audio frequency. In addition, it incorporates a step-type output attenuator and a continuously variable attenuator. Output is indicated on a large 4½" panel meter calibrated in volts and in db. Attenuator system operates in steps of 10 db, corresponding with the meter calibration. Output ranges are 0.003, .01, .03, .1, .3, 1, 3, and 10 volts rms. A "load" switch provides for the use of a built-in 600 ohm load or an external load of higher impedance when required. Output and frequency indicators accurate to within ± 5%. Distortion is less than .1 of 1% between 20 cps and 20,000 cps. Total range is 10 cps to 100 kc. New engineering details combine to provide the user with an unusually high degree of operating efficiency. Oscillator frequency selected entirely by the switch method means that accurate resetability is provided. Comparable to units costing many dollars more, and ideal for use in critical high fidelity applications. Shop and compare, and you will appreciate the genuine value of this professional instrument.

HEATHKIT RESISTANCE SUBSTITUTION BOX KIT

The RS-1 contains 36 1% 1-watt resistors ranging from 15 ohms to 10 megohms in standard RETMA values. All values are switch-selected for use in determining desirable resistance values in experimental circuits. Many applications in radio and TV service work.

MODEL RS-1

$5.50

HEATHKIT CONDENSER SUBSTITUTION BOX KIT

This kit contains 18 RETMA standard condenser values that can be selected by a rotary switch. Values range from 0.00001 mfd to 0.22 mfd. All capacitors rated at 400 volts or higher. Capacitors are either silver-mica or plastic molded.

MODEL CS-1

$5.50

HEATHKIT DECADE RESISTANCE KIT

The Model DR-1 incorporates twenty 1% precision resistors arranged around five rugged switches so that various combinations of switch positions will provide a total range of 1 ohm to 99,999 ohms in 1-ohm steps. Switches are labeled "units," "tens," "hundreds," "thousands," and "ten thousands." Use it for ohmmeter calibration in bridge circuits as test values in multiplier circuits, etc.

MODEL DR-1

$19.50

HEATHKIT DECADE CONDENSER KIT

Precision, 1% silver-mica capacitors are employed in the Model DC-i in such a way that a selection of precision capacitor values is provided ranging from 100 nuf (0.0001 mfd) to 0.11 mfd (110,000 nuf) in 100 nuf steps. Extremely valuable in all types of design and development. Switches are ceramic wafer types.

MODEL DC-1

$16.50

HEATHKIT VARIABLE VOLTAGE REGULATED POWER SUPPLY KIT

This power supply is regulated for stability, and the amount of DC output available from the power supply can be controlled manually from zero to 500 volts. Will provide regulated output at 450 volts up to 10 ma, or up to 130 ma at 200 volts output. In addition to furnishing B-plus, the power supply provides 6 volts AC at 4 amperes for filaments. Both the B-plus output and the filament output are isolated from ground. Ideal power supply for use in experimental work in the laboratory, the home workshop, or the ham shack. Large 4½" panel meter indicates output voltage or current.

MODEL PS-3

$35.50

HEATHKIT AUDIO GENERATOR KIT

The Model AG-8 is a low cost, high performance unit for use in service shop, or home workshop. It covers the frequency range of 20 cps to 1 mc in five ranges. Output is 600 ohms, and overall distortion will be less than .4 of 1% from 100 cps through the audible range. Output is available up to 10 volts, under no load conditions, and output remains constant within ± 1 db from 20 cps to 400 kc. A five-step attenuator provides control of the output. Precision resistors provide control of the output. Precision resistors are employed in the frequency determining network.

MODEL AG-8

$29.50

HEATHKIT

Audio Generator Kit

This particular audio generator is "made to order" for high fidelity applications. It provides quick and accurate selection of low-distortion signals throughout the audio range. Three rotary selector switches on the front panel allow selection of two significant figures and a multiplier for determining audio frequency. In addition, it incorporates a step-type output attenuator and a continuously variable attenuator. Output is indicated on a large 4½" panel meter calibrated in volts and in db. Attenuator system operates in steps of 10 db, corresponding with the meter calibration. Output ranges are 0.003, .01, .03, .1, .3, 1, 3, and 10 volts rms. A "load" switch provides for the use of a built-in 600 ohm load or an external load of higher impedance when required. Output and frequency indicators accurate to within ± 5%. Distortion is less than .1 of 1% between 20 cps and 20,000 cps. Total range is 10 cps to 100 kc. New engineering details combine to provide the user with an unusually high degree of operating efficiency. Oscillator frequency selected entirely by the switch method means that accurate resetability is provided. Comparable to units costing many dollars more, and ideal for use in critical high fidelity applications. Shop and compare, and you will appreciate the genuine value of this professional instrument.

HEATHKIT RESISTANCE SUBSTITUTION BOX KIT

The RS-1 contains 36 1% 1-watt resistors ranging from 15 ohms to 10 megohms in standard RETMA values. All values are switch-selected for use in determining desirable resistance values in experimental circuits. Many applications in radio and TV service work.

MODEL RS-1

$5.50

Shpg. Wt. 2 lbs.

HEATHKIT CONDENSER SUBSTITUTION BOX KIT

This kit contains 18 RETMA standard condenser values that can be selected by a rotary switch. Values range from 0.00001 mfd to 0.22 mfd. All capacitors rated at 400 volts or higher. Capacitors are either silver-mica or plastic molded.

MODEL CS-1

$5.50

Shpg. Wt. 2 lbs.

HEATHKIT DECADE RESISTANCE KIT

The Model DR-1 incorporates twenty 1% precision resistors arranged around five rugged switches so that various combinations of switch positions will provide a total range of 1 ohm to 99,999 ohms in 1-ohm steps. Switches are labeled "units," "tens," "hundreds," "thousands," and "ten thousands." Use it for ohmmeter calibration in bridge circuits as test values in multiplier circuits, etc.

MODEL DR-1

$19.50

Shpg. Wt. 4 lbs.

HEATHKIT DECADE CONDENSER KIT

Precision, 1% silver-mica capacitors are employed in the Model DC-i in such a way that a selection of precision capacitor values is provided ranging from 100 nuf (0.0001 mfd) to 0.11 mfd (110,000 nuf) in 100 nuf steps. Extremely valuable in all types of design and development. Switches are ceramic wafer types.

MODEL DC-1

$16.50

Shpg. Wt. 3 lbs.

HEATHKIT VARIABLE VOLTAGE REGULATED POWER SUPPLY KIT

This power supply is regulated for stability, and the amount of DC output available from the power supply can be controlled manually from zero to 500 volts. Will provide regulated output at 450 volts up to 10 ma, or up to 130 ma at 200 volts output. In addition to furnishing B-plus, the power supply provides 6 volts AC at 4 amperes for filaments. Both the B-plus output and the filament output are isolated from ground. Ideal power supply for use in experimental work in the laboratory, the home workshop, or the ham shack. Large 4½" panel meter indicates output voltage or current.

MODEL PS-3

$35.50

Shpg. Wt. 17 lbs.
HEATHKIT

Signal Generator Kit

* No calibration required with pre-aligned coils.
* Modulated or unmodulated RF output.
* 110 mc to 220 mc frequency coverage.

MODEL SG-8

$19.50
Shpg. Wt. 8 1/2 lbs.

Here is an RF signal generator for alignment applications in the service shop or the home workshop. Thousands of these units are in use in service shops all over the country. Produces RF signals from 160 kc to 110 mc on fundamentals on five bands. Also covers from 110 mc to 220 mc on calibrated harmonics. RF output is in excess of 100,000 microvolts at low impedance. Output is controllable with a step-type and a continuously variable attenuator. Front panel controls provide selection of either unmodulated RF output or RF modulated at 400 cps. In addition, two to three volts of audio at approximately 400 cps are available at the output terminals for testing AF circuits. Employs a 12AU7 and a 6C4 tube. Built-in power supply uses a selenium rectifier.

One of the most outstanding features about the Model SG-8 is the fact that it can be built in just a few hours, even by one not thoroughly experienced in electronics work. Complete step-by-step instructions combined with large pictorial diagrams assure successful assembly. Pre-aligned coils make calibration from an external source unnecessary.

HEATHKIT LABORATORY GENERATOR KIT

This laboratory RF signal generator covers from 100 kc to 30 mc on fundamentals in five bands. The output signal may be pure RF, or may be modulated at 400 cycles from 0 to 50%. Provision for external modulation has been made. RF output available up to 100,000 microvolts. Output controlled by a fixed step and a variable attenuator. Output impedance is 50 ohms. Panel meter reads RF output or percentage of modulation. Incorporates voltage regulated B+ supply, double shielding of oscillator circuits, copper plated chassis, and other "extras."

MODEL LG-1

$39.50
Shpg. Wt. 16 lbs.

HEATHKIT TV ALIGNMENT GENERATOR KIT

This improved sweep generator model provides essential stability and flexibility for work on FM, monochrome TV, or color TV sets. Covers 3.6 mc to 220 mc in four bands. Provides usable output even on harmonics. Sweep deviation from 0-42 mc, depending on base frequency. All-electronic sweep circuit eliminates unwieldy mechanical arrangements. Includes built-in crystal marker generator providing output at 4.5 mc and multiples thereof, and variable marker covering 19 to 60 mc on fundamentals and from 57 to 150 mc on harmonics. Effective two-way blanking.

MODEL TS-4A

$49.50
Shpg. Wt. 16 lbs.

HEATHKIT LINEARITY PATTERN GENERATOR KIT

This instrument supplies information for white dots, cross-hatch pattern, horizontal bar pattern, or vertical bar pattern. It feeds video and sync signals to the set under test, with completely controlled gain, and unusual stability. Covering channels 2 to 13, the LP-2 will produce 5 to 6 vertical bars and 4 to 5 horizontal bars. The dot pattern presentation is a must for the setting of color convergence controls in the color TV set. Panel provision made for external size if desired. Use for adjustment of vertical and horizontal linearity, picture size, aspect ratio, and focus. Power supply is regulated for added stability. Essential in the up-to-date TV service shop.

MODEL LP-2

$22.50
Shpg. Wt. 7 lbs.

HEATHKIT CATHODE RAY TUBE CHECKER KIT

This instrument checks cathode emission, beam current, shorted elements, and leakage between elements in electro-magnetic picture tube types. It eliminates all doubt for the TV serviceman, and even more important, for the customer. Features its own self-contained power supply, transformer operated to furnish normal test voltages for the CRT. Employs spring-loaded switches for maximum operator protection. Large 4½" meter indicates CRT condition on "good-bad" scale. Luggage-type portable case ideal for home service calls. Special "shadowgraph" test permits projection of light spot on screen. Also gives relative check of picture tube screen coating.

MODEL CC-1

$22.50
Shpg. Wt. 10 lbs.
Tube Checker Kit

This fine piece of test gear checks tubes for quality, emission, shorted elements, open elements, and filament continuity. Will test all tube types normally encountered in radio and TV service work. Sockets provided for 4, 5, 6, and 7-pin large, rectangular, and miniature types, octal and loctal types, the Hytron 9-pin miniatures, and pilot lamps. Condition of tubes indicated on a large 4½" meter with multi-color "good-bad" scale. An illuminated roll chart is built right in, providing test data for various tube types. This tester provides switch selection of 14 different filament voltage values from 0.75 volts to 117 volts. Individual switches control each tube element. Close tolerance resistors employed in critical test circuits for maximum accuracy. A professional instrument both in appearance and performance.

The Model TC-2 is very simple to build, even for a beginner. It employs a color-coded cable harness for neat, professional under-chassis wiring. Comes with attractive counter style cabinet, and portable cabinet is available separately. At this price, even the part-time serviceman can afford his own tube checker for maximum efficiency in service work.

HEATHKIT TV PICTURE TUBE TEST ADAPTER

Designed especially for use with the Model TC-2 tube checker. Use it to test TV picture tubes for emission, shorts, etc. Consists of 12-pin TV tube socket, 4 ft. cable, octal connector, and necessary technical data. Not a kit.

HEATHKIT VISUAL-AURAL SIGNAL TRACER KIT

Although designed primarily for radio receiver work, this valuable instrument finds extensive application in FM and TV servicing as well. Features a high-gain channel with demodulator probe, and a low-gain channel with audio probe. Will trace signals in all sections of a radio receiver and in many sections of a FM set or TV receiver. Uses built-in speaker and electron beam eye tube for indication. Also features built-in wattmeter and a noise locater circuit. Provision for patching speaker and/or output transformer into external set.

HEATHKIT CONDENSER CHECKER KIT

The Model C-3 consists of an AC powered bridge for both capacitive and resistive measurements. Bridge balance is indicated on electron beam eye tube, and capacity or resistance value is indicated on front panel calibrations. Measures capacity in four ranges from .0001 mf to .005 mf, .001 mf to .005 mf, .01 mf to .5 mf, and .05 mf to 50 mf, and 20 mf to 1000 mf. Measures resistance in two ranges, from 10 ohms to 50,000 ohms, and from 10,000 ohms to 5 megohms. Selection of five different polarizing voltages for checking capacitors, from 25 volts DC to 450 volts DC. Checks paper, mica, ceramic, and electrolytic capacitors. Indicates power factor of electrolytic capacitors.
HEATHKIT

Impedance Bridge Kit

* 1% precision resistors and silver-mica capacitors.
* Battery-type tubes, no warm-up required.
* Built-in phase shift generator and amplifier.

The Model IB-2 is a completely self-contained unit. It has a built-in power supply, a built-in 1000 cycle generator, and a built-in vacuum tube detector. Provision has been made on the panel for connection to an external detector, an external signal generator, or an external power supply. A 100-0-100 microampere meter on the front panel provides for null indications. Measures resistance from 0.1 ohm to 10 megohms, capacitance from 10 mmf to 100 mfd, inductance from 10 mh to 100 h, dissipation factor (D) from 0.002 to 1, and storage factor (Q) from 0.1 to 1000. ½ of 1% decade resistors employed for maximum accuracy. Typical accuracy figures are: resistance, ±3%; capacitance ±3%; inductance, ±10%; dissipation factor, ±20%; storage factor, ±20%. Employs a Wheatstone bridge, a Capacity Comparison bridge, a Maxwell bridge, and a Hay bridge. Special two-section CRL dial provides maximum convenience in operation. Use the Model IB-2 for determining values of unmarked components, checking production or design samples, etc. A real professional instrument.

HEATHKIT "Q" METER KIT
The Q Meter permits measurement of inductance from 1 microhenry to 10 millihenries, "W" on a scale calibrated up to 250 full scale, with multiplying factors of 1 or 2, and capacitance from 40 mmf to 450 mmf, ±3 mmf. Built-in variable oscillator permits testing components from 150 kc to 18 mc. Large 4½" panel-mounted meter is features. Very handy for checking peaking coils, chokes, etc. Use to determine values of unknown condensers, both variable and fixed. Compile data for coil winding purposes, or measure RF resistance. Distributed capacity, and Q of coils.

HEATHKIT ISOLATION TRANSFORMER KIT
This device isolates equipment under test from the power line. It is rated at 100 volt-amperes continuously, or 200 volt-amperes intermittently. AC-DC sets may be plugged directly into the JT-1 without the chassis becoming "hot." Additionally, since the IT-1 is fused, it is ideal for use as a buffer between the power line and a questionable receiver, or a new piece of equipment. Protects main fuses. Features voltage control, allowing control of the output from 90 volts to 130 volts. Panel meter monitors output voltage. A very handy device at an extremely low price.

HEATHKIT 6-12 VOLT BATTERY ELIMINATOR KIT
This completely modern battery eliminator will supply DC output in two ranges for both 6-volt and 12-volt automobile radios. The output is variable for each range, so that operating voltage can be raised or lowered to determine how the receiver functions under adverse conditions. Range is 0-8 volts DC or 0-16 volts DC. Will supply up to 15 amperes on the 6-volt range, or up to 7 amperes on the 12-volt range. Two 10,000 microfarad output filter capacitors insure smooth DC output. Two separate panel meters indicate output voltage or output current. It makes it possible to test automobile radios inside at the workbench. Will also double as a battery charger.

HEATHKIT 6-VOLT VIBRATOR TESTER KIT
This instrument functions very much like a tube checker, to test auto radio vibrators. Vibrator condition is indicated on a simple "good-bad" scale. Tests for proper starting and overall quality of operation, of both interrupter and self-rectifier types of 6-volt vibrators. The model VT-1 is designed to operate from any battery eliminator capable of delivering continuously variable output from 4 to 6 volts DC at 4 amperes or more. It is an ideal companion unit for the Heathkit Model BE-4 battery eliminator. The construction book for the VT-1 contains vibrator test chart for popular 6-volt vibrator types. A real time saver!

www.americanradiohistory.com
HEATHKIT DX-100 PHONE AND CW

$189.50

**HEATHKIT COMMUNICATIONS TYPE ALL-BAND RECEIVER KIT**

This receiver covers 50 kc to 30 mc in four bands, and is ideal for the short-wave listener or beginning amateur. It provides good sensitivity and selectivity, combined with good image rejection. Amateur bands clearly marked on illuminated dial scale. Employs transformer type power supply—electrical bandspread—antenna trimmer—separate RF and AF gain controls—noise limiter—headphone jacks. MODEL AR-3 and automatic gain control. Has built-in VFO for CW reception.

CABINET: Fabric covered cabinet with aluminum panel as shown. Part 91-15A. Shipping weight 5 lbs. $4.95

**EASY ON THE BUDGET!**

You can buy Heathkits on an easy time-payment plan that provides a full year to pay. Write for complete details and special order blank.

**HEATHKIT VFO KIT**

You can go VFO for less than you might expect. Here is a variable frequency oscillator that covers 160, 80, 40, 20, 15, 11, and 10 meters with three basic oscillator frequencies, that sells for less than $20. Provides better than 10 volt average RF output on fundamental. Plenty of drive for most modern transmitters. Requires a power source of only 250 VDC at 15 to 20 ma. and 6.3 VAC at 0.45A. Incorporates a regulator tube for stability. Illuminated frequency dial reads frequency directly on the band being employed. Temperature-compensated capacitors offset coil heating.

**HEATHKIT CW TRANSMITTER KIT**

This is the original low-priced Heathkit CW transmitter. Its reliable performance has been proven time and time again on the CW bands. Designed for crystal control, the Model AT-1 covers 80, 40, 20, 15, 11, and 10 meters. May be excited from external VFO. Plate power input up to 30 watts. Power supply built in. Panel meter indicates grid current or plate current for final. Incorporates pre-wound coils, copper-plated chassis, built-in line filter, profuse shielding, and top quality parts throughout. Crystal socket and key jack on front panel. Built-in key-click filter, and single-knob bandswitching. 52-ohm external output. Uses 6L6, 6AK5, 6922 power amplifier, and 6V6 oscillator-multiplier. 616 power amplifier, doubler, and SU4G rectifier.

**TRANSMITTER KIT**

The Heathkit DX-100 transmitter is in a class by itself in that it offers features far beyond those normally received at this price level. It takes very little listening on the bands to discover how many of these transmitters are in operation today. A truly amazing piece of amateur gear. The DX-100 features a built-in VFO and a built-in modulator. It is TVI suppressed, and uses pi network interstage coupling and output coupling. Will match antenna impedances from approximately 50 to 600 ohms. Extensive shielding is employed, and all incoming and outgoing circuits are filtered. The cabinet features interlocking seams for simplified assembly and minimum RF radiation outside of the cabinet. Provides a clean strong signal on either phone or CW, with RF output in excess of 100 watts on phone, and 120 watts on CW. Completely bandswitching from 160 through 10 meters. A pair of 1625 tubes are used in push-pull for the modulator, and the final consists of a pair of 6146 tubes in parallel. The VFO dial and meter face are illuminated, and all front panel controls are located for maximum convenience. Panel meter reads driver plate I, final grid I, final plate I, final plate voltage, and modulator current. The chassis is constructed of heavy #16 gauge copper-plated steel. Other high-quality components include potted transformers, ceramic switch and variable capacitor insulation, silver-plated or solid-silver switch terminals, etc. All coils are pre-wound, and the main wiring cable is professionally finished. The kit can be built by a beginner from the comprehensive step-by-step instructions supplied. It is a proven, trouble-free rig, that will insure many hours of "on-the-air" enjoyment in your ham shack.

SEPTEMBER, 1956

HEATH COMPANY
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BENTON HARBOR 20, MICH.

www.americanradiohistory.com
HEATHKIT PHONE AND CW
Transmitter Kit

* 6146 final amplifier for full 65-watt plate power input.
* Phone and CW operation on 80, 40, 20, 15, 11, and 10 meters. Pi network output coupling.
* Switch selection of three crystals – provision for external VFO excitation.

MODEL DX-35
$56.95 Shpg. Wt. 24 lbs.

HEATHKIT ANTENNA IMPEDANCE METER KIT
This instrument employs a 100 microampere panel meter and covers the impedance range of 0-600 ohms for RF tests. Functions up to 150 mc. Used in conjunction with signal source, such as the Heathkit Model GD-1B grid dip meter, the Model AM-1 will determine antenna resistance and resonance, match transmission lines for minimum standing wave ratio, determine receiver input impedance, etc. Will also double as a phone monitor. A very valuable device for many uses in the ham shack.

MODEL AM-1
$14.90 Shpg. Wt. 2 lbs.

HEATHKIT “Q” MULTIPLIER KIT
The QF-1 functions with any receiver with an IF frequency between 450 and 460 kc that is not AC-DC type. Operates from the receiver power supply, requiring only 6.3 VAC at 300 ma and 150 to 250 VDC at 2 ma. Simple to connect with cable and plugs supplied. Provides additional selectivity for separating two signals, or will reject one signal and eliminate heterodyne. A big help on crowded bands. Provides an effective Q of approximately 4000 for sharp “peak” or “null”. Tunes to any signal within the IF bandpass of the receiver, without changing main receiver tuning dial.

MODEL QF-1
$99.50 Shpg. Wt. 3 lbs.

HEATHKIT ANTENNA COUPLER KIT
This device is designed to match the Model AT-1 transmitter to a long-wire antenna. In addition to impedance matching, this unit incorporates an L-type filter which attenuates signals above 36 megacycles, thereby reducing TVI. Designed for 52 ohm coaxial input. Handles power up to 75 watts, 10 through 80 meters. Uses a tapped inductor and variable capacitor. Neon RF indicator on front panel. Copper-plated chassis—high quality components throughout—simple to build. Eliminates waste of valuable communications power due to improper matching. A “natural” for all AT-1 transmitter owners.

MODEL AC-1
$14.90 Shpg. Wt. 4 lbs.

HEATHKIT GRID DIP METER KIT
The grid dip meter was originally designed for the ham shack. However, its use has been extended into the service shop and laboratory. Continuous frequency coverage from 2 mc to 250 mc with pre-wound coils. 500 microampere panel meter employed for indication. Use for locating parasitics, neutralizing, determining RF circuits resonant frequencies, etc. Coils are included with kit, as is a coil rack. Front panel controls include sensitivity control for meter, and phone jack for listening to zero beat. Will also double as an absorption-type wavemeter.

MODEL GB-18
$19.50 Shpg. Wt. 4 lbs.
Receiver Kit

You need no previous experience in electronics to build this table-model radio. The Model BR-2 receiver covers 550 kc to 1620 kc and features good sensitivity and selectivity over the entire band. A 5½" PM speaker is employed, along with high gain miniature tubes and a new rod-type built-in antenna. Provision has been made in the design of this receiver for its use as a phonograph amplifier. The phono jack is located on the back chassis apron. A transformer operated power supply is featured for safety of operation, as opposed to the usual AC-DC supply commonly found in "economy radio kits." Don't let the low Heathkit price deceive you. This is the kind of set you will want to show off to your family and friends after you have finished building it.

Construction of this radio kit is very simple. Giant size pictorial diagrams and detailed step-by-step instructions assure your success. The construction manual also includes an explanation of basic receiver circuit theory so you can "learn by doing" as the receiver is built. The manual even provides information on resistor and capacitor color codes, soldering techniques, use of tools, etc. If you have ever had the urge to build your own radio receiver, the outstanding features of this popular Heathkit deserve your attention.

**HEATHKIT CRYSTAL RECEIVER KIT**

The crystal radio of Dad's day is back again, but with big improvements! The Model CR-1 employs a sealed germanium diode, eliminating the critical "cat's whisker" adjustment. It is housed in a compact plastic box, and features two Hi-Q tank circuits, employing ferrite core coils and variable air tuning capacitors. The CR-1 covers the standard broadcast band from 540 kc to 1600 kc, and no external power is required for operation. Could prove valuable for emergency signal reception. This easy-to-build kit is a real "learn by doing" experience for the beginner, and makes an interesting project for all ages.

**HEATHKIT ENLARGER TIMER KIT**

The Model ET-1 is an easy-to-build device for use by amateur or professional photographers in controlling the timing cycle of an enlarger. It covers the range of 0 to 1 minute with a continuously variable, clearly calibrated scale. The timing period is pre-set, and the timing cycle is initiated by depressing the spring-return switch to the "print" position. Front panel provision is made for plugging in the enlarger and a safelight. The safelight is automatically turned "on" when the enlarger is "off". Handles up to 350 watts. The timing cycle is controlled electronically for maximum accuracy and reliability. Very simple to build in only one evening, even by a beginner.

---

**HEATHKIT PROFESSIONAL RADIATION COUNTER KIT**

This sensitive and reliable instrument has already found extensive application in prospecting, and also in medical and industrial laboratories. It offers outstanding performance at a reasonable price. Front-panel meter indicates radiation level, and oral indication produced by panel-mounted speaker. Meter ranges are 0-100, 600, 6,000 and 60,000 counts per minute, and 0-0.02, 1, 1 and 10 miliremgens per hour. The probe, with expansion cord, employs type 6306 bismuth counter tube, sensitive to both beta and gamma radiation. It is simple to build, even for a beginner.

**HEATHKIT BROADCAST BAND**

**MODEL BR-2**

(Less Cabinet)

Shpg. Wt. 10 lbs.

$19.25

INCLUDING NEW EXCISE TAX*
Preamplifier Kit

- 5 switch-selected inputs, each with its own level control.
- Equalization for LP, RIAA, AES, and Early 78's.
- Separate bass and treble tone controls, and special hum control.
- Clean, modern lines and satin-gold enamel finish.

HEATHKIT HIGH FIDELITY

**HEATHKIT HIGH FIDELITY FM TUNER KIT**

- Illuminated slide-rule dial covers 88 to 108 MC.
- Modern circuit emphasizes sensitivity and stability.
- Housed in attractive satin-gold cabinet to match WA-P2 and BC-1.

This amazing new FM tuner can provide you with real high-fidelity performance at an unbelievably low price level. Covering 88 to 108 MC, the modern circuit features a stabilized, temperature-compensated oscillator, A.G.C., broadbanded IF circuits, and better than 10 UV sensitivity for 20 DB of quieting. A high gain, cascaded RF amplifier is used ahead of the mixer to increase overall gain and reduce oscillator leakage. It employs a ratio detector for high efficiency without sacrifice in high-fidelity performance. IF and ratio transformers are pre-aligned, as is the front-end tuning unit. It means the kit can be constructed by a beginner, without elaborate test and alignment equipment. The FM-3A is designed to match the WA-P2 preamplifier and the BC-1 AM Model FM-3A tuner. An illuminated slide-rule dial is employed for frequency indication. Step-by-step instructions and large pictorial diagrams assure success.

**HEATHKIT BROADBAND AM TUNER KIT**

This AM tuner has been designed especially for high-fidelity applications. It incorporates a low-distortion detector, a broadband IF, and other features essential to usefulness in high-fidelity. Special voltage-doubler detector employs crystal diodes for low distortion. Sensitivity and selectivity are excellent. Audio response is a 1 DB from 20 CPS to 2 kHz, with 5 DB of pre-emphasis at 10 kHz to compensate for station roll-off. Covers the standard broadcast band from 550 to 1600 kc. Incorporates a 10 kHz whistle-filter and provides a 6 DB signal-to-noise ratio at 2.5 UV. RF and IF coils are pre-aligned, and power supply is built-in. Incorporates AVC, two outputs, and two antenna inputs.

Model BC-1

$26.95 INCLUDING NEW EXCISE TAX

(with cabinet)

Shpg. Wt. 8 lbs.

**HEATHKIT ELECTRONIC CROSS-OVER KIT**

This unusual device functions to separate low frequencies and high frequencies so that they may be fed to separate amplifiers and to separate speakers. This eliminates the need for conventional cross-over circuits, since the Model XO-1 does the complete job electronically. Cross-over frequencies of 100, 200, 400, 700, 1,200, 2,000 and 35,000 CPS are selectable with front panel controls on the XO-1, and a separate level control is provided for each channel. Minimizes inter-modulation distortion problems. Handies unlimited power, since frequency division is accomplished ahead of the power stage. Attenuation is 12 DB per octave, with sharp "knee" at cut-off frequency.

Model XO-1

$189.95

Shpg. Wt. 6 lbs.
HEATHKIT ADVANCED-DESIGN

HEATHKIT DUAL-CHASSIS—WILLIAMSON TYPE
HIGH FIDELITY AMPLIFIER KIT

This 20-watt high-fidelity amplifier employs the famous Acro-sound Model 10D-300 “ultra-linear” output transformer and uses 5881 output tubes. The power supply is built on a separate chassis, and the two chassis are inter-connected with a power cable. This provides additional flexibility in mounting. Frequency response is ± 1 DB from 6 CPS to 150 kc at 1 watt. Harmonic distortion is only 1% at 21 watts, and 1M distortion is only 1.3% at 20 watts (600 and 3,000 CPS). Output impedance is 4, 8, or 16 ohms. Hum and noise are 98 DB below 20 watts. A very popular high-fidelity unit employing top-quality components throughout.

MODEL W-3M: Shpg. Wt. 29 Lbs. Express only. ...... $49.75
MODEL W-3: Consists of Model W-3M plus Model WA-P2 preamplifier. Shpg. Wt. 37 Lbs. Express only. ...... $71.50

HEATHKIT 7-WATT AMPLIFIER KIT

This amplifier is more limited in power than other Heathkit models, but it still qualifies as a high-fidelity unit, and its performance definitely exceeds that of many so-called “high-fidelity” phonograph amplifiers. Using a tapped-screen output transformer of new design, the Model A-7D provides a frequency response of ± 3/4 DB from 20 to 20,000 CPS. Total distortion is held to a surprisingly low level. Output stage is push pull, and separate bass and treble tone controls are provided. Shpg. Wt. 10 lbs.

MODEL A-7E: Similar to the A-7D, except that a 12S57 tube has been added for pre-amplification. Two inputs, RIAA compensation, and extra gain.

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SEPTEMBER, 1956

HIGH FIDELITY

Amplifier Kit

This 25 watt unit is our finest high-fidelity amplifier. Using a special design peerless output transformer, and KT-66 output tubes by Genalex, the Model W-5M provides performance characteristics unsurpassed at this price level. Frequency response is ± 1 DB from 3 to 160,000 CPS at 1 watt. Harmonic distortion is less than 1% at 25 watts and 1M distortion is less than 1% at 20 watts (60 and 3,000 CPS, 4 to 1). Hum and noise are 99 DB below 25 watts. Damping factor is 40 to 1. Input voltage for 5 watts output is 1 volt. Tubes employed are a pair of 12AU7's, a pair of KT-66's and a 5R4GY rectifier. Measures 13-3/32" W. x 8½" D. x 8¼" H. Output impedance is 4, 8, or 16 ohms. Featured, also, is the “tweeter saver” which suppresses high frequency oscillation, and a new type balancing circuit requiring only a voltmeter for indication. This balance is easier to adjust, and results in a closer “dynamic” balance between output tubes. The Model W-5M provides improved phase shift characteristics, reduced IM and harmonic distortion, and improved frequency response. Conservatively rated high-quality components are used throughout to insure years of trouble-free operation. No technical background or training is required for assembly. Step-by-step instructions are provided for every stage of construction, and large pictorial diagrams illustrate exactly where each wire and component is to be placed. An amplifier for music lovers who can appreciate subtle differences in performance. Just ask the audiophile who owns one!

HEATHKIT SINGLE CHASSIS—WILLIAMSON TYPE
HIGH FIDELITY AMPLIFIER KIT

The 20-watt Model W-4AM Williamson type amplifier is a tremendous high-fidelity bargain. Combining the power supply and main amplifier on one chassis, and using a special-design output transformer by Chicago Standard brings you savings without a sacrifice in quality. Employing 5881 output tubes, the frequency response of the W-4AM is ± 1 DB from 10 CPS to 100 kc at 1 watt. Harmonic distortion is only 2.7% at this same level. Output impedance is 4, 8, or 16 ohms. Hum and noise are 95 DB below 20 watts.

MODEL W-4AM: Shpg. Wt. 28 Lbs. Express only. ...... $39.75
MODEL W-4A: Consists of Model W-4AM plus Model WA-P2 preamplifier. Shpg. Wt. 35 Lbs. Express only. ............. $61.50

HEATHKIT 20-WATT HIGH FIDELITY AMPLIFIER KIT

This high-fidelity amplifier features full 20-watt output using push pull 6L6 tubes. Built-in preamplifier provides 4 separate inputs, selected by a panel-mounted switch. It has separate bass and treble tone controls, each offering 15 DB boost and cut. Output transformer is tapped at 4, 8, 16, and 500 ohms. Designed primarily for home installations, but also used extensively for public address applications. True high-fidelity performance with frequency response of ± 1 DB from 20 CPS to 20,000 CPS. Total harmonic distortion only 1% at 3 DB below rated output.

MODEL A-98

$35.50
(Express only)

Shpg. Wt. 23 lbs.

77

www.americanradiohistory.com
This range extending unit is designed especially for use with the Model SS-1 speaker system. It consists of a 15" woofer, providing output between 35 and 600 CPS, and a compression-type super-tweeter that provides output between 4,000 and 16,000 CPS. Cross-over frequencies are 600, 1,600, and 4,000 CPS. The SS-1 provides the mid-range, and the SS-1B extends the coverage at both ends of the spectrum. Together, the two speaker systems provide output from 35 to 16,000 CPS within ±3 DB. This easy-to-assemble speaker enclosure kit is made of top-quality furniture-grade plywood. All parts are pre-cut and pre-drilled, ready for assembly and the finish of your choice. Complete step-by-step instructions are provided for quick assembly by one not necessarily experienced in woodworking. Coils and capacitors for proper cross-over network are included, as is a balance control for super-tweeter output level. The SS-1 and SS-1B can provide you with unbelievably rich audio reproduction, and yet these units are priced reasonably. The SS-1B measures 29" H. x 23" W. x 17½" D. The speakers are both special-design Jensens, and the power rating is 35 watts. Impedance is 16 ohms.

This speaker system is a fine reproducer in its own right, covering 50 to 12,000 CPS within ±3 DB. However, the story does not end there. Should you desire to expand the system later, the SS-1 is designed to work with the SS-1B range extending unit — providing additional frequency coverage at both ends of the spectrum. It can fulfill your present needs, and still provide for the future. The SS-1 uses two Jensen speakers; an 8" midrange-woofer, and a compression-type tweeter. Cross-over frequency is 1,600 CPS, and the system is rated at 25 watts. Nominal impedance is 16 ohms. The cabinet is a ducod-port bass-reflex type. Attractively styled, the Model SS-1 features a broad "picture-frame" molding that will blend with any room decorating scheme. Pre-cut and pre-drilled wood parts are of furniture grade plywood. The kit is easy-to-build, and all component parts are included, along with complete step-by-step instructions for assembly. Can be built in just one evening, and will provide you with many years of listening enjoyment thereafter.

**HEATHKIT HIGH FIDELITY**

**Range Extending**

**SPEAKER SYSTEM KIT**

* High quality speakers of special design — 15" woofer and compression-type super-tweeter.
* Easy-to-assemble cabinet of furniture-grade plywood.
* Attractively styled to fit into any living room. Matches Model SS-1.

**HEATHKIT HIGH FIDELITY**

**SPEAKER SYSTEM KIT**

* Special design ducted-port, bass-reflex enclosure.
* Two separate speakers for high and low frequencies.
* Kit includes all parts and complete instructions for assembly.

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**RADIO-ELECTRONICS**

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A n important problem in constructing electronic equipment is to provide a suitable mounting base. This is especially true for experimental work where the number of components and their final arrangements can seldom be accurately predicted. Breadboards, although versatile, are unsuitable for present-day components. Despite frequent improvements they still introduce constructional complexities. In the universal experimental chassis described here, the advantages of earlier breadboards are retained while several other innovations are introduced for assembling temporary and semipermanent circuitry.

Basically, the new chassis (Figs. 1, 2) consists of two spring-loaded gaps into which can be inserted a number of square mounting panels. The end frames have been especially designed to permit tilting the chassis to either side at a convenient working angle. They also serve as carrying handles. Ample clearance from the bench surface protects mounted components. The square slide-in panels, which serve as mounts for tube sockets and other components, can be inserted in any one of four rotational positions for best base-pin arrangement. If necessary, rectangular panels could be used for larger parts.

For easier construction, individual panels can be made to carry complete subassemblies by using socket turrets or by directly suspending components from the tube sockets. Such units can be inserted in their required sequence. When modification or dismantling is required later, they can be removed from the chassis simply by disconnecting the power supply and coupling leads. A small gap between adjacent plates will allow feeding through leads to grid caps. Controls, rotary switches and terminals can be mounted on the sides of the chassis and, like the slide-in panels, placed anywhere along its entire length.

The chassis was designed to be used with external power sources. Power is distributed by bus bars along the center. Each side has its own system separately terminated at one end, permitting construction of two independent circuits. For larger circuits requiring the use of both sides the distribution systems can be strapped and supplied through either of the terminating receptacles.

**Construction**

Consideration has been given to the availability of materials. The design and construction have been simplified to use only standard semihard aluminum stock and most of the material is used as purchased. There is a minimum of machine work. In fact, the complete chassis can be constructed without the aid of power tools if it is necessary.

The parts and their dimensions are illustrated in Fig. 3. A number of identically dimensioned parts can be clamped together and faced simultaneously. The end brackets are cut from a $\frac{3}{4}$-inch square bar. The slots (milled or cut by hacksaw) provide an easy method of making certain that the material bends at the required place with a minimum of bulging. The chassis cross rails are cut from a $1 \times \frac{3}{4}$-inch bar and require only facing. Strips of flexible aluminum are used for the springs. Other materials such as tempered brass or phosphor bronze are equally suitable. All six pieces forming the end supports are cut from one 8-inch length of $1 \frac{1}{8} \times \frac{3}{4}$-inch bar.

The triangular supports A can be obtained by two diagonal cuts and the rectangular supports B by a cut along the center of a $2\frac{1}{4}$-inch portion of the same material. Holes for the power-supply receptacles can be bored in two of the triangular pieces. The square slide-in plates are cut from a $1 \frac{1}{8} \times \frac{3}{4}$-inch strip and should be kept to fairly close tolerances to prevent binding when inserting them into the chassis. Examples of slide-in plates are shown in Figs. 3, 4. However, these can be made to suit individual requirements. The bus bars are lengths of 16-gauge tinned copper wire. A punched plastic card...
RADIO

Fig. 3—Diagram shows the parts forming the chassis, and suggested dimensions.

(Alden 650 ATMS-D) forms the mounting base for four rows of conductors on each side. The conductors are insulated from each other and each side is separately terminated in a suitable receptacle. The card may be obtained from Alden Products, Brockton, Mass.

In general, all parts, except the springs, are fastened together by flat-headed 4-40 machine screws. Tapped holes, receiving the screws to a depth of at least 1/4 inch, are used throughout. The springs can be either riveted or bolted by 2-56 screws. Bolting has the advantage of easier replacement of springs in case of damage.

While constructing a number of these chassis, some difficulty was sometimes encountered in aligning separately drilled holes. To avert this, the following practical, even if somewhat unconventional, method was devised:

Components which are to be bolted together are clamped in their required positions on a piece of angle iron or a mounting fixture, as shown in Figs. 5, 6. Tapping holes are then drilled through both parts. Inserting scrap pieces of 1/4-inch material as spacers results in uniform gaps in the chassis sides; slide-in panels may be inserted in gaps of the chassis top.

Assembly procedure

1. Mount springs to both faces of the cross rails forming the chassis top. Let
RADIO

them protrude ⅛ inch beyond each edge. The springs should extend to within ⅝ inch of each end. On the center rail, mount springs to both edges.

2. Attach end supports to their corresponding cross rails, clamping and drilling at both ends as indicated in Fig. 5.

3. Mount chassis on the end brackets, inserting slide-in panels as spacers (Fig. 6).

4. Using the center portion of mounting fixture, attach cross rail to top of end brackets.

5. To complete the chassis, bolt the punched-card assembly to the center cross rail and solder connections to the terminating receptacle.

Modifications and accessories

So far, the construction has been kept to simple cutting and drilling. Where more extensive shop facilities are available the versatility of the chassis can be increased. A disadvantage of the above construction is that centrally located plates cannot be removed without disturbing adjacent ones. This can be overcome by replacing the top springs of the center rail with a solid strip which can be moved sideways so that either chassis gap can be freed. This modification is shown in Fig. 7. A piece of 1/16 inch thick aluminum, 12 x 1½ inches, replaces the top springs. Three angular slots are filed in this strip which is held against the center rail by spring-loaded screws. When the strip is in its central position, both chassis gaps are locked. Pushing or pulling one end tab moves the strip aside, opening either gap and permitting removal or insertion of any of the desired plates.

Casters are best mounted directly on the chassis. A suitable attachment which will accommodate up to a 3½ x 1-inch meter is shown in Fig. 8 and affords full protection from all sides. It consists of two type A supports mounted on a slide-in plate. An ⅛-inch clearance is cut into the support. Two spring strips (3/4-inch chassis spring) and a spiral spring or strong elastic band hold the meter securely.

Materials for experimental chassis

4—end brackets, 4 feet ⅛ inches of ⅛ x ⅛-inch bar; 8—cross rails, 8 feet of ⅛ x ⅛-inch bar; 8—springs, 7 inches of ⅛ x ⅛-inch strip; 4—end supports A, 2—end supports B, 8 ⅛ inches of ⅛ x ⅛-inch bar; slide-in panels, ⅛ x ⅛-inch bar.

Experience has indicated that the structure is sturdy and the all-metal construction has provided adequate shielding up to reasonably high frequencies. The chassis described is both practical and versatile and is proving to be an indispensable unit for the experimenter in the laboratory, lecture room and ham shack.

I wish to express my thanks to Drs. C. C. Lucas and W. G. B. Casselman of the Banking and Business Department, University of Toronto, for their helpful suggestions in preparing this paper.

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www.americanradiohistory.com
Once upon a time I had a good transistor that went bad. Just a little carelessness Gave me one transistor less.

By STAN SCHENKERMAN

The radio-TV service technician must again cope with the advance of technology! Transistor radios are coming into his shop in increasing numbers. No doubt he will rise above this challenge with his usual proficiency.

But servicing transistor radios requires some modification of the techniques used for tube radios. To aid technicians entering this new field, the following 10 hints will serve as a guide:

1. Whether a tube or transistor set, A superhet is a superhet. The block diagram of a transistor radio is the same as for a conventional tube receiver. Fig. 1 shows the schematic of a transistor radio put out by Raytheon. Fig. 2 is a block diagram of the set. Note that it is almost the same as for conventional tube jobs.

2. In checking transistors you should Replace with ones known to be good. Substitution is the only reliable check. A transistor may seem good on a transistor checker and still cause poor operation.

3. Your substitute should be the kind That in the radio you find. Transistors by different manufacturers may be similar, but they are probably not similar enough, at present, for direct interchange.

4. A rose is a rose by any name, But tubes and transistors are not the same. Even with the power switch off, the impedances of the transistor are not infinite as are the tube's. Always remove all transistors when making ohmmeter measurements. If the transistors are in, the ohmmeter current may damage them. Of course, you will

5. Transistors with heat cannot co-exist Protect them from it or they won't transist! Transistors are very temperature-sensitive and can be permanently damaged by the heat from a soldering iron. Use a pencil type iron of not more than

---

Fig. 1—Schematic diagram of the Raytheon chassis 8RT1 transistorized portable radio—unit uses eight transistors.

Fig. 2—Block diagram of Raytheon set.

Fig. 3—Using pliers as a heat sink. Also obtain incorrect readings.

Fig. 4—Heating a transistor.

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RADIO

35-40 watts and small-diameter multiplex-core 60/40 solder. Remove the transistor when soldering at or near its socket, or use a pair of long-nose pliers as a heat sink. This is done by grasping the transistor electrode to which you are soldering, with the pliers between the soldering point and the transistor body. (See Fig. 3.)

6. Many transistors have laid down and died. Simply because of wrong bias applied.

Be sure that transistors are inserted in their sockets so that the proper polarity bias is applied. There are a

Fig. 4—Identifying transistor leads using a red dot near the collector. A number of schemes used to specify which electrodes are the emitter, base and collector. Fig. 4 shows one method where a red dot is placed near the collector. Fig. 5 shows a pin-spacing method.

Fig. 5—The pin-spacing method of identifying transistor electrodes.

7. With a new transistor you may find that the whole set must be realigned.

This is due to the nonuniform transistors produced at the present stage of the art. Even rearranging the original order of the transistors may throw the set out of alignment.

8. When aligning you should know enough to keep your signal low.

Transistors, because they work at such low levels, can be easily overloaded by what may be a small signal for a tube. Furthermore, the entire alignment procedure should be repeated two or three times for best results. The input and output circuits of the transistor are not isolated from each other, as they are in tube sets. Tuning one transistor stage affeets the tuning of the others and repetition is the only way of securing perfect alignment.

9. Transient currents shouldn’t be passed through transistors you want to last.

Have the power switch off when removing or installing batteries or transistors. That way you will never subject the transistors to those damaging transients.

10. To your customers suggest that there are small-plate cells. Replaceable batteries of the mercury-oxide type will give about five times the playing life of conventional flashlight batteries. Although initial cost is higher, the long-term cost per playing hour is much less.

SEPTEMBER, 1956

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Superior’s New Model 770-A

The FIRST Pocket-Sized VOLT- OHM MILLIAMMETER

USING THE NEW “FULL-VIEW” METER

71% MORE SCALE AREA!

Yes, although our new FULL-VIEW D’Arsonval type meter occupies exactly the same space used by the older standard 2 1/2" Meters, it provides 71% more scale area. As a result, all calibrations are printed in large easy-to-read type and for the first time it is now possible to obtain measurements instead of approximations on a popular priced pocket-sized V.O.M.

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- Housed in round-cornered, molded case.
- Beautiful black etched panel. Depressed letters filled with permanent white, insures long-life even with constant use.

Specifications

A.C. VOLTAGE RANGES: 0-15/30/150/300/1500/3000 Volts. 6 D.C. VOLTAGE RANGES: 0.75/1.5/3/5/7.5/15/30/75/150/300/1500 Volts. 2 RESISTANCE RANGES: 0-10,000 Ohms, 0-1 Megohm. 3 D.C. CURRENT RANGES: 0-15/150 Ma, 0-1.5 Amps. 3 DECIBEL RANGES: -6 db to + 18 db, + 14 db to + 38 db, + 34 db to + 58 db.

The Model 770-A comes complete with self-contained batteries, test leads and all operating instructions.

$15.85 NET

Superior’s New Model TV-60

20,000 OHMS PER VOLT MILLIAMMETER

Includes services never before provided by an instrument of this type.

- The line cord, used only when making Capacity measurements, need be plugged in only when using that service. It is out of the way, stored in its platinium compartment at all other times.
- A built-in Isolation Transformer automatically isolates the Model TV-60 from the power line when the capacity service is in use.
- Selected, 1% zero temperature coefficient metalized resistors are used as multipliers assuring unchanging accurate readings on all ranges.
- Use of the latest type of printed circuit guarantees maintenance of top quality standard in the production runs of this precise instrument.
- A new improved type of high-voltage probe is used for the measurement of high voltages up to 30,000 Volts. This service will be required when servicing color TV receivers.
- Simply plug-in the R.F. probe and convert the Model TV-60 info an efficient R.F. SIGNAL TRACER permitting the measurement of stage gain and cause of trouble in the B.F. and I.F. Circuits of A.M., F.M., and TV receivers.
- Plug in the Audio probe and convert the Model TV-60 into an efficient AUDIO SIGNAL TRACER. Measure the signal levels and comparative efficiency of hearing-aid, public-address systems, the amplifier sections of Radio & TV receivers, etc.

Features

- A sensitive, accurate Volt-Ohm-Milliammeter with giant meter and mirrored scale.
- An accurate direct-reading Capacity meter.
- A Kilovoltmeter.
- An Audio Signal Tracer.
- Giant recessed 6 1/2" inch 40 Microampere meter with mirrored scale assures accuracy and easy-reading. All calibrations are printed in large easy-to-read type. Fractional divisions are easily read with the aid of the mirrored scale.

Read and compare features and specifications below!

Specifications

D.C. VOLTAGE RANGES: (At a sensitivity of 20,000 Ohms per Volt) 0 to 15/30/150/300/750/1500/3000 Volts. 6 D.C. VOLTAGE RANGES: 0.75/1.5/3/5/7.5/15/30/75/150/300/1500 Volts. 2 RESISTANCE RANGES: 0-10,000 Ohms, 0-1 Megohm. 3 D.C. CURRENT RANGES: 0-15/150 Ma, 0-1.5 Amps. 3 DECIBEL RANGES: -6 db to + 18 db, + 14 db to + 38 db, + 34 db to + 58 db.

R.F. SIGNAL TRACER SERVICE:

Features following the R.F. signal from the antenna to speaker of any radio or TV receiver and using that signal as a basis of measurement to first isolate the faulty stage and finally the component or circuit condition causing the trouble.

Audio Signal Tracer Service:

Functions in the same manner as the R.F. Signal Tracing service specified above except that it is used for the isolation of cause of trouble in all audio and amplifier systems.

Model TV-60 comes complete with book of instructions; pair of standard test leads; high-voltage probe; detachable line cord; R.F. Signal Tracer Probe and Audio Signal Tracer Probe. Platinium bag for all above accessories is included. Price complete. Nothing else to buy. Only $52.50 NET

Superior’s New Model 670-A

SUPER-METER

A COMBINATION VOLT- OHM MILLIAMMETER
PLUS CAPACITY REACTANCE INDUCTANCE AND DECIBEL MEASUREMENTS.

D.C. VOLTS: 0 to 7.5/15/75/150/750/1,500 Volts. A.C. VOLTS: 0 to 15/30/150/300/1,500 Volts. OUTPUT VOLTS: 0 to 15/30/150/300/1,500 Volts. OUTPUT CURRENT: 0 to 1.5/15/150 Ma. 0 to 1.5/15 Amps. RESISTANCE: 0 to 1,000/100,000 Ohms 0 to 10 Megohms. CAPACITY: .001 to 1 Mfd. 1 to 50 Mfd. (Good-Scale Bar for checking quality of electrolytic condensers). REACTANCE: 50 to 2,500 Ohms. 2,500 Ohms to 2.5 Megohms. INDUCTANCE: .15 to 7 Henries 7 to 7,000 Henries. DECIBELS: -6 to + 18, + 14 to + 38, + 34 to + 58.

ADDED FEATURE: Built-in ISOLATION TRANSFORMER reduces possibility of burning out meter through misuse.

The Model 670-A comes housed in a rugged crackle-finished steel cabinet complete with test leads and operating instructions.

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Superior’s New Model TC-55

**TUBETESTER**

**FOR**
The Experimenter or Part-time Serviceman, who has delayed purchasing a higher priced Tube Tester.
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Speedy, yet efficient operation is accomplished by:
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"Free-point" element switching system

The Model TC-55 incorporates a newly designed element selector switch system which reduces the possibility of a filament pin and the voltage applied between that pin and any other pin, or even the "top-cap". Checks for shorts and leakages between all elements. The Model TC-55 provides a super sensitive method of checking for shorts and leakages up to 5 megohms between any and all of the terminals. Continuity between various sections is individually indicated. This is important, especially in the case of an element terminating at more than one pin. In such cases the element or internal connection often completes a circuit.

Elemental switches are numbered in strict accordance with R.M.A. specifications.

One of the most important improvements, we believe, is the fact that the 4 position fast-action snap switches are all numbered in exact accordance with the standard R.M.A. numbering system. Thus, if the element terminating in pin No. 7 of a tube is under test, button No. 7 is used for that test.

The Model TC-55 comes complete with operating instructions and charts. Housed in rugged steel cabinet. Use it on the bench—use it for field calls. A streamlined carrying case, included at no extra charge, accommodates the tester and book of instructions.

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**Superior’s New Model TV-11**

**TUBETESTER**

**SPECIFICATIONS:**

- Tests all tubes including 4, 5, 6, 7, Octal, Lock-It, Peanut, Eastern Hearing Aid, Triatron, Minatures, Sub-miniatures. Novals, Sub-miniars, Proximity fuse types, etc.
- Uses the self-cleaning Lever Action Switches for individual element testing. Because all elements are numbered, one to pin number in the RMA base numbering system, the user can instantly identify which element is under test. Tubes having tapped filaments and tubes with "filaments terminating in more than one pin are truly tested with the Model TV-11 as any of the pins may be placed in the neutral position when necessary.
- The Model TV-11 does not use any combination type sockets. Instead individual sockets are used for each type of tube. Thus it is impossible to damage a tube by inserting it in wrong socket.
- Free-moving built-in roll chart provides continuity of all elements and internal connections.
- Newly designed Line Voltage Control compensates for variation of any Line Voltage between 115 Volts and 230 Volts.
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**EXTRA SERVICE** — The Model TV-11 may be used as an extremely sensitive Condenser Leakage Checker. A relaxation type oscillator incorporated in this model will detect leakages even when the frequency is one per minute.

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- The Model TV-12 will accommodate all transistors including NPN's, PNP's, Photo and Tetodes, whether made of germanium or silicon, either point contact or junction type diodes.
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The Model TV-40 is absolutely complete! Self-contained, including built-in power supply, it tests picture tubes in the only practical way to efficiently test such tubes; that is by the use of a separate instrument which is designed exclusively to test the ever-increasing number of picture tubes!

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VARIABLE AUDIO FREQUENCY GENERATOR: In addition to a fixed 400 cycle sine-wave audio, the Model TV-50 Genomenter provides a variable 300 cycle to 20,000 cycle peaked wave audio signal.

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THE MODEL T.V.-50 comes absolutely complete with shielded leads and operating instructions.

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Superior's New Model TV-80

5" OSCILLOSCOPE

The Model TV-80 is a practical Radio & TV Oscilloscope. It does not include those requirements which are provided in Scopes intended primarily for laboratory and research work. It does include all the services required for Radio TV Servicing.

When you read the specifications which follow, you will find not a single Radio & TV service requirement has been omitted. Yet, by eliminating "laboratory" features rarely if ever needed by the average Radio TV Serviceman, SUPERIOR is able to offer a comparatively low-priced scope which provides maximum usage.

SPECIFICATIONS

✓ Push-pull vertical and horizontal amplifiers.
✓ Cathode follower vertical input circuit.
✓ High vertical amplifier sensitivity, .02 volts (20 MV) per inch.
✓ Vertical frequency response flat within 2 db from 20 cycles to 500 Kc.
✓ Vertical square wave response from 20 cycles to 50 Kc.
✓ High horizontal amplifier sensitivity, .05 volts (50 MV) per inch.
✓ Horizontal frequency response flat within 3 db from 20 cycles to 200 Kc.
✓ Wide range horizontal phasing control.

Model TV-80 comes housed in rugged steel cabinet. Complete with book of instructions........................................only

Internal linear sweep from 10 CPS to 30 Kc.
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Analyzing current flow in popular type power supply

By GEORGE P. PEARCE

JUST why is it possible to connect a couple of rectifiers and a couple of capacitors in an alternating current circuit and finish up with over twice the voltage, and direct current at that?

Suppose we have an electronic check valve that will permit current to flow in only one direction and a couple of capacitors. Let us mark the electronic check valve V, the capacitors C1 and C2 and then wire the assembly as shown in Fig. 1. V is connected as a switch between terminals L and P and set so current (electrons) can flow only from P to L. Apply 100 volts (peak) a.c. across terminals T1 and T2. Current will flow as shown, and C1 will charge to 100 volts positive with respect to T2. T3 will also be 100 volts positive since it is connected to the positive side of the capacitor C1.

After the input voltage passes the 100-volt peak and starts to decrease,
the capacitor will be prevented from discharging backward because V will not permit current to flow in the reverse direction. Thus, when the line voltage has fallen to zero, there will still be 100 volts across C1.

Suppose that when the voltage reaches zero we instantaneously change the direction of flow through check-valve V, connect from N to L and open-circuit L to P. The line voltage passes zero (current flows in the opposite direction) and continues to fall until it reaches a negative value of 100. This will make the voltage on C2 rise to 100 volts negative with respect to T2. And since T4 is directly connected to this capacitor, the terminal will also be 100 volts negative (Fig. 2). Thus the po-

![Diagram](attachment:diagram.png)

**Fig. 2**—Direction of current flow during second half of input cycle.

ential drop between terminals T3 and T4 will be from 100 volts positive to 100 negative (with respect to our reference point T2) a 200-volt difference. The line voltage T1 and T2 is 100 volts ac; the voltage between T3 and T4 is 200 dc.

A rectifier such as a selenium type is the same to an electric current as a check valve is to the flow of water. So if we install two rectifiers, each the reverse of the other, we shall then have an arrangement that will accomplish electrically the equivalent switching arrangement as indicated in Figs. 1 and 2. And if the ac line is connected to terminals T1 and T2, C1 and C2 will be continually recharged 60 times per second—60-cycle power. If a load is connected between T3 and T4 to permit a current to flow which is in reasonable proportion to the storage capacity of the capacitance, a 200-volt dc voltage will be available.

![Diagram](attachment:diagram.png)

**Fig. 3**—Above is the symmetrical voltage doubler in the theoretical bridge form; below in the more familiar practical schematic style.

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Cl and C2, a voltage will be maintained across the load at approximately twice the line voltage. (The peak ac voltage is equal to the rms voltmeter reading multiplied by the square root of 2 or 1.41.) A typical schematics of this device (both in theoretical form and how it looks in an actual circuit) is shown in Fig. 3.

A handy little voltage doubler is shown in the photo. The transformer voltage output is 6.3 and the dc output of the unit is 13 volts at 50 ma. The capacitors are 100 µf with a working voltage of 50.

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EARLY superhet tube receivers used low intermediate frequencies of 175 kc or so. As more broadcast stations went on the air and as they increased their radiated power, a higher if became necessary. Eventually, 455 kc was adopted by most radio manufacturers. The higher if produced less image interference.

The design of a transistor superhet with an if of 455 kc had to await the development of efficient high-frequency transistors and if transformers. Transistor gain falls off with increasing frequency, so only very-high-gain transistors are suitable at high intermediate frequencies. Transistors with a cutoff of at least 2.5 or 3 mc are suitable for use at an if of 455 kc.

Among the highest cutoffs now available in junction transistors (Radio-Electronics, February, 1956, page 40) are Raytheon 2N113, 2N114 and G-E 2N187. Having cutoff values of 10, 20 and 10 mc, respectively, any of these will give very high gain at 455 kc.

Modern transistors can provide up to 32 db or more gain in a single stage. A gain of 33 db is equivalent to a power increase of 2,000 times. The specified gain of a complete transistor stage usually includes the 3-db loss in a matching transformer.

Raytheon FM-101A (modified)

One of the first superhet receivers designed for 455 kc was Raytheon's FM-101A, a modified version which is shown in Fig. 1. It uses p-n-p transistors operating from a 6-volt battery. Three rf transistors are indicated in the schematic: 2N112, 2N113, 2N114. Gain-wise there is about 1-db difference between them, the higher number providing the greater gain. The 2N114 has a frequency cutoff of 20 mc.

The receiver has separate transistors for mixer and oscillator functions to provide maximum stability and gain. The variable tuning capacitor has two 355-µf sections. The large padder (600-1,250 µf) tunes the oscillator circuit 455 kc higher than the mixer.

Oscillator V1 is stabilized by an emitter resistor and a voltage divider feeding the base. Bias on each element is about 2 volts. Mixer V2 has zero bias since it must rectify as well as amplify. Note the filter network in the oscillator supply lead—this stage must be decoupled and isolated to prevent feedback through the common battery. A fixed 100-µf capacitor injects the oscillator voltage into the mixer base.

The two if stages (V3, V4) follow circuit principles previously outlined.

![Fig. 1—Schematic diagram of the Raytheon FM-101A (modified) receiver. Oscillator V1 may be a type 2N113 or 2N114.](www.americanradiohistory.com)
There are decoupling and stabilizing networks in the collector and emitter leads. Neutralizing capacitors NC are 30 µf.

The if transformers are No. 3015 (made by Automatic Manufacturing Co.), or their equivalent. The primary has 155 turns with a tap at 55 turns. The secondary has 18 turns. The primary is slug-tuned (from the bottom of the transformer) and is shunted by a 125-µf capacitor. Each transformer is ¾ inch high by ¾ inch square. There are five terminals, of which only four are wired in circuit.

Detector V5 is biased class B. The biasing resistors are R1 and R2. The voltage across R2 is less than 0.15 volt and only a small bias current can flow through the base. Therefore V5 is near cutoff in the no-signal condition. At this time the collector current is about 0.1 mA and the drop across R3 0.1 volt. When an if signal arrives, collector current increases. On a strong station the drop across R3 may reach 1 volt or more. Therefore a voltmeter across this resistor may be used to measure signal strength if accurate measurements are required.

The variable dc collector voltage is fed back to both if amplifiers to control their gain. This arc drives the if bases more positive with increasing signal, cutting gain and preventing overload. V3 operates from 3 volts, rather than the entire battery. This permits greater control of the stage. The second-stage emitter is self-biased.

Audio stage V6 drives a push-pull class-B output amplifier (V7, V8). These transistors are popular low-output types but, when used in class B, they are capable of 100-mw output. The output stage is held near cutoff by voltage divider R5-R6, so that with no signal very little current flows in the collector circuits.

An af signal drives these transistors into conduction, one at a time. Each transistor can conduct only when its base goes negative, therefore V7 conducts on one half of the cycle and V8 on the other. Both halves are combined to re-create the original signal in the output transformer. The stronger the input signal, the greater the conduction of each transistor. A total of about 27 ma flows at maximum signal. This drops to 1 ma in the absence of a signal. Evidently, we pay only for what we use in a class-B amplifier.

About 1.2 mA is lost in divider R5-R6. This loss cannot be reduced simply by using larger resistors. Relatively large peaks of current may flow in this stage, so low resistance is needed in the input and output circuits. The secondary driver transformer has a secondary resistance less than 50 ohms. This transformer matches 10,000 to 2,000 ohms, base to base. The output transformer has a primary resistance of only 90 ohms. It drives the speaker to 500 ohms, collector to collector. Negative feedback (through R4) is used to reduce distortion.

An interesting feature of this receiver is that it uses components now available to experimenters. All parts are available from mail-order houses or stores specializing in transistors and parts. This circuit is adequately decoupled, filtered and operated well within all ratings. Of course, the home builder cannot make such a circuit as light and compact as the commercially built, printed-circuit receiver, with specially manufactured components to fit a small case.

DeWald K-701

This receiver (Fig. 2) uses six transistors of the p-n-p type. It is powered by a 9-volt battery (Eveready 276 or equivalent) which can give about 500 hours of service.

The first transistor oscillates and converts to if. Oscillations are generated by coupling the collector and emitter windings. As in any tickler arrangement, the polarity of each coil is important. In the diagram, a shows the start and f the finish of each winding. To maintain high Q, reduce antenna capacitance and at the same time match the low input impedance, the base is fed from a secondary rather than the antenna coil itself.

The if strip uses the same transistors and neutralizing arrangement shown in the previous receiver. Voltage divider R1-R2-R3 supplies no-signal bias to the first if, and positive bias is supplied by the arc lead. The stronger the signal, the more positive this control voltage and the lower the if gain. Because of the larger voltage supply, it is possible to use larger decoupling resistors here than in the previous circuit.

The secondaries of each of the two if transformers are wound to match 600 ohms, the transistor input. The secondary of the third transformer matches a higher impedance, the crystal diode. This detector supplies positive arc voltage and also feeds the rectified if to the volume control.

The af is fed to a conventional audio circuit. Each stage is fixed-biased. The push-pull stage is biased to near cutoff by a 70-to-1 ratio voltage divider. Output is about 75 mw maximum.

Fig. 3 shows the parts layout. Set dimensions are 8 ½ x 6 ¼ x 2 ¼ inches. This cabinet permits inclusion of a 4-inch speaker, much larger than in tiny pocket sets, and is nonbreakable.

Zenith Royal 500

This receiver uses seven transistors, all n-p-n type. The battery is 6 volts, which may be four penlight (size AA) cells in series. These will supply the set for approximately 50 hours at an operating cost of about 1 cent an hour. If longer life is desired, mercury cells (Zenith Z9) may be substituted. Conelrad frequencies 640 and 1240 kc are (Continued on page 99)
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(Continued from page 92)

A 1N205 diode detects and furnishes ac (negative) voltage. The audio channel uses three 2N35 high-gain transistors. A jack provides an outlet for an earphone for private listening. There is no need to disconnect the output stage during this time because there is negligible drain by a class-B stage operating at zero signal.

Undistorted power output is 100 mw, with a maximum of 180 mw. The receiver has a sensitivity of 500 microvolts per meter for 50-mw output.

G-E models 675, 676

Both of these sets use five transistors, all of which are p-n-p except the detector. A single transistor operates as an oscillator-mixer. Another is the audio output stage which can deliver up to 40 mw at 10% distortion and an audio peak of 60 mw. The receivers (Fig. 5) are plate-wired.

V1 is the converter transistor. Mixing is done by a series connection of T1 (the antenna loop) and T2 (the oscillator coil). Inductive coupling between the base and collector windings generates the local oscillations. V1 is biased for detection (otherwise it cannot produce the desired if beat). This bias is set by voltage divider R1-R2-R3. A blocking capacitor prevents the coils from shorting R1.

Note the absence of neutralization. To make this possible V2 is operated at less than maximum voltage (13.5 volts) to stabilize it. The emitter is returned to a -4.5-volt tap rather than to ground directly or through a resistor. A nearly equal voltage drop is needed at the base, and this is generated in the larger series resistor R4 and the drop across R5. Some degeneration is introduced by omitting bypass capacitance across the 4.5-volt tap of the battery. In other words, collector current is bypassed to ground through C1. To return to the emitter it must flow through the battery to the -4.5-volt tap. There is no bypassing through this portion of the battery.

V3, also unneutralized, receives nearly full voltage since its emitter is directly grounded. In this stage regeneration is lowered by resistor R6 shunting the transformer secondary. R6 is normally 470 ohms. However, if regeneration occurs in spite of it, damping may be increased by using a still lower resistance; it should be as large as possible without producing instability.

V4 is biased for detection by the voltage divider, 47,000 and 220 ohms. High frequencies are bypassed through a .05-uf capacitor, but audio appears across the volume control. Note the direct coupling to the output stage. While this means less than optimum matching, it is a convenient coupling method, and eliminates power losses in a transformer.

When V4 delivers greater output (as it does when the signal is stronger), a larger negative drop appears across the volume control since the detector is n-p-n. Thus V5 (a p-n-p type) is driven to greater conduction so it can handle the greater signal impressed on it.

Tuning and alignment are as specified on the diagram. First, adjust the if transformers, starting with the last and working forward. Couple the signal generator loosely to the high end of the antenna loop. Now the high-frequency end of the broadcast band may be aligned, then the low-frequency end. Repeat the alignment if it proves necessary.

TO BE CONTINUED
PHASE shift is important in automatic frequency control, synchronized sweep, tone correction, chrominance and color oscillator sections—to mention only a few of its applications in modern electronics. Phase-shift circuits consist of capacitors or inductors or both, and usually resistors, in series or parallel combinations.

The number of degrees by which voltage across a series resistor is shifted with reference to the source voltage varies with the amounts of resistance, capacitance or inductance and operating frequency. Problems are simplified by combining capacitance or inductance, and frequency, in a single term—reactance, at the operating frequency. Knowing ohms of reactance and ohms of resistance we may read phase shifts in degrees for any series circuit on the chart of Fig. 1.

On the chart are sloping lines for phase shifts of 0 to 90° at intervals of 5°. The resistance and reactance scales may be multiplied or divided by any number, but both by the same number, to bring them into a range for any resistance and reactance in a problem. Reactance for any capacitance and frequency may be read directly from alignment charts in the December, 1955, issue of RADIO-ELECTRONICS or both capacitive and inductive reactances may be computed from formulas at the end of this article.

Here are the rules:

1. Phase difference between voltage across a resistor and voltage across either a capacitor or inductor in series always is 90°.
2. With only capacitance and resistance in series the resistor voltage leads source voltage, capacitor voltage lags source voltage.
3. With only inductance and resistance in series the resistor voltage leads and inductor voltage leads source voltage.
4. With capacitance, inductance and resistance in series it is necessary to determine the separate capacitive and inductive reactances, then take their difference as the net reactance for use on the chart. Consider the net as capacitive if capacitive reactance is the larger, inductive if inductive reactance is the larger.

To illustrate how phase shift is read assume, as in Fig. 2, 5,000 ohms resistance and 1 µf capacitance in series, at 90 cycles. Capacitive reactance may be determined from an alignment chart as about 2,600 ohms. Mentally we multiply the resistance and reactance scales of the phase-shift chart by 100, then go to 5,000 ohms along the resistance scale and down to a point opposite 2,600 ohms on the reactance scale.

At the intersection for resistance and reactance we read on the angle lines and their scale that voltage across the resistor leads the source voltage by about 27°. Since the difference between resistor and capacitor voltages always is 90°, the capacitor voltage in this problem must lag the source voltage by 90°–27° or 63°.

In Fig. 3 we have a fixed resistor of 1,000 ohms, an adjustable resistor of 10,000 ohms and a capacitor of .033 µf in series, at 1,000 cycles. What will be the limits of phase shift when adjusting the 10,000-ohm resistor through its range? From an alignment chart we read about 4,800 ohms capacitive reactance for .033 µf on 1,000 cycles. Spotting the intersections for 1,000 ohms minimum resistance and for 11,000 ohms maximum resistance along the reactance line for 4,800 ohms on the phase-shift chart shows the total shift will be from about 28.5 to 78°.

Voltage phase across a resistor may be shifted with respect to source voltage by a variable capacitor in series with the resistor. In Fig. 4 we assume a 150-650-µµf mica trimmer in series with a 47,000-ohm fixed resistor and a 10-kc source. From the alignment chart for capacitance we read reactance of about 100,000 ohms for 150 µf at 10 kc, about 25,000 ohms for 650 µf. On the phase-shift chart we spot intersections for these two reactances along a vertical line for resistance of 17,000 ohms and on this line read the limits of phase shift as 28° for maximum and 65° for minimum capacitance.

In Fig. 5 we have 250 mh inductance and .01 µf capacitance in series with a 10,000-ohm resistor at 5 kc. This requires determining both kinds of reactance and taking their difference. From an alignment chart we read capacitive reactance as about 3,100 ohms for .01 µf at 5 kc. Computing the inductive reactance from a formula gives 7,860 ohms for 250 mh at 5 kc. The difference is 4,760 ohms of net reactance, inductive because the inductive reactance is greater than the capacitive reactance.

Spotting the intersection for 10,000 ohms resistance and 4,760 ohms reactance on the phase-shift chart indicates a shift of slightly more than 25°. Voltage across the resistor lags source voltage because the net reactance is inductive.

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Fig. 1—Phase-shift chart for computing voltage lead or lag in circuits containing resistance, inductance and capacitance.

Fig. 2, above—A simple R-C series circuit.

Fig. 3, right—R-C circuit with potentiometer.
whether one voltage leads or lags some other voltage, look at it this way. The resistance line across the top of the phase-shift chart represents voltage across the resistor. The reactance line down the left-hand side represents voltage across a capacitor or inductor. Any diagonal line drawn from zero to an intersection represents source voltage.

As in Fig. 6, all these lines are to be considered as rotating counter-clockwise around the zero point as a center, but without changing their relative positions. If, during this rotation, some voltage line would arrive at any given point around the circle before another voltage line, the first voltage is leading the second—B gets there first. Of course, the second voltage is lagging the first one—it gets there later.

Color problems

The phase-shift chart may be used for solving problems in chrominance and color oscillator sections of color TV receivers. Chrominance signals, their components and phase relations often are shown as in Fig. 7, where are marked the values for two problems to be solved with the phase-shift chart.

The first problem (Fig. 8) is to put together two color-difference signals and find the resultant chrominance signal. The color-difference signals consist of 51.5 voltage units of \(- (R - Y)\) and 28.5 voltage units of \(- (B - Y)\). Since color-difference signals are in quadrature (separated by 90°) we may place them on our phase-shift chart as shown. The resultant is a line drawn from zero to the intersection. This line lags the \(- (R - Y)\) voltage by about 29° and, of course, leads the \(- (B - Y)\) signal voltage by the difference between 90° and 29°, 61°. On a color-phase chart such as that of Fig. 6 we would identify this resultant as a chrominance signal for green.

Reversing the procedure, we may commence with a chrominance signal voltage for some known color and determine the color-difference signals from which it is formed. Fig. 9 represents an orange chrominance signal of 60 volts units strength lagging the \(- (B - Y)\) signal or reference phase by 50°. On the phase-shift chart we spot a point which is 60 units distant from zero and on the 50° radial line. Following upward from this point we come to 38 units on the \(- (B - Y)\) axis, and following to the left we come to 46 units on the \(R - Y\) axis. Thus we learn that the orange chrominance signal is the resultant of 38 units of \(B - Y\) voltage combined with 46 units of \(R - Y\) voltage.

Reactance Formulas

**Capacitive reactance, ohms**

\[
X_c = \frac{160,000}{\text{cycles} \times \mu \text{f}}
\]

**Inductive reactance, ohms**

\[
X_L = \frac{160}{\text{ke} \times \mu \text{f}}
\]

\[
X_L = \frac{160,000,000}{\text{ke} \times \mu \text{f}}
\]

\[
X_L = \frac{0.160}{\text{me} \times \mu \text{f}}
\]

\[
X_L = \frac{170,000}{\text{me} \times \mu \text{f}}
\]

Fig. 4—Resistor and variable capacitor.

Fig. 5—Graph of circuit containing inductance, capacitance and resistance.

Fig. 6—Relationship of ac voltages. 29°, of course, leads the \(- (B - Y)\) signal voltage by the difference between 90° and 29°, 61°. On a color-phase chart such as that of Fig. 6 we would identify this resultant as a chrominance signal for green.

Reversing the procedure, we may commence with a chrominance signal voltage for some known color and determine the color-difference signals from which it is formed. Fig. 9 represents an orange chrominance signal of 60 volts units strength lagging the \(- (B - Y)\) signal or reference phase by 50°. On the phase-shift chart we spot a point which is 60 units distant from zero and on the 50° radial line. Following upward from this point we come to 38 units on the \(- (B - Y)\) axis, and following to the left we come to 46 units on the \(R - Y\) axis. Thus we learn that the orange chrominance signal is the resultant of 38 units of \(B - Y\) voltage combined with 46 units of \(R - Y\) voltage.

Fig. 7—Color TV phase relationships.

Fig. 8—Finding resultant color signal.

Fig. 9—Finding components of signal.

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Here is an improved version of the power supply used in the Transistor-Operated Geiger Counter (Radio-Electronics, April, 1956).

Improvements include much smaller physical size, increased power efficiency and replacement of the vacuum-tube diode by a selenium rectifier. An off-the-shelf transformer eliminates hand winding required in the original. The present low cost of transistors makes construction of this power package even more attractive than when the original model was devised.

Fig. 1 is a schematic of the unit. A tapped primary winding on the high-voltage stepup transformer is used instead of a separate feedback winding. The transformer is a UTC Ouncer type O-2 (line to grid) with only half of the primary used. Oscillation is guaranteed with the connections shown, there being no ambiguity as to the polarity of feedback pulses. If the primary terminals are not connected as shown, the unit will not oscillate and the transistor may be damaged. If the secondary output connections are changed from those shown, capacitive loading of the output voltage (by the internal winding capacitance of the transformer) will lower the voltage.

The selenium-rectifier polarity must also be correct to rectify the highest-amplitude pulses. The selenium rectifier (type S5Y30PL) is manufactured by and available from the Union Switch & Signal Co., Swissvale, Pa., at a cost of $1.05. It is a very small (1/4-inch diameter) high-efficiency type. Extremely high back (inverse) resistance and good forward conductance result in very efficient operation.

Four NE-2 neon bulbs in series with a 4.7-megohm resistor make up the voltage regulator; filtering is handled by a 0.1-mF capacitor.

Any high-voltage half-wave rectifier, including vacuum diodes or selenium rectifiers, will work with the improved high-voltage power supply, provided the peak inverse voltage rating is high enough (at least 1,000). If selenium rectifiers are used, their reverse current must be very low, about 1 microampere or less, for the power supply to deliver peak voltage. This requires a good-quality selenium stack of at least 30 cells in series. Of course, vacuum diodes such as the Victoreen 5799 or Sylvania 5785 may also be used with practically zero reverse current. However, the necessity for heating the filament is a real disadvantage. Cold-cathode gas diodes such as the 5617 or CK1015 are not recommended due to a 100-volt drop across the diode which lowers the available useful voltage output of the power supply.

High-voltage low-current selenium rectifiers are the best choice due to their small size, efficient operation and long life. I have found that selenium stacks of 30 (or more) 26-volt cells and 2.5-ma current rating are best. More than 30 cells in series reduces the reverse current and raises the useful output voltage. However, a penalty is paid in longer length and higher cost.

Conventional 135-volt 50- to 75-ma selenium rectifiers may work but six or more are needed in series (increasing cost) and their distributed capacitance and size are excessive.

The S5Y30PL symbol represents a 1/4-inch-diameter Bakelite tube 1 11/16 inches long containing 30 2.5-ma cells in series. An axial wire lead 1 1/8 inches long extends from each end of the tube. This rectifier is rated at 390 volts rms for a capacitor-input filter and has a 1,080 peak inverse voltage rating. It will deliver 2.5 ma of dc. However, in this power supply it is called upon to deliver only 3 or 4 microamperes.

Primary power may be drawn from any 6-volt source. Current drain at 6 volts input is under 2 ma. At this rate 4 penlight cells (size AA) will operate the unit continuously for well over 200 hours. For normal field use, as in a Geiger counter, say for 6 hours of operation per day 5 days a week, these same 4 cells should provide over 10 weeks of operation. And batteries can be replaced for only a few pennies! Mercury batteries or larger dry cells will provide even longer operation. This power unit is constructed on a printed-circuit card.

The transistor-oscillator type power source has many advantages over conventional types such as 300-volt dry batteries (too expensive) and vibrators (too inefficient besides generating radio-frequency interference). In fact, I have this power pack with a Geiger tube built into a portable radio-Geiger counter combination. Both functions may be performed at the same time, the output of the Geiger tube being fed into the antenna of the portable receiver (Fig. 2)! This feature may also be used with a car radio (any radio in fact), thus permitting testing of rock samples for radioactivity.

After the unit is wired up, correct operation will be indicated by a steady or flashing glow of the neon bulb a few seconds after power is applied.

Power output, though minute, is sufficient to operate from one to a dozen or more 1B86 counter tubes in parallel.

The case of the transformer may be grounded if necessary. However, it is

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Fig. 2—Setup for feeding signals from geiger tube to receiver antenna circuit. Best left floating with respect to ground to minimize capacitance to ground.

Fig. 3—Measuring the current gain.

The only problem that may confront the constructor is the choice of R1 and C1 in the oscillator circuit. The values shown should operate in most cases. Slight variations in transformer characteristics may make it necessary to use other values. If the output is too low at 6 volts, 2-ma input, increase or decrease the value of C1.

Incidentally, when inserting a meter in the battery leads to measure current drain, it is necessary to bypass the meter with a 25-mf (or larger) electrolytic capacitor to neutralize the meter inductance (Fig. 3). If the input current is not between 1½ and 2 ma, increase R1 if current is low and decrease it when current is high. Where necessary choose values of C1 and R1 so that with 2-ma battery input current, the neon bulbs emit a steady light or fast flashing rate (approximately 10 or more flashes per second).

Fig. 4—A positive-voltage supply.

This particular circuit generates the high voltage with the positive side grounded. To furnish a negative high-voltage ground it is necessary to connect the transistor, rectifier and transformer as in Fig. 4.

END
PHOTOELECTRIC LIGHT COMPUTER

By JOHN R. SATTER

Handy device for photographic darkroom use

The most time-consuming part of darkroom work is making test strips to find the proper exposure time for each negative. With this computer, test strips are banished forever from your darkroom. It will, at the flick of a finger, let you determine exactly how much light is striking your enlarging easel, regardless of negative density or the size of the enlargement.

By using a high-gain vacuum tube this instrument is much more sensitive than light meters available for general use. And, since no expensive microammeter is necessary, the cost of parts is limited to approximately $10—less if the constructor has an electronic junkbox available. Eyestrain is at a minimum since the indicator is an illuminated bulb rather than a meter, most difficult to read by the light in a darkroom during enlarging operations.

To keep the weight of the computer to a minimum, no filament transformer is used. Instead, a 3-µf paper capacitor is the filament dropping reactor. Consuming no power in itself, there is no heat generated as with a resistor, and power consumption of the instrument is limited to approximately 2 watts. Layout of parts and the method of wiring is not critical.

Operation and application

When the pushbutton switch is depressed, plate voltage is applied to V1-a, causing plate current to flow. The magnitude of the plate current depends upon the bias, set by the potentiometer in the cathode circuit. If the potentiometer is set so that the neon bulb across the plate load resistor is just extinguished in total darkness, the unit will be most sensitive. The phototube conducts more current as the light falling on its cathode becomes brighter, thereby reducing the bias and allowing more plate current to flow in V1-a. More current flow produces a larger voltage drop across the plate load resistor. This continues until the voltage drop is great enough to fire the neon lamp.

To calibrate, make an enlargement at some convenient exposure time in the usual way. Then, with the phototube placed on the easel under the darkest portion of the projected negative image, adjust the potentiometer so that the neon bulb is just extinguished. Thereafter it is necessary only to place the phototube over the darkest portion of any projected image and close the enlarging lens diaphragm until the neon bulb is just extinguished.

With the same predetermined exposure, all the brightest portions of the positive prints will have the same tone.

The light computer may also be used to judge the contrast of paper required for a given negative by noting the difference between positions of the bias adjustment for the lightest and darkest portions of a projected negative image. The greater the bias difference needed to extinguish the lamp, the greater is the contrast of the negative and the softer the paper contrast required.

Exposure time may also be indicated using the same principles set forth above.

The pushbutton switch should never be operated with normal room lights on; doing so will overload the neon bulb. The darkroom light should also be shaded from the enlarging easel or erroneous readings may result. After an evening of use this instrument will become an indispensable part of your darkroom equipment.

END
GUILD PLANS EXHIBIT

A brochure issued by the Radio & Television Guild of Long Island (N. Y.) indicates that plans for the Long Island Electronics Fair have reached the concrete stage. Exhibitors are offered an unobstructed space of 90 x 130 feet in a building which forms part of the State University of New York at Farmingdale. Fifty-one booths are planned for the hall, and an antenna system covering all local TV channels is being set up for exhibitors as well as a closed-circuit system which will carry color signals during exhibit hours. Plans for technical lectures and other activities are being made but had not been published at the time of writing.

TV SERVICING ENDED

A new circular slide-rule type of device (see photo below) makes the set owner his own troubleshooter, according to a New Jersey company selling the device. Prepared for the man who found the fix-it-yourself books popular a few years ago too difficult, it has a number of pictures showing screen defects. These are distributed around a revolving outer dial, and it is necessary only to turn the picture with the fault to the index point to establish the tubes at fault and the adjustments to be made. To aid in adjustments, the rear of a "typical" chassis is shown so Mr. Set Owner will know where to reach for his width control and where for the centering or focus. There is even a drawing to drive home the point that miniatur tube pins should go in the corresponding socket holes when replacing tubes.

The owner then "removes the tubes, has them tested and replaces them and his set is working like new again."

100 FIRMS SUPPORT CODE

A nine-point code to govern TV service companies' advertising tactics has been subscribed to by more than 100 firms in the Memphis, Tenn., area, according to George V. Morse, Jr., manager of the Memphis Better Business Bureau.

Firms are pledged, among other things to: make no extremely low-price quotations on service calls; make no discount offers for a first service call; issue no coupons entitling the holder to special service discounts; to avoid underselling or overpricing claims; and to make no statements disparaging to competitors.

Some 300 complaints and inquiries on TV service have been received by the Memphis BBB during the first five months of this year, Mr. Morse said. Most of the complaints were based on the cut-price call, which economical setowners found extremely expensive in the long run.

Mr. Morse stated radio and TV were in seventh place among the categories most active from the standpoint of the BBB.

S E P T E M B E R, 1 9 5 6
NEW PHAOSTRON PROBE-LITE

ILLUMINATED TEST PROBE
SELF-CONTAINED
SEE WHAT YOU ARE TESTING!

$250 LIST

It is just like having an extra hand. Simply insert the probe from your tester into the jack of the Probe-lite and the Probe-lite becomes alive to instantly give you a brilliant, pre-focus spotlight on the area that you are testing plus a long, extra slender, probe tip for making electrical contact in difficult places which previously were inaccessible. It could pay for itself the first time you use it.

GET A FREE PROBE-LITE

If you are the fortunate owner of a Phaostron "555" or "555A" VOM, we will send you a Probe-lite free. Mail us the warranty page you will find in your instruction manual. We will send you a new Probe-lite and return your warranty. Be sure you include your correct name and address.

This offer is good until October 1, 1956.

PHAOSTRON INSTRUMENT & ELECTRONIC CO., 151 Pasadena Avenue, South Pasadena, Calif.

TECHNICIANS' NEWS (Continued)

NATESA CONVENCES SEPT. 14

The annual convention of the National Alliance of Television & Electronic Service Associations will be held at the Sheraton Hotel, Chicago, Sept. 14-16. It will undoubtedly be the largest NATESA has held and the business to come before the delegates will include some of the most important the organization has ever handled.

A full program of lectures and demonstrations—so timed as to be compatible with the business meetings—will cover both the technical and business problems of the service operator. Entertainment has not been overlooked and an interesting time is promised to all.

NEW MID-STATES GROUP

Technicians from High Point, Greensboro and Winston-Salem, N. C., met June 14 to lay the groundwork for an association of TV-radio service shops in the central part of the state. The group will be known temporarily as the Tri-City Technicians' Association. Officers elected for a three-month period are Jim Hornaday, High Point, president; Van Sickles, Winston-Salem, vice president; Joe Woods, Greensboro, secretary; C. B. Steele, Greensboro, treasurer. It is hoped that the group may serve for the state-wide organization, and to that end all full-time shops in the area—not merely the three cities—have been invited to join and a monthly schedule of meetings has been set up. All interested are asked to communicate with Joe Woods, 1708 Spring Garden St., Greensboro, N. C.

12% OF SERVICE IN N. Y.

Preliminary reports of the census of business conducted by the U. S. Bureau of the Census, indicate that as of 1954, 12% of the nation's radio and TV repair shop income was being earned in New York. Illinois received 9.1%, California 9%, Pennsylvania 6.7% and Ohio 6%. Unfortunately the report did not give any data later than 1954.

The report brought out the further interesting fact that the income of radio and TV shops increased more than 200% between 1948 and 1954, the 1948 receipts being $100 million and the 1954 income $313 million.

DETROIT APPOINTS BOARD

The committee to enforce Detroit's new TV servicing ordinance has been appointed by the Mayor. It consists of Alexander Weiss, G and G Radio and Television; Ralph Carew, University Radio; Lawrence Howard, Radio Electronic Television Schools; Patrick Brennan, Independent Television Repairmen's Association; Edgar Love, chief engineer WWJ-TV; Edwin C. Denstaedt, director of communications for the Detroit police department, and Heilborn B. Love, chief of the bureau of electrical inspection of the city's department of buildings and safety engineering. END
Designed for Perfect Color Reception on all 12 VHF channels

New WINEGARD Engineering Development Increases Antenna Sensitivity 47%... Doubles Front-to-Back Ratios!

If awards were given for antenna performance, the new WINEGARD COLOR'CEPTOR would win them all! That's right! In side-by-side field tests, competing with other types of antennas in all parts of the United States, the amazing COLOR'CEPTOR outperformed all others tested. These tests included sensitivity (where the COLOR'CEPTOR averaged 47% more gain on the high band and 30% more gain on the low band**)... picture quality (both color and black-and-white on all 12 VHF channels)... ability to reject co-channel interference... consistency of reception in fringe areas under changing atmospheric conditions... and horizontal directivity (the ability to reject multipath signal reflection and ghosts).

These tests were conducted by fifty independent servicemen selected at random throughout the country, whose final decisions were in no way influenced by the Winegard Company. However, Winegard did furnish non-reactive 300 ohm line pads, into which test lines were terminated to insure accurate gain test results.

Besides being an outstanding antenna electrically, the new COLOR'CEPTOR is unmatched in quality of materials and workmanship. It comes in a beautiful gold anodized finish at no extra cost.

WINEGARD COLOR'CEPTOR Gives You Clear--HIGH DEFINITION Pictures in COLOR BLACK & WHITE

NATIONALLY
WINEGARD
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3000 Scotten Blvd. BURLINGTON, IOWA

MODEL CL-4X
List Price $44.90

MODEL CL-4
List Price $29.95

Here are the FACTS!
FIRST high gain all-VHF channel antenna expressly designed for Color TV!
FIRST with POWER-PACK. Gives exceptional signal boost on all 12 VHF channels!
FIRST all-channel 18-element yagi. Extra elements that give extra performance!
FIRST gold anodized aluminum antenna at no extra cost! (salt-spray tested for corrosion resistance)
FIRST dual-spaced Electro-Lens* director system (ask for Bulletin CL-1000 on engineering specifications)

*Patent No. U. S. 2700105 and Canada No. 511984 Other Patents Pending

(see details on reverse side)
"Power Pack" gives Big Power Boost to COLOR'CEPTOR

The exclusive Winegard POWER-PACK converts the regular 11-element model CL-4 COLOR'CEPTOR into an ultra-sensitive, super-powerful 18-element all-channel yagi. The Power-Pack consists of three separate parts - the front five-element Electro-Lens director system (shown outlined in red) that gives a tremendous gain boost on both VHF bands ... plus the two extra reflector elements (shown as the long red elements at the right). The two extra reflector elements, in conjunction with the regular reflector, create a flat tuned screen that literally blocks off all signals arriving from the rear and, at the same time, increases the gain uniformly across the low band. The final result is a high performance 18-element yagi that sets new standards for the industry!

Power-Pack plugs in easily.

COLOR'CEPTOR CL-4 $29.95 list
POWER-PACK (PK) 14.95 list
COLOR'CEPTOR with POWER-PACK CL-4X 44.90 list

( NOTE: Standard gold anodized finish unless otherwise specified. Available on special order only in green or blue anodized finish or standard aluminum at same prices as above.)

STACKING BARS (SB-4C) 2.20 list
WEIGHT (Model CL-4) Net 4 lbs. 14 ozs.
Shipping 7 lbs. 8 ozs.
(Model CL-4X) Net 10 lbs. 8 ozs.
Shipping 14 lbs. 12 ozs.

OVERALL DIMENSIONS WIDTH LENGTH
CL-4 110" 78"
CL-4X 110" 122½"

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ATTENTION, Service Dealer! Here's a chance for you to get a gleaming gold super DeLuxe 18-element COLOR'CEPTOR antenna ... absolutely FREE ... for your personal use or for set demonstration. See your nearest Winegard jobber, or send coupon for complete details — today!

WINEGARD COMPANY
3000 Scotten Blvd., Burlington, Iowa

Please rush me the following:
[ ] How to get free COLOR'CEPTOR Antenna
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[ ] Engineering specifications, catalog sheet and other promotional material available to help me sell COLOR'CEPTOR Antennas

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for PERFECT COLOR RECEPTION

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HAND-OPERATED NIBBLING TOOL. Model NT-1 cuts any shape of opening in sheet metal without distorting edges. Cuts holes any size or shape over leverage for easier cutting and one-operation cutting and crimping to prevent cut wire from sliding back through hole of printed circuit board. — Utica Drop Forge & Tool Corp., Utica 4, N. Y.

POCKET TOOL. Packet-size wire cutter andstripper. Wire-size adjustment for easy stripping, 5-inch blades. For wire stripping, set adjusting stop to wire size, close jaws of tool around wire and strip with straight pull. Weights 2 ounces. — Jo-El Co., 14009 Leroy Ave., Cleveland, Ohio.

7/16 inch. Cuts in all directions. Capacity: 1/16 (0.063 inch) maximum; aluminum, copper, plastic, etc. 1 1/16 inch. Harrison Radio Corp., 225 Greenwich St., New York 7.

PRINTED-CIRCUIT PLEIERS, No. 470-5, featuring compound

7/16 inch. Cuts in all directions. Capacity: 1/16 (0.063 inch) maximum; aluminum, copper, plastic, etc. 1 1/16 inch. Harrison Radio Corp., 225 Greenwich St., New York 7.

Get This Valuable Book

Yes, you get this big, brand new book. "150 Radio-Television Picture Patterns and Diagrams Explained" absolutely FREE! Just off the press. Gives complete 11 x 22" Schematic Diagrams on leading models Radio and TV Sets. Easy-to-read, large 6 1/2 x 11" pages, with full instructions on how to use the diagrams. A "must" in every repair kit. You get this book as a FREE Gift for asking to see Coyne's new 7-volume set, "Applied Practical Radio-Television!"

At Last! Money-Making "Know-How" on Transistors, Color TV and Servicing

Coyne's great 7-volume set gives you all the answers to servicing problems—quickly! For basic "know-how" that's easy to understand you'll find everything you want in Volumes 1 to 5 on over 5000 practical facts and data. Every step from fundamentals of installing, servicing and troubleshooting all types of radio and TV sets. So up-to-date it covers COLOR TV, UHF and the latest on TRANSISTORS. All this plus Volume 6—NEW Coyne TECHNICAL DICTIONARY with over 4000 definitions of the latest terms, symbols and abbreviations in radio-TV, electronics and electricity.

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NOW! 7 BIG BOOKS IN ONE GREAT SET!

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September, 1956

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NEW DEVICES

7580 Garfield Blvd., Cleveland 28, Ohio.

ANTENNA MOUNTINGS, Snap-In, with U bolt permit one-hand Spinittie fastening of antenna mast. After mast is snapped into spring-tension mast retainers, insert U bolts and tighten.

South River Metal Products Co., Inc., South River, N. J.

PLASTIC TUBULAR CAPACITORS, Gem, for bypass, coupling and buffer applications. Seamless case made of high-grade mineral-filled phenolic material that will not distort, burn or soften when heated. Rated at 600 volts or higher and impregnated with mineral oil; lower-voltage units, with wax. Leads won’t loosen under soldering.

— CORNING LOW-POWER RESISTORS

available now through ERIE distributors

for Service Replacements

Corning Low-Power Resistors Types LP-4 and LP-5 have been especially designed for radio, TV, and similar applications. They have the highest resistance range of any low-power resistors on the market, and are used by leading manufacturers. They are stable and non-inductive, and impervious to moisture and dirt. Resistance spiralling is automatic and is electronically controlled.

For complete service information and prices . . . see your Erie Distributor.

TRANSMITTER TRANSFORMERS, flexible coded leads. Open type mountings. Series of five includes one input, two output and two interstage. — Merit Coil Products Co., Inc., 4427 North Clark St., Chicago, Ill.

SINGLE-UNIT RESISTOR-CAPACITOR Tube-Cap, standard size tubular ceramic capacitor incorporating a ceramic-base resistor in parallel. Length 0.9 inch, diameter 0.28 inch. 470 mfd., 1,500 volts ac; ½ megohm, ½ watt. Centralab Div., Globe-Union Inc., 900 E. Keefe Ave., Milwaukee 1, Wis.

ELECTRONIC SWITCHING DEVICE, Snapittie relay, for airborne computers and control units. Weighs 1/16 ounce and measures ¾ by ½ inch. Available with 2,000-ohm cell and 1,000-, 500-, 200- and 50-ohm coils with 100-mw sensitivity. — Elgin National Watch Co., Elgin, Ill.

Ohms ¼-watt miniatured controls. Completely closed, can be sealed or potted. 28 selections, 10% tolerance, 1,200 ohms to 2.5 megohms. Model JP: plain round shaft, ¼-inch diameter and ½ inch long. Model JL: screwdriver-splotted shaft. — Centralab Div., Globe-Union Inc., 900 E. Keefe Ave., Milwaukee 1, Wis.

PIC PROBE checks operation of TV receiver — any section of set seen on picture tube. Two coils and network of resistors, capacitors and diodes. Induced into these windings are horizontal and vertical deflection currents. Integrating circuits form a sawtooth wave from the sweep signal picked up in windings. Sawtooth waves are then fed to horizontal and vertical inputs of oscilloscope, giving a raster. Intensity terminal of the scope is fed with video information from TV set, producing on scope a picture identical to that on TV set screen. — Radionic Industries, 3215 W. North Ave., Chicago 47.

CAPACITOR-RESISTOR ANALYZER, CRA-3, for use in industrial and military electronics, black-and-white and color TV. Leakage current values read directly from meter while rated operating voltage is applied to capacitor. Accurate insulation-resistance values for many types of capacitors. Power-factor measurements of electrolytics rated as low as 6 volts dc, as high as 600 volts dc. "In circuit" tests for short, open, intermitent high-rf impedance and high power factor. — Pyramid Electric Co., 1445 Hudson Blvd., North Bergen, N. J.


...
Taco again introduces an original antenna design, engineered for results. The Topliner represents better performance than any other antenna now on the market. And, best of all, you get this extra performance at no increase in cost.

RIGHT!
FOR COLOR AND BLACK & WHITE!

TOPS IN GAIN PER DOLLAR!
TOPS IN DEPENDABILITY PER DOLLAR!
TOPS IN DIRECTIVITY PER DOLLAR!

TACO TOP LINE FOR '57
TECHNICAL APPLIANCE CORPORATION, SHERBURNE, N. Y.
IN CANADA: Hackbusch Electronics, Ltd., Toronto 4, Ont.

SEPTEMBER, 1956
NEW DEVICES

REACTANCE SLIDE RULE, for technicians and students. Re-
High reliability manufacturing of miniaturized paper tubular capacitors—hermetically sealed in metal cans

To produce subminiature paper capacitors free from any possibility of latent defects, for use in the most critical applications, the Sangamo Electric Company has recently intensified its high reliability program of fabrication and inspection methods.

Incoming materials for these capacitors are rigidly inspected to meet stringent high reliability standards and are stored in areas where temperature, humidity and dust are controlled at all times.

Complete production histories are kept on the basis of small capacitor lots. X-raying of individual units, heat tests, vibration tests, altitude tests, and total destruction tests of a given percentage of all finished units assure components with an extremely low AQL. Testing facilities and resultant performance characteristics are far in excess of military specifications. Specify these high reliability capacitors for your critical applications.

Mail the coupon below for Sangamo’s NEW Engineering Catalog TS-105A. It contains full information, including an easy-to-follow cross reference showing each variation listed in MIL-C-25 versus the comparable Sangamo unit.

**Sangamo Electric Company**
Capacitor Division
SPRINGFIELD, ILLINOIS

Please send me your NEW Engineering Bulletin TS-105A.

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For your design convenience, an exceptionally wide choice of styles—twelve in all—is available with regard to tolerances, circuit assembly, lead styles, mounting brackets, insulating sleeving, and inductive or non-inductive sections.

SEPARATE FACILITIES are maintained for the exclusive processing and manufacture of high reliability capacitors. Only specially trained, highly skilled operators, who wear special clothing to prevent any possible source contamination, work here.

OIL-FILLED CAPACITORS are subjected to vacuum under elevated temperatures, then are individually examined to insure complete hermetic seal.
NEW DEVICES

HI-FI TAPE RECORDER, SIT-2, for simple plug-in use. Uses transistors and printed circuitry. Nonmicrophonic, hum-free, 30-15,000 cycles. Takes all types of standard magnetic tapes in 5- and 7-inch reels. Installed either vertically or horizontally. Records and reproduces at 7½ and 3½ ips. Fast forward-and-reverse speeds, 200 ft in 45 seconds. Only one mechanical linkage: a cam action which operates pressure roller on capstan. VU meter recording-level indicator, installed in standard 10½-inch mounting rack. Automatic tape lift during fast winding; monitor jack for plug-in earphones. 10½ x 18 x 5½ inches, 35 pounds.—Radio Corp. of America, Camden, N. J.

HI-FI SPEAKER, RCA-5051, combines 12-inch low-frequency woofer, 3-inch hi-fi tweeter and crossover network. Handles 12 watts continuously with uniform response 40-18,000 cycles. 8-ohm aluminum voice coil and 1½-ounce Alnico V magnet. Tweeter unit mounted off-axis for smooth acoustical crossover.—RCA Tube Div., Harrison, N. J.

EXPLOSION-PROOF SPEAKERS for hazardous service.

Type HLE-1-30 (see photo) for paging and talk back; HLE-1-42 for maximum sound coverage. Built-in line-matching transducers available.—Atlas Sound Corp., 1481 39 St., Brooklyn 18, N. Y.

ANTISTATIC MAGNETIC CARTRIDGE, B6O A+ Special, single stylus (diamond or sapphire), for professional arms with ½-inch center-spaced mounting holes or standoffs. B6O 350 A+ Special, 350-ohms, 30-裤子 output at 4.4 cm/sec for use with high-level magnetic input professional amplifiers; B60 72 A+ Special, 72-ohms; 10-裤子 output at 4.4 cm/sec for use with amplifiers having only low-level magnetic input.—Fenton Co., 15 Moore St., New York 4, N. Y.

PHONO CARTRIDGES, Climatic series, weatherproofed. Model 380s high output, high compliance, wide-range crossover containing separate reproducible, 1- and 3-mil synthetic sapphire needles. Model 310T. 3 volts output, compliance of 0.7, frequency response 50-12,000 cycles. Turnover contains separate 1- and 3-mil synthetic sapphire-tipped needles. Model 312T, 0.8 volt output, high compliance of 2, frequency response 30-16,000 cycles. Turnover contains separate 1- and 3-mil synthetic sapphire-tipped needles. Model 314T-1 for 40-rpm changers. Same as model 310T, only 1-mil synthetic sapphire-tipped needle.—Astatic Corp., Conneaut, Ohio.

AMPLIFIER—PREAMPLIFIER KIT, model FL-10. Tape output unaffected by loudness and tone controls. Williamson type amplifier and built-in preamp. Ultralinear output circuit uses 2 6J5-GT's. Power output 12 watts at 1½M; peak power 19 watts; output impedances 4, 8 and 16 ohms; response ±1 dB 10-40,000 cycles, ±½ db 40-15,000 cycles below 10 watts. Hum: minimum volume 50 db below 10 watts, aux and tuner —65 db below 10 watts, phono hum —55 db below 10 watts. Tone controls ±16 db at 50 and 10,000 cycles. Input levels: aux 0-8 volts, phono 6 mv. Record equalization—LP, RIAA and EUR. 1/2% x 4 x 8½ inches.—Radio Kits Inc., 120 Cedar St., New York, N. Y.

HI-FI 3-SPEED DECK Four Tone Brenell MARK IV for stereo record playback. Incorporates many improvements over former Mark II deck. Model Bren IV: upper-track monaural heads (1½-p and 1¼-ips), 4 pressure pads and mounting holes for two additional heads. Model Bren IV/B: 4 staggered stereo heads (one pair each upper and lower tracks), 3 motors—capstan, feed and take-up, instantaneous mechanical braking, 3½- and 1¼-ips and 15-ips operation.—Fenton Co., 15 Moore St., New York, N. Y.

When signal conditions
demand a TOWER...
choose one built by AERMOtor

AERMOtor Towers have proven their excellence in thousands of installations . . . installations exposed to the most severe weather and wind loading conditions.

AERMOtor steel antenna towers are self supporting . . . require no cumbersome guy wires. Each part is heavily galvanized after fabrication to insure complete protection from exposure. Towers are shipped knocked down in convenient bundles; well designed parts make section-by-section assembly easy.

AERMOtor 3-post antenna towers are available in heights of 33, 47, 60, 73, 87 and 100 feet.

WRITE FOR ADDITIONAL INFORMATION ABOUT THE AERMOtor TOWERS AND A DEALER NEAR YOU IN YOUR TERRITORY.

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(See page 57 of the January, 1956, issue)

We investigate carefully when we have grounds to suspect that any advertiser is not living strictly up to these rules.
New RCA WR-46A Video Dot/Crosshatch Generator.
Produces stable, sharp patterns at high-level video output for convergence adjustments.

Saves installation time; enables more precise convergence adjustments.

- high-level video output permits direct connection to grid or cathode circuits of color picture tubes—eliminates pattern distortion which may be caused when generator signals are fed through rf, if, or vt channels—results in clean, extremely sharp pattern display
- permits simultaneous display of pattern with broadcast picture in background to assure that convergence adjustments are made at correct horizontal and vertical scanning rates
- switch-selection of four types of patterns is provided:
  - "V" bars for vertical tilt and amplitude convergence adjustments;
  - "H" bars for horizontal dynamic phase and amplitude convergence;
  - Crosshatch for simultaneous check of "V" and "H" convergence adjustments;

Magnified view shows sharply defined Dot pattern produced by WR-46A on typical picture tube.

Saves installation time; enables more precise convergence adjustments.

RCA WR-61B Color-Bar Generator.
Provides crystal-controlled signal source for trouble-shooting, and adjusting color-phasing and matrixing circuits.

WR-61B simplifies the usually complex measurement of the relative gains of the 3 chrominance channels (R-Y, B-Y, G-Y). With the WR-61B the relative gains of these channels can be measured at the output of each demodulator stage. This simplified method of measuring gain is possible because the subcarrier output of the generator is constant for all color-phase angles. Curve A shows WR-61B output as it would appear on a scope. Curve B shows the output signal of one of the demodulators.

Outstanding features of WR-61B:
- generates signals for producing 10 different color-bars simultaneously—including bars corresponding to R-Y, B-Y, G-Y, I, and Q, signals
- excellent signal source for localizing trouble ahead of or following the 2nd detector
- accepted as a standard for checking accuracy of color-phasing in many TV stations and network operations
- light weight

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NEW RECORDS (Continued)

demanding enough to winnow the superb systems from the merely adequate. The music is interesting and grows with repeated playing. Congratulations to Vox for a good job of recording a difficult subject.

GRIEG: Peer Gynt Suites 1 and 2
IPPOLITOVA-IVANOFF:
Caucasian Sketches
Felix Slatin conducting
Hollywood Bowl Orchestra
Capitol P-8329

If you have one of the few superlative speaker systems capable of doing drums real justice, this recording is for you. The two sides have an interesting variety of tone, size and damping of drums as I know of, and in Arabian Dance of the Peer Gynt they are recorded practically life-sized. But this could well be also one of the most popular of all demonstration records on any system, even the moderate ones. The music is popular, played with spirit and with a bright handbell liveliness. Running all the way from soothing mood music to spectacular fortissimo, it has a little of just about everything including some very nicely damped plucked basses. There are plenty of high highs to go with the big drums and the middle highs are very sweet. Arabian Dance, Andrea's Dance and Procession of the Sardar are fine demonstration pieces, and the first of these is, in my opinion, absolutely top-drawer.

SMETANA: "From My Life" Quartet
GLAZOUNOV: Five Nocturnes
Hollywood String Quartet
Capitol P-8331

Chamber music not only provides a good change of pace for the listener but also sounds much more natural in most living rooms than a full orchestra. This is an exceptional offering of unusual string quartet music. Five Nocturnes, particularly is very different, delightful music which manages within the limited means of the four instruments to get an amazing variety of total color. But the Smetana quartet, too, is novel within its more conventional framework. The recording is excellent and the sound has a notable presence.

BARTOK: Concerto for Orchestra
Reiner conducting Chicago Symphony
RCA Victor IM-1934

Though modern in date (1943) this will not offend the ear of classicists. Nor will it offend the hi-fi ear. It is one of RCA Victor’s best recordings. Very little spectacular material here it is fairly typical of the ampler yet well-balanced sound currently most popular with recording engineers. There is an excellent and pretty heavy bass, good drums, very nice traps and some brassy brass in spots. As good a way to start learning to like Bartok as any I know of.

SURINACH: Hollywood Carnival
GLAVINVILLE-HICKS: Sinfonia Pacifica
Three Gymnopédies
Surinach conducting MGM Chamber Orchestra
MGM E-3336

What the hi-fi world has needed for some time is a percussion record with some amazing music to string the drums, etc., on. Carlos Surinach has filled this order in the Hollywood Carnival which offers some very skillful impressions of the movies. Three separate percussion sections present no fewer than 15 percussion instruments in superlative renditions of their gamuts. They are contrasted with the typically sharp brasses familiar from previous works of this composer, and a string background. The record is rather dead acoustically but this produces in the normal living room a very fine illusion of closeup presence and realism—something not always achieved.

For concerti, as it were, Peggy Glavinville-Hicks provides some additional percussive material in the Sinfonia Pacifica. Section, or movement, three has some especially fine drums in a jazzy impression of Hindustani music. The Gymnopédies are a mood-music change of pace.

www.americanradiohistory.com
A Hi-Fi Frolic with Strauss
Panik conducting Vienna State Opera Orchestra
Vanguard VRS-476

Another superb presentation of the music of the several Strausses in the authentic Viennese style, with superb recording quality and very high-fi throughout but without any exaggeration of tonal balance. That great big drum is here very dull and highly damped, just barely audible but gratifyingly so on systems which reproduce it at all. There are fine kettle drums, fine double basses, lovely high highs and all sorts of percussive rattlers, jangles, etc., including the water whistle.

There are innumerable sharp attacks and stops to test stability and hangover characteristics. The definition is superb. The music, with the Blue Danube thrown in for lagniappe, should delight just about everybody. All you need to enjoy the illusion of being right in the Brahmsaal in Vienna, besides a first-class hi-fi system is a big stein of beer.

WEBER: Oberon, Der Freischuetz, Euryanthe
SCHUBERT: Rosamunde
MENDELSSOHN: Fingal’s Cave, Ray Blas
Perlea conducting Bamberg Symphony
Vox PL-9590

Six favorite overtures played with characteristic bravura and well recorded with a nice audiotorium silveness, sharp strings, good basses and drums and an overall big sound which should provide a good test for stability when played loudly and will show off good systems nicely at any levels.

FRESCOBALDI: Toccata in G Minor
12 Partitas on Aria Ruggerina
Caprice en Battle Air known as Frescobaldino
SCARLATTI: Six Sonatas
Sylvia Marlowe, Harpsichord
Capitol P-8336

BACH: 15 Two-Part Inventions
Concerto in D Minor
Wanda Landowska, Harpsichord
(plus orchestra)
RCA Victor IM-1974

Master and pupil, and the Capitol recording does far better for the pupil. In fact, Marlow's disc is one of the best harpsichord recordings, most faithful to tone. The contrast between damped and undamped strings is especially well indicated; the variety of harpsichord stops is greater, the tone is more resonant and sharper and better defined to my ear. But the 15 Two Part Inventions in the Landowska disc present more of the "accompanying" transients. The Concerto was recorded in 1938 and presents a rather pathetic contrast. I know of no better example showing the progress made in 30 years. The distortion is almost unendurable on a fine system (though I don't remember that it bothered me at all on the original shellac) and the harpsichord is a mere shadow of its real self. I recommend the Marlowe for those who want harpsichord music for pleasure both in music and tone: the other for collectors and merely for demonstrating progress and showing what distortion sounds like.

MOZART: Musical Joke (K522)
Divertimento No. 11 (K251)
Reiner conducting Members of NBC Symphony
RCA Victor IM-1952

Another offering for the Mozart birthday celebration and this one presenting two lesser known works. Musical Joke is amusing and has some divertingly different effects. The Divertimento is soothing. The sound is excellent.

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Name
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New releases this month run the gamut from improved image orthicons to silicon diodes. Transistor-wise, this month's feature is a unit capable of delivering 3 amperes.

Image orthicons

The 5820, for black-and-white, and the 6474, for three-tube color cameras, are improved image-orthicon television camera tubes produced by RCA. A Micro-Mesh screen, a 750-mesh unit, replaces the 500-mesh screen heretofore standard in both tube types.

The mesh of 750 lines per inch eliminates all traces of moire patterns and is "more than adequate" for the present 525-line TV system. So fine is the grid forming the mesh that the minute openings represent more than 60% of the total screen area.

Power transistors

The H5, H6 and H7 have been announced by Minneapolis-Honeywell Regulator Co. These germanium p-n-p alloyed junction power transistors (see photo) are hermetically sealed and designed for operation on 28-volt systems where they can deliver 3 amp-

ers. They are capable of dissipating 10 watts at a case temperature of 158° F. Maximum emitter current is 3.5 amperes rms; maximum base current 500 ma rms. Maximum power conductance ratings are: H5, 35 mhos; H6, 71 mhos; H7, 141 mhos. Average cutoff frequencies are: H5, 12.5 kc; H6, 10 kc; H7, 8.5 kc.

Silicon rectifiers

The 1N537 and 1N538 silicon rectifiers have been announced by G-E. Occupying a total volume of only 0.08 cubic inch and weighing .07 ounce, the diodes come with pigtail leads. Both are hermetically sealed.

The silicon rectifiers are rated at a maximum dc output current of 250 ma at 150°C. They may be designed into circuits for outputs of up to 750 ma where lower temperature conditions prevail. Maximum leakage current over their entire ambient operating temperature range of -65°C to 150°C is 0.5 ma.

High current loads can be carried
NEW TUBES AND TRANSISTORS (Continued)
without the use of any heat sink. Thus, the new units are suitable for computer power supplies and for guided missiles, blocking, magnetic amplifiers, other low-leakage applications and a wide variety of high-temperature electronic equipment power supplies.

The 1N587 is rated at a maximum peak inverse voltage of 100; the 1N588 at 200. Maximum surge current for both is 10 amperes. Full-cycle average forward voltage drop is a maximum of $\frac{1}{2}$ volt for both.

6CD6-GA

The 6CD6-GA, a high-pervance beam power tube of the glass-octal type for use as a horizontal-deflection amplifier tube in TV receivers, has been announced by RCA. It is smaller and more compact than the 6CD6-G, but features a modified mount design to maintain the same high perveance and to permit operation at higher ratings.

The 6CD6-GA has a maximum peak positive-pulse plate voltage rating of 7,000 and a maximum plate dissipation of 20 watts. These ratings in addition to low nu-factor, high plate-current rating at low plate voltage and a high operating ratio of plate current to grid-2 current enable a 6CD6-GA, in suitable circuits, to deflect fully picture tubes having a deflection angle of 90°.

Like the 6CD6-G, its structure provides for cool operation of both grids 1 and 2 to minimize grid emission and also for maximum distribution of heat to prevent plate hot spots.

The 6CD6-GA is unilaterally interchangeable with the 6CD6-G. Its heater requirements are 2.5 amperes at 6.3 volts.

2N170

A new high-frequency n-p-n transistor for radio hobbyists, the 2N170, was announced by G-E. Its introduction marks the first time the price of a high-frequency transistor has reached the level of equivalent electron tubes. It is being sold at "considerably less than $2."

In a typical common-emitter circuit the 2N170 has a power gain of 22 db.
NEW TUBES  (Continued)

at 455 kc, making it useful in hf circuits. Alpha, or maximum frequency cutoff with useable gain, is 4 mc. Maximum ratings are: collector to base voltage (emitter open), 6; collector current, 20 ma; emitter current, 20 ma; collector dissipation (25°C), 25 mw.

6903

A head-on type of multiplier phototube, the 6903 is intended for detecting and measuring ultra-violet radiation and for other applications involving low-level radiation sources.

The 6903 is constructed with a fused-silica faceplate which transmits radiant energy in the ultra-violet region down to and below 2,000 angstroms. At 2,000 angstroms, the spectral sensitivity is more than 50% of the maximum response. The spectral response covers from about 2,000 to 6,500 angstroms, maximum at approximately 4,400 angstroms.

Other design features include a semi-transparent cathode having a minimum diameter of 1/8 inches; 10 electrostatically focused multiplying (dyode) stages; a focusing electrode with external connection; the capability of multiplying feeble photoelectric current produced at the cathode by a median value of 400,000 times.

5725

A "premium" sharp-cutoff pentode of the 7-pin miniature type, the 5725 is intended particularly for use in gated amplifier circuits, delay circuits, gain-controlled amplifiers and mixer circuits. Constructed to give dependable performance under conditions of shock and vibration, this tube, which is similar to the 6AS0, is especially suited for use in critical industrial applications and in mobile and aircraft equipment.

The 5725, announced by RCA, includes separate base-pin terminals for grids 1 and 3. Each of these grids has a sharp-cutoff characteristic and can be used independently as a control electrode.

Featured in the design of the 5725 is a compact structure in which special attention has been given to features which improve its strength for both shock and vibration, and a pure tungsten heater having high mechanical strength to give long life under conditions requiring frequent "on-off" switching.

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**Question Box**

**SIMPLE PHONO AMPLIFIER**

Please print the circuit of a simple transformerless type audio amplifier for use with a high-output crystal pickup.—N. J. S., Blowing Rock, N. C.

Here is the circuit of a simple amplifier that will deliver a maximum output of approximately 1.5 watts. You can use any of the tubes listed in any combination.

**ADDING A TONE CONTROL**

I have an ac–dc radio-phonograph to which I'd like to add inverse feedback and a tone control. What general rules that I can follow in making the modification?—H. O. M., Greensboro, N. C.

The diagram shows a typical audio circuit as used in an ac–dc type radio or phonograph amplifier. The input stage is a 6SQT, 12AT6 or similar type and the power amplifier is a 50C5, 50L6-GT or equivalent. Inverse feedback and tone control circuits are shown in dashed lines. The feedback network is designed as described in "Improving Your TV Audio" in the January, 1956, issue. The tone control is between feedback loop and ground.

**THERMAL SWITCH**

Several TV boosters, phono pre-amplifiers, control units and similar devices have a built-in switch or relay that turns them on when the audio amplifier, TV set or other equipment is turned on. Please explain how these units work and tell me where I can obtain one.—L. A. W., Florence, S. C.

SEPTEMBER, 1956
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QUESTION BOX

Thermal switches or relays have a bimetallic strip that bends and closes a contact when heated. In some units the bimetal strip is heated directly by current flow through it. Others have an auxiliary heater that carries the current drawn by the main equipment.

In the average unit the contacts are rated at around 0.5 amp at 115 volts and the load drawn by the main equipment (amplifier, TV set and the like) ranges from 0.1 to 3 amps. The diagram shows the circuit connections, using an indirectly heated unit. The diagram of a directly heated unit is shown at a. The switch may be a Blonder-Tongue TR-3 or equivalent.

VOLTOMETER QUERY

I'm having trouble with the transistorized voltmeter described in the December, 1954, issue. I used high-grade parts throughout. The calibration is good up to about half-scale on all ranges. The top half of each range is very crowded. For example, on the 50-volt range 25 volts input will deflect the meter to 0.5 ma (mid-scale) but 50 volts deflects the needle only up to 0.55 ma. The other ranges exhibit the same trouble. I tried replacing the CK722 and even substituted a CK722 for the CK721 without improving the performance. What causes this trouble and how can I eliminate it?—L. W. G., New Kensington, Pa.

Mr. Turner reports that this trouble is caused by excessive static collector current (Ic) in the first transistor. This drives the second transistor to saturation and crowds the readings above mid-scale. This can be cured by selecting a transistor with low Ic. Ordinarily these transistors have such low static collector current that this trouble does not occur. Apparently you had the misfortune of purchasing two units with unsatisfactory characteristics for this application.

CORRECTION

Mr. Cerveny states that there is a transposition of text material on page 35 in his article "Color Demodulator Alignment" in the July issue.

The text beginning with the sentence starting on line 11 of the third column and continuing through the 24th line should be inserted between lines 58 and 59 of the second column.
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An extremely dark picture accompanied by unstable sync was found to be due to a leaky capacitor connected between the triode and diode plates of the age amplifier tube. This capacitor leaks and disturbs normal age action. It places a positive voltage on the age bus which is then fed to the grids of the rf and if tubes. Replace the capacitor with a .01 uf 600-volt molded type.

J. E. Ryan

MAGNAVOX CHASSIS CT 358

A pronounced hook appeared in the top 20 lines or so of the picture. The cause was pulses from the vertical oscillator feeding back into the horizontal circuits despite electrolytics C1 and C2. The pulses upset the horizontal oscillator directly and, via the horizontal afc, indirectly. This caused the hook at the top of the picture.

The remedy consists of adding a decoupling filter in the feed to the vertical linearity control. This line is the B-plus supply to the vertical oscillator, the source of the offending pulses. Break circuit as shown, insert a 2,200-ohm 2-watt resistor and the bypass capacitor C3, a 10 µf 450-volt electrolytic. — E. A. Chung

HORIZONTAL JITTER

Shaking of bushes in a strong side wind is a good description of the jitter displayed intermittently on a Sparton model 22812. After several false starts, the age line was grounded by a jumper. The trouble did not recur after hours of monitoring. Further checking disclosed that a 2 µf, 60-volt, positive-ground capacitor hooked on the age line to filter the spurs of age voltage
delivered by the age keyer had an intermittent loss of capacitance. Disconnecting this capacitor, with the set performing normally, produced the jitter. The unfiltered pulses resulted in a spurious modulation of the horizontal sync by the spurs on the age line feeding through the if.—A. Philip Monroe

G-E MODEL 2177

A jagged effect on circles, like the teeth on a cog wheel, was the complaint of the owner of this set. The effect was more pronounced than simple interference trouble resulting in the pairing of lines with somewhat similar distortion of circles.

Resistance checks localized the trouble to R1, 33,000 ohms, which had increased in value to about 150,000 ohms. This resistor (see diagram) is part of the grid filter network of the 12AU7 horizontal reactance tube. Replacing the resistor eliminated the cogwheels in the picture.—Alfred Roberts

FAINT PIX ON WARMUP

On an RCA KC577 chassis the picture would come on very faint when the set was turned on. After about 10 minutes the picture would suddenly blossom to full strength. I checked the picture and horizontal output tubes. All were normal, except that one of the 6BQ6's had a loose plate cap. I put the output tubes back and, when the picture came on weak, I pressed down on the loose plate cap. This caused the picture to jump to full strength. I dented the plate cap for better contact with the plate wire and resoldered this joint.

The trouble was that only one of the horizontal output tubes (see diagram) was functioning and the loss of high voltage produced a dim picture. As the heat from the tube with the bad cap expanded the plate wire, after about 10 minutes it contacted the cap, restoring normal operation.—A. R. Clawson

PURE OIL 518 RADIO

In case of birdies due to if oscillations, decouple the B-plus feed to the screen grid of the 12AS7 converter by inserting a 2,200-ohm 1-watt resistor between the screen grid and the electrolytic capacitor. In place of the pres-
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TECHNOTES

(Continued)

ent .01-µf bypass capacitor from the screen grid to chassis, insert a 0.1-µf capacitor.—E. A. Chung

MILKING A PIX TUBE

Like the farmer who tries to milk the last drop from his cow, this set owner (see photo) used not one brightener or rejuvenator but four! Despite this array of voltage boosters, the picture-tube heater did not fail. I'm surprised he didn't try to buy rejuvenators for the rest of the tubes!—Alfred Roberts

DU MONT RA-340/341 342/343

To prevent horizontal line displacement due to erratic firing of the horizontal oscillator when no station is being received or when the fine tuning control is misadjusted, additional filtering (see diagram) is added to the age circuit. The filter completely eliminates the horizontal sweep keying pulse from the age line. Resistor R254, a 3,300-ohm unit, is added to the age circuit.

MILKING A PIX TUBE

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SEPT. 27-30 1956

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Only a limited quantity of the #630 TV KITS left. Restocking parts would bring the price way up! Our lowest priced competitor sells the same KIT for $159.50. We are closing out the balance of the KITS that we still have in stock at the new low price as shown in the bargain column at right, for only

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**Build your own**

#630 Super Deluxe TV CHASSIS

With a

**#630 SUPER DELUXE 31-TUBE TV KIT**

OPERATES 16" TO 21" PICTURE TUBES - Engineered in strict adherence to the genuine RCA #630 plus added features • FULL 4MC BANDWIDTH CASCODE TUNER • COSINE DEFLECTION YOKE • LARGER POWER TRANSFORMER • KEYED AGC • 12" SPEAKER • CAPACITORS and RESISTORS in raised columns • COMPLETE SET OF PARTS & TUBES, everything needed is included (less wire & CRT). All I.F. Coils and Transformers are factory pre-aligned and tuned. You will enjoy building it with "LIFE-SIZE easy to follow step-by-step ASSEMBLY INSTRUCTIONS" included with each KIT. NOTHING BETTER AT ANY PRICE!

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GEM $35.91

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H-36" W-25" D-23"

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Convert any 27" Picture Tube. COMPLETE SET OF ESSENTIAL PARTS includes matched set of Todd 70° COSINE DEFLECTION Yoke and TODD HV FLATBACK TRANSFORMER, FOCALIZER, 20K FILTER, DRIVE TRIMMER, LINEARITY Coil, CONDENSERS, RESISTORS, List Price $33.50 Special for this Sale...

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Fastest, most accurate and the easiest KIT to install on any Make TV RECEIVER. Includes the No. 900 INTEGRATED CONVERSION. Complete set to finish the picture tube for cut-in-and-play performance and insured a steady picture on all channels.

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up time of the tube. New Variable Sensitivity
Shorts Test shows leakage up to 2.0 megohms.
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Meter calibrated in Good-Bad as well as Percent
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Indicator, Life Line Indicator, New Zig Zag Roll
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tests. Accessories may be added any time, per-
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DARB HOLIDAY RECEIVER

A number of readers have asked for
additional information on the bicycle
radio shown on the cover and page 43
of the February issue. It is the Holiday
model made by D arb, a division of
S. C. Ryan Co., 1316 Yale Place,
Minneapolis, Minn. This four-tube port-
able operates from dry batteries, 117
volts ac or a 6-volt vibrator-type supply.
The power packs are separate units that
can be clamped to the bottom of the
4 x 5 x 6-inch cabinet or mounted at a
remote point and connected to the
receiver through a power supply cable.
This set does not have continuous
tuning over the broadcast band. Instead,
it has a three-position lever switch for
station selection. Position 1 is for any
pretuned station between 540 and 1560
kc and positions 2 and 3 are for stations
in the 600-1600-kc range. Stations are
preset by adjusting the oscillator and
antenna trimmers with a screwdriver
through holes in the case. The ac and
battery power packs are shown at a
and b, respectively.

ADAPTER FOR INTERCOMS

An intercom in the home is a prac-
tical device with innumerable uses.
For example, a remote station can be
mounted outside the front door so a
caller can be identified before the door
is opened. Mother, without interrupting
her chores, can keep an attentive ear
on Junior in the playpen on the porch
or she can save needless trips to the
doors just to say, "Please leave those
quarts of milk" or "Johnny can't play
with you now. He is eating his lunch."

Intercoms in the home have been
restricted largely to baby-sitting applica-
tions. They have not been popular
for other uses because of the incon-
venience of waiting for them to warm
up. If you have a remote at the front
doors, a caller must wait for you to
reach the master station and then
another half minute or so while the
unit warms up. Leaving the system
constantly on is not practical in the
home where hours or even days may
pass without the unit being used.
Here is a simple and inexpensive
method of cutting down the lag be-
tween the ringing of the doorbell and
time that the normally off intercom is
ready to operate. It also permits other
remotes to turn on the master when

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Look... what RADIO-ELECTRONICS has in store for you in the months ahead...

- Underground Antenna by Harry J. Miller
- The New Motion-Picture Sound by Norman H. Crouhurst
- Audio Transformers
- A Self-Calibrating Marker Generator by Richard Graham
- Simple Transistor Shortwave Receiver by Joseph Braunbeck
- Improving Sound in AM Radios by Albert Stratmoen
- A Home Intercom System by John F. Millar
- Selling Extra Television Service by Matthew Mandl

The OCTOBER issue of RADIO-ELECTRONICS goes on sale Sept. 25th at better parts distributors and newsstands.

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Three years $10.00

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oscillations heavily and the trace will appear as Fig. 2-b. The choice of sweep frequency is not at all critical. One make of scope I found 1,500 cycles best, while another gave good results on 3 kc.

Remember that this is a comparative test. The best way is to find which speed most suits your instrument and stick to that. In my case I set the fine frequency control to maximum and chose position 2 on the coarse frequency control. The same applies to the vertical gain; choose the setting which gives optimum results and always return to that same setting.

When a faulty trace is obtained, first disconnect the deflection coils. If the trace still indicates a short circuit, disconnect the remaining leads from the transformer one by one. If the trace suddenly goes normal, check for a short in the width control, yoke or other component just removed.

Experiment with various types of horizontal output transformers to learn the specific characteristics of each.—Peter E. Clement, Essex, England
UNDERCOVER STORY PROVES JERROLD SUPERIORITY

...MODEL 2300 RF AMPLIFIER FOR MASTER TV ANTENNA SYSTEMS

The new Jerrold Model 2300 is a high gain (38 db minimum), high output (.3 volt/channel) broad band amplifier specifically designed for use in large TV master antenna systems. It insures easy, low-cost installation and requires minimum maintenance. But the real reason for better performance and longer life is the undercover story.

SPECIFICATIONS:

| FREQUENCY RESPONSE: ±1 db—Channels 2 thru 6 and 7 thru 13 |
| GAIN: 38 db min. |
| GAIN CONTROLS: Hi and Lo, 16 db range |
| TILT CONTROLS: Separate Hi and Lo |
| RATED OUTPUT (MAX.): .3v/channel for 9 channel operation |
| TUBE COMPLEMENT: 4-6BQ7A, 2-12BY7A, 1-6C86 |
| POWER REQUIREMENTS: 117 volts AC 63 watts |

LIST PRICE for MODEL 2300—$164.00

slightly higher west of the Rockies

Universal input circuit permits use of a variety of 72 ohm or 300 ohm antennas—broad band or separate hi-lo arrays. An alignment tilt control (reached through hole in cover) can be adjusted so that the Jerrold Model 2300 will work with various lengths of coax cable without need for external line equalizers. Unit is housed in handsome silver-gray metal housing with perforated cover for ample ventilation.

Model 2300 may be shelf or wall mounted. It may be used singly or in cascade. It has wide application for TV master system use in motels, apartment houses, hotels, schools and for line extenders in community antenna systems.

Jerrold never compromises with quality—that's why Jerrold equipment always means a more consistent and better picture on the TV screen. Yet Jerrold equipment actually costs less to install, is easier to maintain and lasts longer.

For complete information on the Model 2300 broadband amplifier write today for Jerrold Technical Bulletin #544 or see your nearest Jerrold Distributor.

SEPTEMBER, 1956

JERROLD ELECTRONICS CORPORATION

23RD AND CHESTNUT STREETS

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RADIO-ELECTRONICS
154 W. 14 St. New York 11, N. Y.

CONTROL DEVICE
Patent No. 2,717,356
James H. Foster, Erie, Pa. (Assigned to Erie Resistor Corp.)

This control device consists of a capacitor whose capacitance varies with applied voltage. It is basically a dielectric body made of barium and strontium titanate. This mixture has a dielectric constant that varies considerably with applied potential. One side of the dielectric body has three metallic electrodes, A, B, and C. A resistive coating connects B and C, A and B are terminals of a capacitor, B and C are resistor terminals.

Capacitance between A and B varies with the voltage between them. When current flows between B and C, there is heating of the titanate and further increase in dielectric constant. For maximum effect, A and C are strapped together as a single terminal and B is used as the second terminal. An applied voltage now produces a greater change in capacitance than is possible when the resistor or capacitor is used alone. The effect of the polarizing voltage is almost instantaneous. The heating effect requires about 29 seconds for full stabilization.

AND-OR NETWORK
Patent No. 2,729,753
Raymond W. Ketchledge, Whippany, N. J. (Assigned to Bell Telephone Labs, Inc.)

Relay and switching networks often require and or circuits. In the and type each of several inputs must be energized before an output is obtained. In the or type any of several inputs will produce output. The diagram shows a combination and-or network. It contains several stages of spark gaps which may be fired in turn. When any spark gap breaks down, its spark initiates a shock wave which carries ions. This
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Mr. H. N. Ashby, Technical Employment
Missile Test Project, Dept. N-15J
RCA Service Company, Inc., P.O. Box 1226
Melbourne, Florida

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At your request AMPHENOL now provides new 25 foot hanks in two popular types of Twin Lead. Add these to your AMPHENOL Twin Lead Display Board—and watch your sales and profits increase while your selling job gets easier! Your growing Twin Lead market includes: those who buy a second set (black & white or color) or replace worn-out lead-in or need extra lengths for moving sets.

Don't wait for your customers to ask—stock and display AMPHENOL Hanks in all the popular sizes listed below.

<table>
<thead>
<tr>
<th>Part No.</th>
<th>Description</th>
<th>Available in Hanks of</th>
</tr>
</thead>
<tbody>
<tr>
<td>214-318</td>
<td>Indoor*—60 mil. 7/28 pure copper cond.</td>
<td>✓ ✓ ✓ ✓</td>
</tr>
<tr>
<td>214-056</td>
<td>Standard—60 mil. 7/28 pure copper cond.</td>
<td>✓ ✓ ✓ ✓</td>
</tr>
<tr>
<td>214-555</td>
<td>Stetho—72 mil. 7/28 copperweld cond.</td>
<td>✓ ✓ ✓ ✓</td>
</tr>
<tr>
<td>214-298</td>
<td>Rotator—4 conductor—7/28 pure copper cond.</td>
<td>✓ ✓ ✓ ✓</td>
</tr>
<tr>
<td>214-100</td>
<td>Century—100 mil. 7/28 pure copper cond.</td>
<td>✓ ✓ ✓ ✓</td>
</tr>
</tbody>
</table>

**New Available In Coils**

214-271 Air-Core**—U.S. Pat. 2543696 7/28 pure copper cond.

*Indoor is the newest AMPHENOL Twin Lead. It's made of pure virgin natural polyethylene to harmonize with any interior.

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Remember: for finest quality, virgin polyethylene is used in all AMPHENOL Twin Leads.

AMPHENOL ELECTRONICS CORPORATION
chicago 50, illinois

PATENTS

(Continued)

wave is transmitted to the next gap in line. The wave alone is not sufficient to fire a gap, but if the latter is pulsed at the same instant, breakdown will occur. Absorption material (shaded sections) is placed between the gaps to guide the shock wave from one gap to the next.

When the initial gap is fired by a signal pulse, the shock wave travels down to the next gap. This one will also fire if pulse A occurs at the same instant. The next stage is an or stage which may be fired by either pulse B1 or B2. All stages in the series constitute an and network because each stage must be excited by a pulse before output can occur. The last gap is coupled through a cathode follower.

The gaps may be spaced by 0.1 inch and the electrodes in any gap may be 0.5 inch apart. Breakdown voltage is about 5 kv.

ELECTROLUMINESCENT LAMP
Patent No. 2,728,870

Warren Calvin Gangle, Providence, and Robert Emmons Cleary, Tabra, Mass. (Assigned to Sylvania Electric Products, Inc.)

Electroluminescence is the term applied to light generated when a phosphor is excited by an electric field. As shown in the diagram, the lamp may consist of a phosphor dielectric between two conductive layers. The phosphor is embedded in a plastic material and may contain zinc sulphide with small amounts of lead, copper and chlorine. When 600 volts ac is applied between conductors, the phosphor gives off light that is visible through the glass plate.

This inventor finds that efficiency is greatly increased if the phosphor dielectric is heated while voltage is applied, permitting the phosphor particles to align themselves in the direction of the electric field. After cooling, the particles retain their positions and can emit more light for a given power.

RADIATION DETECTOR
Patent No. 2,728,862

Pierre L. de Baugniet, Racine, Wis. (Assigned to Trueral Inc., Racine)

Radiation detectors are most useful when they can measure over a very wide range, perhaps from a million to one. This can be done by this measuring circuit that functions logarithmically.

The diagram shows in ionization chamber under the influence of a radiation source. The current through the chamber and the diode is a linear function of the radiation count. As the count increases, a greater voltage appears across the diode. This is amplified and indicated on the meter. The amplifier output feeds the diode filament. Thus more intense radiation increases diode emission and lowers its internal resistance. The lower resistance reduces the voltage across
The positive cathodes flows. Normally, V2 now conducts while D3 conducts. V1 (Fig. 1) is one triode of a 12AV7; V2- V3 triodes of a second 12AV7. The diodes are 1N54 or equivalent.

Inverter V1 receives the pulses from the tape and feeds them to V2-V3, a one-shot multivibrator. Normally, V2 is blocked and V3 conducts since the latter has the smaller plate resistor load. R1 and C1 control the timing of the multivibrator. With the constants shown in the diagram, the multivibrator remains "flipped" for about 400 µsec, after which it returns to its normal condition. Flip-flop occurs when a positive pulse is received at the 1 terminal.

The cathodes of V2-V3 are normally very positive because heavy current flows into V3. The positive cathodes block D2 while D3 conducts. The output terminal is 10 volts positive. At this time the plate of V3 (which is blocked) is at 150 volts, and there is sufficient potential difference to ignite the neon lamp which therefore indicates that no signal is being received.

Upon receiving pulses (through V1) the multivibrator flips. V2 now conducts and V3 is blocked. V2 has a larger plate resistor so less current flows through it than did through V3. The multivibrator's cathodes are less positive than previously and D2 now conducts while D3 is blocked. The output from this circuit is -36 volts.

The grid of V2 returns to a voltage divider which maintains it at -38 volts. D1 is blocked. The output of this grid may pass considerable current. This flows through D1, so the voltage divider action is not disrupted. When V2 conducts, its plate voltage drops, whereupon the neon lamp is extinguished.

Fig. 2 shows the operation of this circuit. It assumes tape pulses that are 85 µsec wide and spaced 100 µsec apart. Since the period of the multivibrator is 400 µsec, the spacing between pulses is too short to permit it to flop back to normal. This can occur only 400 µsec after the last pulse arrives.

The end of a recording is indicated when the output voltage rises from -86 to 10 and when the neon lamp lights.

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**KNIGHT MULTIMETER KITS**

Some of the Knight 83F140 20,000-ohms-per-volt multimeter kits are supplied with the small penlight cells without paper jackets—just the bare zinc cans. If these cells are installed in the battery holder in this condition, adjacent cans will touch each other as well as the battery retaining strap, and three of the four cells will be shorted out. The instructions do not mention this. The remedy is to wrap each cell with a band of adhesive tape around its middle. This keeps them separated from each other and from the retaining strap and prevents shorts.—John Sarvida, Knight Electronics Corp., reports that some of the flashlight cells supplied with these kits did not have insulated paper jackets and will short when not insulated as mentioned above. The remainder of these cells have been removed from stock and replaced with insulated types. They will be happy to replace the uninsulated ones with insulated types upon receipt of a letter from the customer.—Editor)

**DUPLEX SIGNAL TUNING**

Duplex signal positioning is an attractive feature, easily installed on most communication receivers, that enables the ham or SWL to switch from one side of the phone QSO to the other and eliminates tuning back and forth across the dial.

The procedure to follow is this: Install at some convenient spot on the receiver front panel an E. F. Johnson or similar 1.8-8.7-muf miniature variable capacitor with dial plate and knob.

Near by on the panel install a toggle, lever or slide-type spot switch. Wire the switch in series with the grid side of this midget variable as shown. The stator plates go to ground or B minus. In most sets the midget capacitor is wired directly across the bandspread and main tuning capacitors.

With the duplex signal positioning switch open, tune in a QSO. Only phone bands below 50 mc are recommended. Get station A and then wait until the conversation is turned over to station B. When station B takes over, flip the duplex positioning switch closed and...
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Precision tuning is SUPERIOR for each channel!

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TRY THIS ONE (Continued)

and MIKE

tune in station B. Now the bandspread capacitor is handling station A. And your miniature variable with duplex switch closed will take care of station B. Actually, this same switching can be done with relays operated by the carriers. When station A cuts its carrier, station B is automatically switched over.

Remember that frequency lowers as capacitors mesh. Therefore it is advisable when spotting your stations on the dial to allow sufficient down-frequency coverage so that the complete spectrum of the phone band being used may be covered on the miniature. It sometimes takes practice to become accustomed to this new method of lining up your stations. But soon you will be more than satisfied with the ease with which you will be able to switch quickly from one side of the QSO to the other.

As might be expected, additional wire and other capacitances effect a slight change in the receiver oscillator settings. This may be amply compensated for by readjusting the receiver oscillator trimmer.

So long as the part of the band to be covered when using duplex positioning is below 50 mc, there is only slight rf loss in the receiver when, for instance, station B is a bit down the band from station A. Phone bands are comparatively narrow and the rf circuits are fairly broad so tracking and sensitivity will not suffer too much. This method of tuning works best when both stations are ST or better. -George D. Philpott

TRANSISTOR SHIPPING TUBE MAKES A HANDY INSULATOR

If the negative terminal of an electrolytic capacitor -its outer case-is connected to the chassis, there is no problem of insulation except for the positive lead. However, in many applications the positive terminal is grounded, leaving the capacitor case "hot." This occurs frequently in transistorized portables.

The photograph shows a use for the plastic case in which many transistors are shipped. Punch a hole in its bottom for the pigtail lead and put the capacitor in it. If your transistors have different type cases or subminiature capacitances are employed, a plastic pill tube may be obtained from the drugstore.

If the shipping tube does not hold the capacitor snugly, a piece of tape or cardboard will do the trick. The cardboard from a match cover can be used to wedge it tightly.-Lawrence Show

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<th>Type No.</th>
<th>Price</th>
<th>Impedance - Ohms</th>
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<td>IZ-1</td>
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<td>600/250/50</td>
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<tr>
<td>IZ-2</td>
<td>20.20</td>
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<td>IZ-6</td>
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<td>10000</td>
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<tr>
<td>IZ-7</td>
<td>15.10</td>
<td>1000</td>
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</tbody>
</table>

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RADIO-ELECTRONICS

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Merchandising and Promotion
Perma Power Co., Chicago, Ill., de-
signed a new three-dimensional dis-
play, shown in the photo above, for
to garage-door opener.
Telematic Industries, Brooklyn,
N.Y., is promoting its new line of TV
color extensions and service aids
through the use of a new counter dis-
play.
Rek-O-Kut Co., Long Island City,
N.Y., has prepared a recording table
for standard and microgroove
discs. It is available from Rek-O-Kut
for $25.
Futuramic Co., Chicago, has prepared
a series of lab lessons for TV trade
schools. The lessons show photographi-
cally how to use voltmeter probes for
troubleshooting by means of signal-
tracking techniques.
ORRadio Industries, Opelika, Ala., de-
signed a new self-service package dis-
played its most popular Irish
brand recording tapes.
Sylvania Electric Products, New
York, will sponsor a TV film adventure
series, "The Buccaneers," this fall,
according to an announcement by Terry
P. Cunningham, director of advertising
and sales promotion. Sylvania has re-
linquished its sponsorship of "Beat The
Clock" after 5½ years.
Production and Sales
RETMA reported production of 2,-
862,177 TV sets and 5,585,290 radios for
the first 5 months of 1956 compared to
3,238,820 TV sets and 5,853,954 radios for
the 1955 period. It also announced retail
sale of 2,428,888 TV sets and
2,551,272 radios, exclusive of automo-
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pares with 2,722,648 TV sets and 2,-
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pares with 2,722,648 TV sets and 2,-
BUSINESS (Continued)

007,831 radios sold in the first 5 months of 1955.

New Plants and Expansions

Sylvania Electric Products completed a 50,000-square-foot addition to its picture-tube plant in Fullerton, Calif.

P. R. Mallory & Co. moved its New York district sales office to Teaneck, N. J.

Hickok Electrical Instrument Co. opened a new San Francisco branch in Berkeley, Calif. George Ksander, Hickok sales engineer, was named West Coast manager. Bert Clintsman, manager of the new office, and Bill Cotie, manager of the Los Angeles branch, will work with him.

Raytheon Manufacturing Co. purchased a 15-acre site in Goleta, Calif., where it will erect a new engineering laboratory for airborne electronics and infra-red equipment.

Alliance Manufacturing Co., Alliance, Ohio, leased an additional building which will provide 80,000 square feet of floor space for expanded production facilities.

Hycon Electronics Inc., Pasadena, Calif., has realigned its organization to provide for an increase in production and sales. Its engineering facilities will be increased by drawing skilled personnel from the parent company, Hycon Manufacturing Co. Hycon Electronics will also market many products developed by other divisions. Hycon Eastern Inc., Cambridge, Mass., also a subsidiary of Hycon Manufacturing Co., acquired an additional 7,000 square feet.

Olympic Radio & Television, Long Island City, N. Y., purchased Presto Recording Corp., Paramus, N. J. George J. Salla, president of Presto, will continue to direct operations as vice president and general manager. David Bogen Co., New York City, another Olympic subsidiary, will transfer part of its manufacturing activities to a plant adjoining the Presto factory. END

CORRECTIONS

Mr. Queen points out that the ferrite rod antenna used in his shirt-pocket radio (July) is a type MS-204 rather than the MS-166 specified in the article and that the now-available MS-272 ferrite loop provides better tracking and is highly recommended. Do not remove turns from this unit. Just cut enough of the wire so it fits snugly in the case like the original unit. He also advises that the type MS-126 if transformer has been discontinued and replaced by the MS-268. Headphones should have an impedance of 3,000 ohms or higher.

There are two errors in the signal-tracer diagram on page 81 of the June issue. The switch connected to the second 6BA6's grid is part of the band-switch and should be ganged to the other three sections. The top lead of the secondary of the output 550-1650-kc transformer goes directly to the band-switch fixed contact and should not be connected to tuning capacitor and diode plates.
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PEOPLE

John R. Ward, appointed controller of Pyramid Electric Co., North Bergen, N. J., comes to the company from CBS-Columbia, where he held a similar position, at the age of 76.

Cecil C. Agate, director of advertising for Sonotone Corp., at his home in Orange, N. J., at the age of 68.

Brig. Gen. Stephen H. Sherrill, at Walter Reed Hospital, Washington, D. C., following a heart attack. Awarded the Legion of Merit for supervising the training of 64,000 radar specialists during World War II, he was later commandant of the Eastern Signal School Training Center, Fort Monmouth, N. J.

Col. George P. Dixon, USA (Ret.), at Georgetown University Hospital, Washington, D. C., at the age of 67, executive vice president of the Armed Forces Communications & Electronics Assoc, and former director of communications for the Army Air Forces in Europe. A vice president of IT&T before joining the Armed Forces Communications & Electronics Assoc, he was editor of the association's journal, Signal.

Obituaries

Frank A. Poor, founder and vice chairman of Sylvan Electric Products, at Huggins Hospital, Wolfsboro, N. H., after a brief illness, at the age of 76.

For the full text, please refer to the source provided.
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**TECHNICAL MANUAL, Sylvania Tubes.** Sylvania Electric Products Co., 1740 Broadway, New York 19, N. Y. 5½ x 9½ inches, loose-leaf binding, pages not numbered. $2.

Intermediate in price as well as content between the cheapest tube handbooks and the elaborate affairs selling for more than $10, this manual contains a surprising number of features found in the more expensive books. The purchaser obtains for 1 year supplements to increase this book, thus keeping up-to-date with the newer tubes. (Incidentally, tube tester settings for users with Sylvania tube testers are included. No doubt these could be converted to other testers, solving the problem of new tubes without checking data.)

A tube-data section of abridged information on obsolete and discontinued types as well as on a number of more popular tubes is very useful. Other sections cover picture tubes, special tubes (including crystal diodes but not transistors), resistance-coupling data and an appendix of useful information.

Resistance-coupled amplifier data is given for two sets of input signal values—representing high and low input levels, and the percentage of distortion is given for each.


Compatible color TV has been accomplished only through the intensive efforts of many scientists. In 1950, the NTSC (National Television System Committee) was organized by the TV industry for the purpose of setting up standards for color. At that time, several systems were being proposed and confusion was beginning to mount. No existing system could provide a satisfactory and compatible color picture. The NTSC went to work to determine the problems and how to solve them. By the middle of 1953, a final report was forthcoming, and this forms the basis of our present-day color system. This book covers the activity of the NTSC, details of the final standard signals, latest types of color films and processes and definitions relating to color TV.

As examples of the contents, one committee report describes in very simple language the features of a compatible color signal. Another panel was given a questionnaire regarding...
BOOKS (Continued)

the subjective factors of color TV. These questions (and the panel's answers) form a very interesting report on such topics as: depth of field, fidelity, surrounding room brightness and other characteristics of a color picture. Still another group was assigned the task of making field tests of the finally standardized color signal. Their results appear in the book.—IQ


A tape recorder is mechanical as well as electronic and therefore needs description from both viewpoints. This introductory book makes a good job of it. Prospective buyers will find here which important factors differentiate one recorder from another. Hi-fi fans will be interested in the discussions on wow and flutter and also how noise and hum are reduced. Technicians will note especially the typical schematics and the hints on maintenance and lubrication.

The book begins with a history and brief theory of magnetic recording. The transport mechanism receives considerable attention and there is data on motors. Several exploded views show the insides of a few recorders. As for the electronic end, chapters appear on volume indicators, bias oscillators, equalizers and amplifiers. There is a chapter on tape characteristics and another (very, very brief) on test procedures.


The 10th edition of an internationally known listing of broadcast and TV stations of the world. Prepared mainly for the shortwave listener but lists long and medium-wave stations (151-1875 kc) as well. Shortwave stations are listed by country and by frequency. The listings by country also include mailing addresses, hours of operation, QSL'ing information and a few bars of the stations' identifying musical themes.
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