Build a 3-Tube 2-Way Stereo Amplifier

Radio-Electronics

JUNE 1959
IND

HUGO GERNSBACK, Editor

35c

Kompleat Kommercial Killer Works from Chairside Light

Simple 3-Transistor Distortion Analyzer

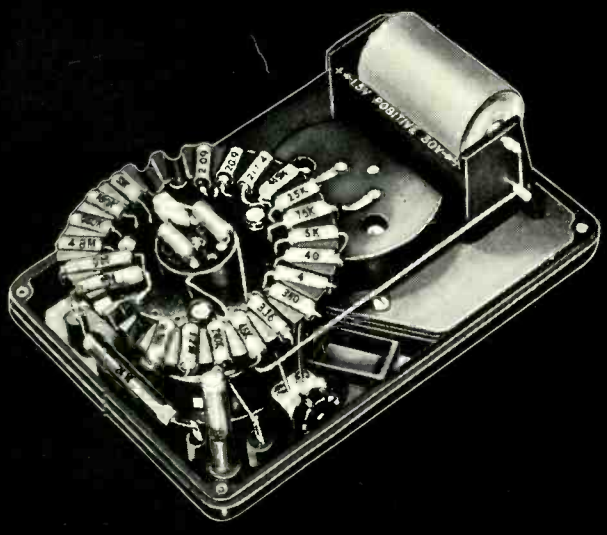
Help the Mute to Speak!

Diagnose Common TV Faults

New Tube Is Dime Size

See page 40

Burton Browne Advertising



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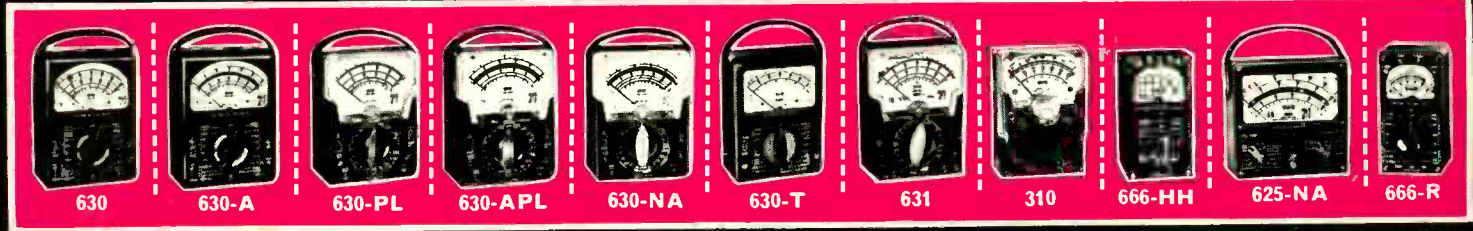

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ON THE COVER

Story on page 40

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NEWS BRIEFS

FCC'S BOOSTER STAND REVERSAL settled a 5-year hassle by proposing to allow on-channel television booster stations to operate with FCC sanction in the future. The FCC has been trying to get the several hundred boosters off the air with no success. Now it is going to ask Congress for laws helping it set up standards for transmission and encouraging booster operation. One possible problem is that with establishment of real engineering standards the cost of booster equipment will rise toward that of translators. In any case, booster operation on channels 4 and 5 is forbidden, since these channels are too near aircraft bands on which safety of life depends.

NEW COLOR TV SYSTEM is proposed by a Maryland inventor. The receiver's picture tube uses a single gun that emits three closely spaced beams. There is no mask or post-acceleration grid, as in the RCA and Lawrence tubes. The screen is made up of narrow red, blue and green stripes.

The problem of proper registration is solved by using two *pilot* frequencies, which modulate the red and green beams, respectively. The phases of the two pilot frequencies differ, and the carrier is so weak as not to interfere with the picture, even in the darker portions. (The Philco "Apple" system used a single pilot beam.) These beams correct for misregistry by setting up an error signal whenever the pilot beams strike the blue phosphor or secondary-emission surface over the blue strips. The pilots also correct for errors in convergence.

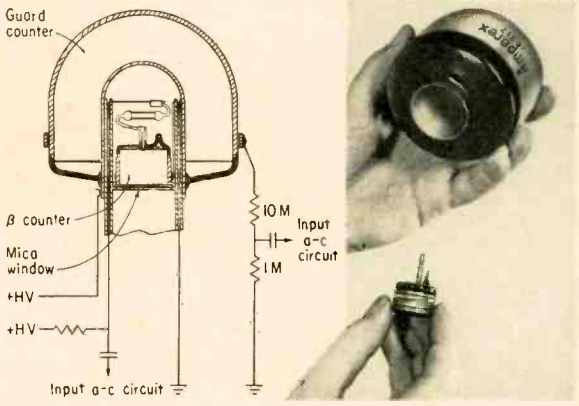
The inventor, Arnold Lesti, formerly a senior engineer at the Bureau of Standards and International Telephone & Telegraph (ITT), has been working with specially built tubes and does not expect to demonstrate the new system until some further improvements in the tubes have been made, possibly in about 6 months.

SERVICE DEALERS may be small businessmen, but the radio-TV service business is a big industry today, amounting to nearly $2.5 *billion* spent annually by set owners for parts and repairs. In fact, it's bigger business than the business of making and selling the sets.

According to the Electronic Industry Association figures compiled by veteran surveyor Frank Mansfield, consumers spent $2.49 billion for installation, parts and servicing during 1958, compared with only about $2 billion for new TV, radio, phonos and hi-fi equipment. The life span of TV sets is increasing slowly—it was 7 years in 1955, but is now nearer 9. Too, more and more sets are being put into use, with fewer being retired each year. This should mean a continuing increase in the demand for servicing. However, improved reliability of components and solid-state electronics, including the expected future transistor switchover will tend to counteract some of the increase in service needs.

Actual servicing and installation income last year was about $1.13 billion, while parts brought in about $1.36 billion. This repair revenue has been growing steadily since 1950, when it was $350 million.

GEIGER TUBE for measuring minute amounts of radiation, yet within the means of hospitals, industrial and medical laboratories formerly unable to afford ultra-sensitive radiation detectors, has been announced by Amperex Corp.



To measure the amounts of radiation found in radioactive fallout, for example, it is necessary to neutralize the background noise, caused by cosmic radiation and gamma rays. Detectors have commonly used as many as 30 "guard tubes" which surround the counter. Radioactive particles passing through a guard tube and then through the counting tube set up pulses in two bucking ("anti-coincidence") circuits, thus producing no count. Only radiation so oriented as to pass through the counter without also going through a guard tube is recorded.

The Amperex guard tube is cup-shaped and surrounds the counter tube except at one end, where the mica window for the desired beta radiation is replaced. Thus one guard tube is used instead of 30. Due to the smaller size of the assembly, the necessary lead shield for keeping out gamma rays can be made much lighter, reducing the weight of the equipment from the previous 2 tons to about 400 pounds. A background count as low as 1 per minute can be obtained with the assembly.

ATOMIC POWER for electricity, predicted for years, may now be nearing practical achievement. The latest development is an atomic thermocouple in which one of the metals, cesium, is converted from its normal solid state to a gas by lowering the thermocouple into an atomic reactor. The other metal is uranium.

Earlier atomic generators have required no reactor, but have been capable of producing relatively low power. There may be no limit, theoretically, to the amount of power the plasma thermocouple can supply. The word plasma here derives from the fact that the cesium gas is heated to such a high temperature that the cesium atoms lose their electrons.

FM BEATS TV for the upper-income families who receive the 13 FM-linked stations of New York WQXR network, a group of 13 FM stations in the upper part of the state. A recent survey indicated that their average income is $10,000 (national average is under $5,000). They spend 5.5 hours a day hearing FM, but only 1.7 hours on TV. The study also showed half a million homes, one-third of all in the area, had FM sets.

HIGH-FREQUENCY WAVES affect the way microscopic animals swim, and also the physical arrangement of living cells. Scientists of the New England Institute

(*Continued on page* 10)

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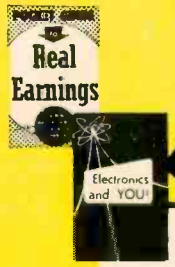

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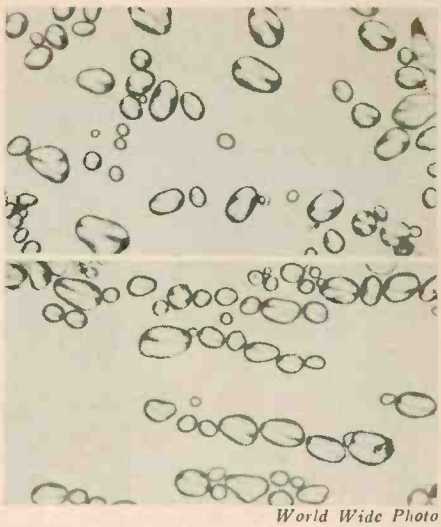
for Medical Research, Ridgefield, Conn., have found that amoebas, staphlococcus and other germs, red blood corpuscles, and even polystyrene particles, can be controlled by the megacycle pulses. CW cannot be used lest it fry the living cells, as in dielectric heating. Actual frequencies required to control action or arrangement vary between 5 and 40 megacycles. One tiny organism swims one way at 6 mc, shifts 90° at 15 mc.



World Wide Photo

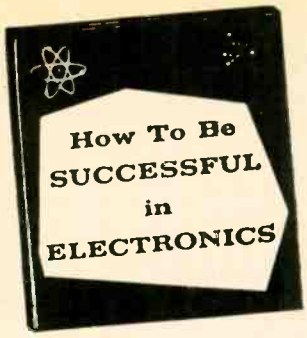
Chromosomes, which determine inherited characteristics, can be controlled. Work already done has resulted in new strains of vinegar flies and certain bacteria. This technique will undoubtedly be extended to higher-order animals, and perhaps some day even to man. Photographs show starch particles in normal random arrangement above, and, below, lined up when subjected to high-frequency radiation.

PORTABLE TV SETS using transistors may be closer than officials of major producers will publicly admit. A number of the big receiver makers are believed to have working models of truly portable transistor TV receivers in the labs. When rumoured Japanese sets start coming in, these developmental models may break loose here.

Truly portable receivers will be more practical when power for heating the picture-tube cathode can be eliminated, possibly with the technique recently announced for the cold-cathode tube (RADIO-ELECTRONICS, page 98, April, 1959). Available transistors can work up to the 218 mc required for vhf channels, but are very expensive compared to ordinary transistors used in most receiver circuitry. Even the power transistors required for deflection circuits are reasonably priced now.

Straw in the wind is appearance here of imported FM–AM transistor portable. Front-end transistors in an FM set work on channels 2–6. A harmonic type transistor oscillator and a crystal mixer setup can be used for channels 7–13 until suitable inexpensive vhf transistors (now being made in small numbers by at least two American manufacturers) are ready.

(*Continued on page* 14)



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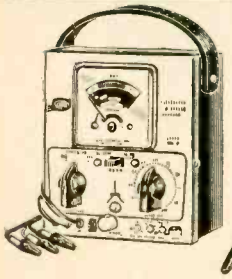

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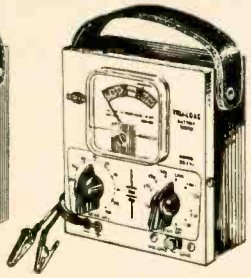

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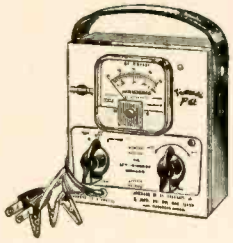

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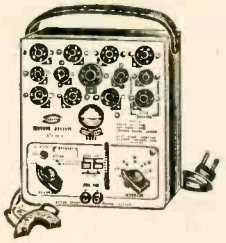
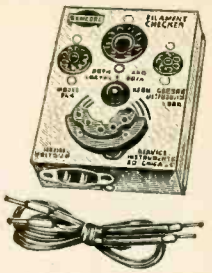
SENCORE Tube Checkers make quick-accurate checks



LC3 LEAKAGE CHECKER—Tests nearly 200 different tube types including UHF and latest types; Checks CRT without removing tube from chassis. Roll-Chart design for quick checking; prevents obsolescence. Two spare pre-heating sockets cut down test time. Dynamic filament checks include heater to cathode leakage and shorts. Leakage sensitivity is 100 megs and 50,000 ohms; can be increased by changing the value of one resistor only. Capacitors can be easily tested for leakage to 100 megs, opens, shorts and charge with voltage applied. Compact unit 7"x6"x3½" comes in black hammertone case with aluminum panel. Weight 3 lbs.

Net Each.....$28.95



FC4 FILAMENT CHECKER—Here is a new filament checker that automatically tests ALL tubes, including loctals and picture tubes; and also acts as a continuity and voltage tester. Continuity and voltage checks are made by simply plugging test leads into pins 1 and 12 of the picture tube socket—no switches. A neon indicator acts as a voltage indicator as well as GOOD-BAD tube tester.

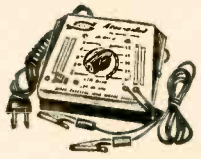
Net Each.....$2.75
With Leads.....$2.95

Eliminates Costly Call-Backs

NEW MODEL FS3 "FUSE-SAFE" TESTER—Prevents expensive call-backs on fuses and fuse resistors. Tests fuse, fuse resistor or circuit breaker circuits. Has individual scale for each value fuse resistor; reads red or green. Measures wattages up to 1100 watts at 115 volts. Two current ranges, 0-2 amps. and 0-10 amps. Test leads clip in place of fuse or fuse resistor. Tests both AC and DC. Safety 5-ohm, 10-watt resistor prevents circuit damage; simulates operating conditions.

Sencore Model FS3 Circuit Tester
Net Each.....$8.95

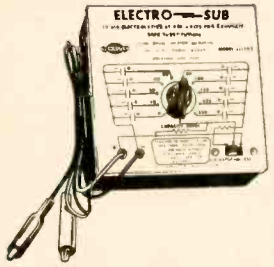
For AGC and Alignment Work



MODEL BE3 ALIGN-O-PAK — Fully isolated DC supply for TV alignment—AGC troubleshooting and other DC checking requirements. Provides all DC voltages recommended by TV manufacturers. Provides 0 to 18 volts, positive or negative, with less than 0.1% ripple. For alignment, merely plug in 115-volt AC and set knob at required voltage; for AGC trouble shooting, connect to AGC buss and vary voltage from 0 to 18 volts neg. If picture stabilizes, AGC is defective. Black hammertone case with aluminum panel. Complete with test leads. Shipping Weight, 2 lbs.

Sencore Model BE3 Align-O-Pak
Net Each.....$7.85

Capacitors and Resistors at your fingertips for *Easy-Safe-Substitution*



ES102 ELECTRO-SUB — Checks all Electrolytic Capacitators in seconds, merely select the electrolytic and substitute it. 10 big electrolytics from 4 to 350 mfd to safely substitute in any circuit from 2 to 450 volts. Automatic capacitor discharge within seconds. Unique surge protector circuit prevents accidental healing of capacitor being "bridged," completely safe. Compact unit can be carried anywhere, measures 4¾" h. x 4¾" w. x 2¼" d.

Net Each.....$15.95

NEW MODEL H36 R-C SUBSTITUTOR—Provides 36 of the most often needed components for direct substitution: 12 one-watt 10% resistors from 10 to 5600 ohms; 12 half-watt 10% resistors from 10K ohms to 5.6 megs.; 10 capacitors from 100 uuf to 0.5 uf, 600 volts; one 10 uf and one 40 uf 450 volt electrolytic. Three-pole, 12-position switch selects each component individually.

Sencore Model H36 R-C Substitution Unit
Net Each.....$12.75
Leatherette Carrying Case for H36—Net Ea. $2.95

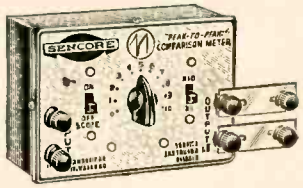
Quick check for Vibrators

MODEL VB2 "VIBRA-DAPTOR"—Permits checking vibrators in any tube checker; provisions for 3- or 4-prong vibrators. Plugs into tube tester; set for 6AX4 (or 6SN7) for 6-volt, 12AX4 (or 12SN7) for 12-volt vibrators. Two lamps in top of adaptor indicate good or bad. Rugged steel construction. Unbreakable #51 lamps are used. Complete instructions screened on front.

Sencore Model VB2 "Vibra-Daptor"
Net Each.....$2.75

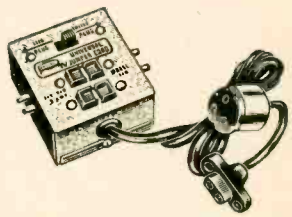
MODEL LB2 UP-DOWN VOLTAGE BOOSTER—For TV set or appliance up to 300 watts. No need to contend with inadequate picture width, insufficient height, low picture brightness, poor sync and oscillator drift, low sensitivity in fringe areas and/or excessive tube failure, due to lower than normal or higher than normal line voltages. Increase or decrease line voltage 10 volts with the flick of a switch.

Sencore Model LB2 Up-Down Voltage Booster
Net Each.....$5.97
Sencore Model LB2N Up-Down Voltage Booster—Same as above except with neon warning light that glows at 126 volts.
Net $7.17



MODEL PP2 PEAK-TO-PEAK METER—Completely assembled peak-to-peak meter for quickly servicing gated AGC and sync separator circuits. Occupies minimum space on the bench—only 4" x 6" x 3". Installed in seconds. A real time saver when servicing any TV set or electronic circuit. Essential for color with up to six gated circuits. Permanently connected to scope—straight through when turned off. Uses wire-wound potentiometer for accuracy. Calibrated against Dumont Calibrator and Textronix scope.

Sencore Model PP2 Peak-to-Peak Meter
Net Each.....$8.75



MODEL JC2 UNIVERSAL TV JUMPER CORD—Universal jumper cord that can be utilized with any TV set. Extends power from back of TV set—no moving furniture to get to the wall plug. Two handy power outlets for soldering iron and test equipment. Will fit many speakers, focus coils, etc. Two plugs accommodate all TV rearboard sockets and two sockets to fit the interior connections. Requires 115 v. AC, 3 amps.

Sencore Model JC2 Jumper Cord
Net Each.....$1.95

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SENCORE

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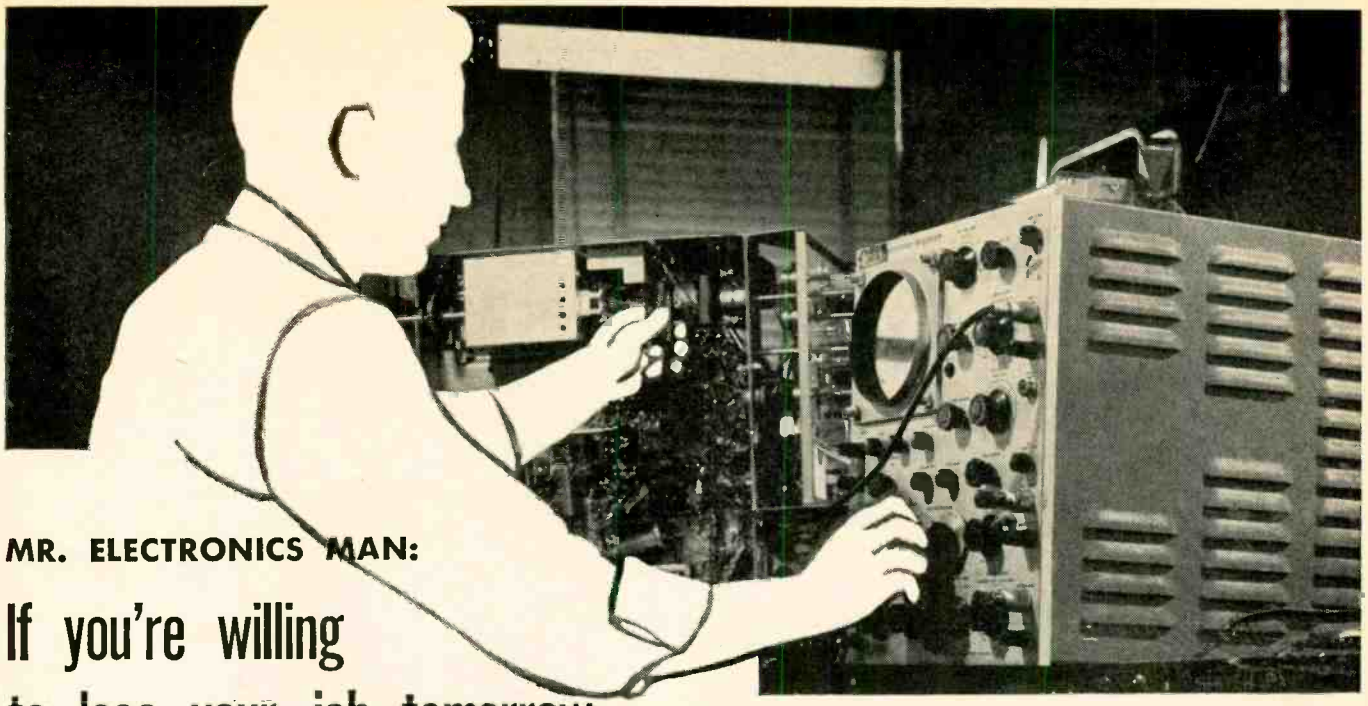

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If you're willing to lose your job tomorrow to a technically-trained man, *turn the page, mister*

There always <u>has</u> been . . . there always <u>will</u> be PERMANENT, PROFITABLE EMPLOYMENT IN ELECTRONICS . . . For <u>everybody</u>? No . . . only for well-trained electronic engineering personnel

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In Los Angeles. May and June saw classified advertising for engineers almost quadruple. Airframe manufacturers and missilemakers are drawing heavily on electronics manpower reserves in the West. In Chicago. demand for electronics engineers has trebled in the last 90 days and is still rising.

Chief engineers and personnel officers in industry agree on several major points:

• Many of the men currently on the street are there for a reason. "As many as 8 out of 10 are dead wood," estimates the chief engineer of a medium-sized Philadelphia firm; the problem is to find the live ones.

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'TRIMENSIONAL' TMS-2 *Components:* C-12HC dual voice coil woofer, two 8" mid-range speakers, two wide-angle tweeters, two networks with "presence" and "brilliance" controls. *Dimensions:* 30" wide, 25" high, 12½" deep. *User net:* mahogany — $258, blond or walnut — $263.00.

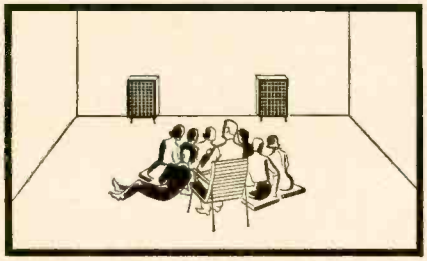
New developments have proved that a single cabinet integrated speaker system can provide stereo sound equalling or surpassing the performance of two separate units. Up to now, however, to achieve sufficient separation, such integrated systems have had to be large — and often expensive.

Now, University, employing a new principle of obtaining stereo separation presents the TMS-2 . . . containing two complete multi-speaker systems in one handsome enclosure only 30" wide.

The "Trimensional" TMS-2 projects frequencies of both channels to the rear and side walls of your room. Thus, one large wall area becomes channel "A", another becomes channel "B" . . . exactly as if you had a series of widely distributed speakers for each channel. This results in a *new* standard of stereo performance . . . excellent separation, real depth and broad sound distribution.

IMPORTANT ADVANTAGES OF TMS-2 'TRIMENSIONAL' STEREO

TMS-2 STEREO



CONVENTIONAL STEREO

1 Smooth, full-bodied, *balanced stereo sound throughout the room* (rather than the 'two point source' effect with critical listening area of conventional systems).

2 *'Hole-in-the-middle' effect eliminated* by central position of the dual voice coil woofer together with the unique wall reflection system.

3 Full complement of controls, and adjustable doors allow you to *place the compact TMS-2 virtually anywhere* along a wall, or in a corner, irrespective of existing furniture or furnishings.

4 *Stereo spread can be controlled easily* by means of the adjustable doors — according to program material and personal preference (e.g. wider spread for full orchestral works, less spread for small groups).

Hear TMS-2 stereo at your dealer . . . now. But don't be fooled by its small size. Close your eyes and let your ears judge the quality of its musical and stereo performance.

For the complete TMS-2 story, write to Desk J-2, University Loudspeakers, Inc., White Plains, N.Y.

University®

NEWS BRIEFS *(Continued from p. 10)*

MULTIPLEX SITUATION is still so unclear says H. H. Scott, maker of FM tuners and other consumer electronics, that he recommends no one purchase any of the currently available multiplex adapters. These adapters allow reception of multiplex programs from FM stations now broadcasting experimentally under special FCC permits. Scott points out that, when the FCC finally approves one system, some or all adapters now on the market may not be usable.

ONLY 2 NEW TV STATIONS this month:
WNED-TV, Buffalo, N. Y.....17
WQEX, Pittsburgh, Pa.....16
Milwaukee's WXIX on channel 18 left the air since our last report.

These changes make our new total of US operating stations 556 (468 vhf and 88 uhf). WQEX being educational, the noncommercial total: 43.

Calendar of Events

National Symposium on Microwave Theory and Techniques, June 1–3, Harvard University, Cambridge, Mass.

National Conference on Production Techniques, June 4–5, Villa Hotel, San Mateo, Calif.

Southwest Stereo Hi-Fidelity Show, June 5–7, Hotel Adolphus, Dallas, Tex.

Southwest Stereo Hi-Fidelity Show, June 12–14, Rice Hotel, Houston, Tex.

Symposium on Electro-magnetic Theory, June 15–20, University of Toronto, Toronto, Ontario, Canada.

International Conference on Information Processing, June 13–22, UNESCO House, Paris, France.

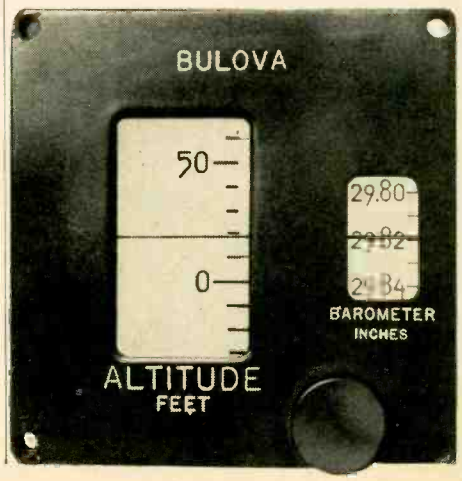
International Symposium on Circuit and Information Theory, June 16–18, University of California, Los Angeles, Calif.

International Conference on Medical Electronics, June 24–27, UNESCO Building, Paris, France.

National Convention on Military Electronics, June 29–July 1, Sheraton-Park Hotel, Washington, D. C.

British IRE TV Convention, July 1–7, University of Cambridge, England.

AIRPLANE ALTIMETER that records pressure electronically and displays altitude on a servo-actuated tape has been demonstrated by Bulova. The tape is graduated logarithmically, so that a difference of as little as 2 feet at ground level can be registered. At sea level, 50 feet occupies 1 inch of tape—



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THE KNIGHT STEREO ENSEMBLE

KN 734

deluxe 34-watt stereo amplifier

Fourteen stereophonic and monophonic controls • 34 watts rated stereo output... 68 watts peak • Separate bass and treble controls for each channel • 5 pairs of stereo inputs... input jack for accessory remote control • Hum-free DC on all preamp heaters • Wide range stereo balance control • 3-step loudness contour selector • Input loading control for magnetic cartridges • Mar-proof vinyl-clad metal case... solid aluminum gold anodized front panel..... *only* **$129.50** *$12.95 down*

KN 120

deluxe stereo FM-AM tuner

Separate FM and AM sections for stereo reception • Exclusive DSR corrective feedback circuit for minimum distortion of FM • Dual limiters on FM • Tuned RF stage on FM and AM • 2.5 microvolt sensitivity on FM • Cathode follower multiplex output jack • Four cathode follower main outputs • Dual "Microbeam" tuning indicators • Illuminated 9½" tuning scale; precision inertia tuning • High-sensitivity AM ferrite antenna • Handsome solid aluminum front panel, gold anodized, with mar-proof vinyl-clad metal case..... *only* **$129.50** *$12.95 down*

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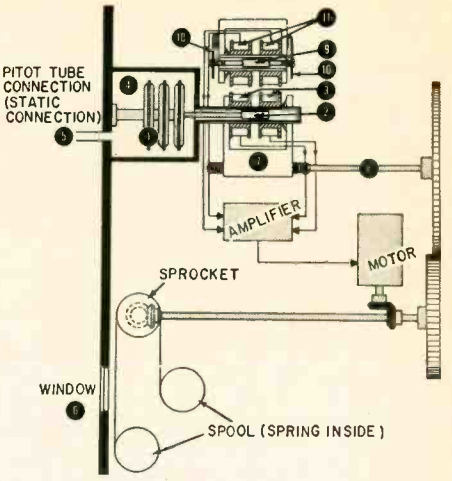

at 60,000 feet, 1 inch covers 500 feet.

The altimeter uses special aneroid units (1) as pressure-sensing devices. Changes in pressure extend or retract a soft-iron armature (2), which acts as the core of a differential transformer (3), increasing or decreasing the coupling—and therefore the energy transfer—between windings. Outside pressure is conveyed to the pressure chamber (4) through the tube (5) to the airplane's static pressure source. (The pressure source is a tube located in the plane's airstream arranged so it indicates static air pressure and is unaffected by the plane's motion.)

The signal (400 cycles) generated in the secondary of the differential transformer is amplified and used to actuate the servo motor which moves the tape past the window (6) to indicate the altitude, at the same time restoring the transformer coils to null to be ready to register any new changes. They are transported in a frame (7) which is moved right or left by a lead screw (8) geared to the motor.

A second armature (9) with a spring assembly (10) that exactly duplicates the mechanical restraints of the sensing assembly moves in a second differential transformer (11). It acts as a compensator for gravity or aircraft accelerations by producing a signal which bucks out any error that might be introduced in the sensing coils by such forces. A manual setting compensates for changes in atmospheric pressure.

BELL LABS SEMICONDUCTOR device, new four-terminal *field-effect tetrode*, performs functions impossible previously, or possible only with extensive circuitry. The field-effect tetrode can function as a transformer, a short-circuit stable negative resistance, an isolator, a modulator or a gyrator. This last is a nonreciprocal network which acts like a transformer while shifting phase 180°. For example, it can convert the reactance of a miniature capacitor into that of a high-Q inductor. The device, still in the laboratory stage, can also act as an electronically controlled resistor for large signals. Because it makes possible actions previously quite complex or impossible, areas of usefulness have scarcely been scratched. END

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The Grantham course covers the required subject matter completely. Even though it is planned primarily to lead directly to a first class FCC license, it does this by TEACHING you electronics. Some of the subjects covered in detail are: Basic Electricity for Beginners, Basic Mathematics, Ohm's and Kirchhoff's Laws, Alternating Current, Frequency and Wavelength, Inductance, Capacitance, Impedance, Resonance, Vacuum Tubes, Transistors, Basic Principles of Amplification, Classes of Amplifiers, Oscillators, Power Supplies, AM Transmitters and Receivers, FM Transmitters and Receivers, Antennas and Transmission Lines, Measuring Instruments, FCC Rules and Regulations, and extensive theory and mathematical calculations associated with all the above subjects explained simply and in detail.

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If you should fail the F. C. C. exam after finishing our course, we guarantee to give additional training at NO ADDITIONAL COST. Read details in our free booklet.

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Grantham School of Electronics *specializes* in F.C.C. license preparation. Correspondence training is conducted from Washington, Hollywood, and Seattle; also, resident DAY and EVENING classes are held in all three cities. Either way, by correspondence or in resident classes, we train you quickly and well.

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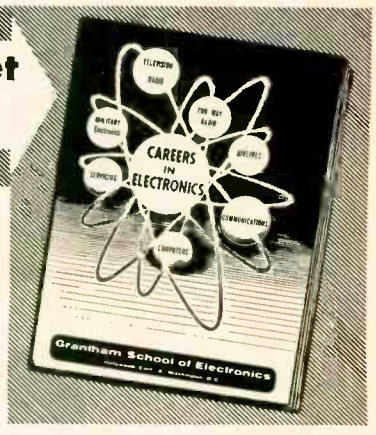

This free booklet gives details of our training and explains what an F.C.C. license can do for your future.

HERE'S PROOF...

that Grantham students prepare for F.C.C. examinations in a minimum of time. Here is a list of a few of our recent graduates, the class of license they got, and how long it took them:

	License	Weeks
Roy E. Alexander, Pikeville, Kentucky	1st	12
Robert J. Conley, 129 W. 46th St., New York 36, N. Y.	1st	14
W. R. Smith, 1335 E. 8th St., Long Beach, Calif.	1st	12
Howard E. Martz, 301 S. Penn. St., Fairmount, Ind.	1st	24
John W. Dempsey, Box 55, Rising Sun, Md.	1st	12
Donald H. Ford, Hyannis RD, Barnstable, Mass.	1st	12
Richard J. Falk, 2303 Holman St., Bremerton, Wash.	1st	22
Denson D. McNully, 1117 N. Houston St., Amarillo, Texas	1st	9
James D. Hough, 400 S. Church St., East Troy, Wisc.	1st	12
Odie B. Perry, Jr., Rt. #3, Zebulon, N. C.	1st	12
Milton C. Gee, Rt. #1, Washington, N. J.	1st	11

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Concentric volume control adjusts balance on each channel— plus overall volume...

DC on all preamp filaments for hum-free operation...

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knight-kit 20-watt stereo hi-fi amplifier

Newest complete stereo high-fidelity amplifier at an amazing low $44.50—the most sensational value ever offered in a stereo amplifier kit. It's a pleasure to assemble. It's a truly fine instrument—the worthy heart of the finest stereo hi-fi music system. Ideal for use with newest stereo records or stereo radio broadcasts. Delivers 10 watts per channel into each of two speaker systems for 20 watts of stereo—or 20 watts into one or more speakers for monaural use. Includes two fully integrated built-in preamps to accommodate magnetic cartridges. Single switch selects phono, tuner or auxiliary stereo inputs, plus stereo reverse on each; also switches monaural input to both amplifier channels. Has separate bass and treble controls with both boost and attenuation for complete control of tonal color. Special clutch-type concentric volume control permits individual channel balance adjustment, plus overall volume control. RIAA equalized for stereo discs. Has four pairs of stereo inputs: magnetic cartridge, ceramic cartridge, tuner and auxiliary. With switched AC accessory outlet for added convenience. Response is 20-20,000 cps, ± 1.5 db. Hum and noise, better than 85 db below full output. Distortion less than 1½%. Simple point-to-point wiring for easy assembly—even without previous electronic experience. Custom cabinet attractively finished in French gray; aluminum front panel with ebony trim; 4¼ x 13¼ x 9". With case, tubes, all parts, wires, solder and instructions. Shpg. wt., 27 lbs.

Model Y-773. Knight-Kit 20-Watt Stereo Hi-Fi Amplifier Kit. Net only. . **$44.50**

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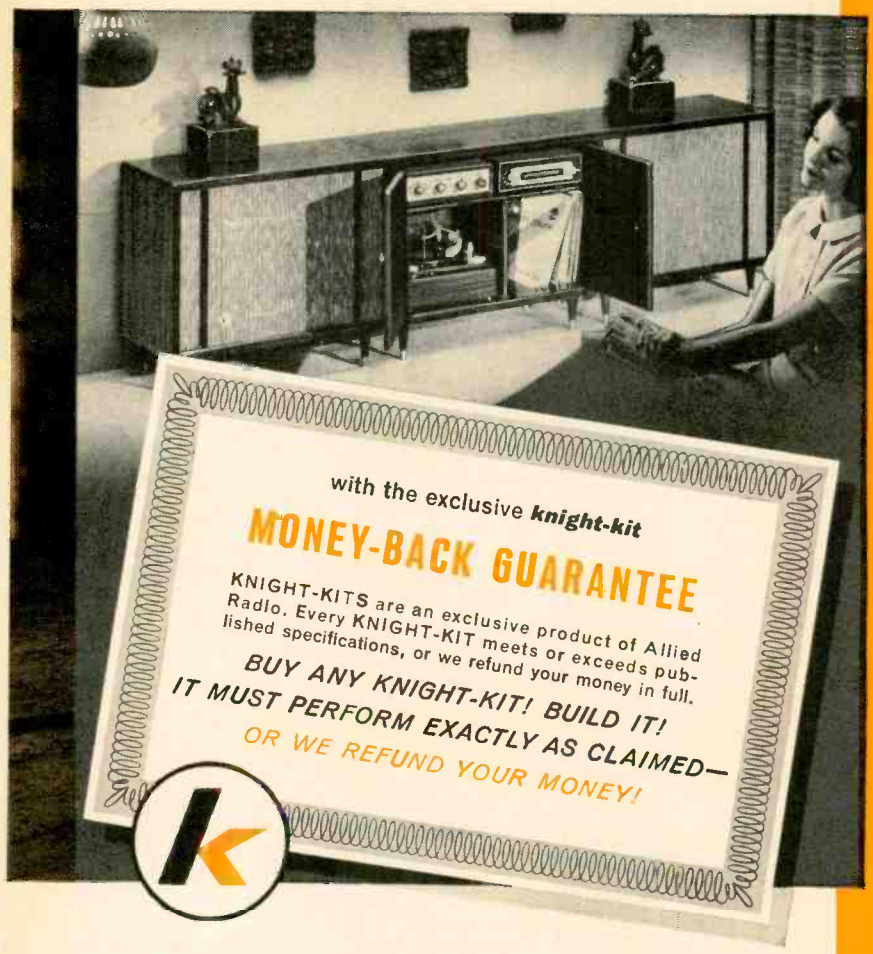

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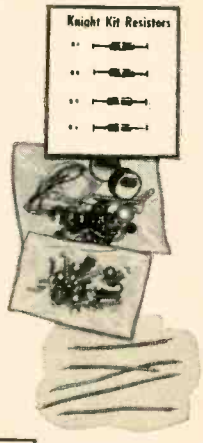

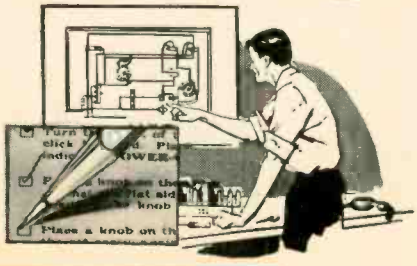

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- FM Tuner
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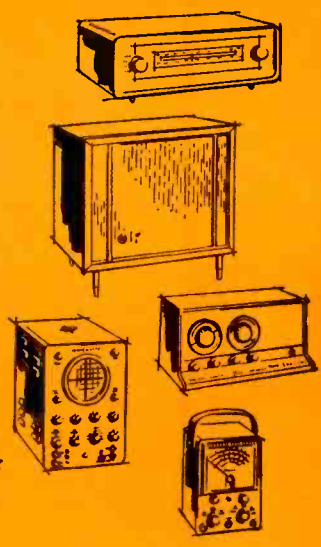
- Speaker Systems, etc.



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- "Ocean Hopper" Radio
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- 2-Transistor Pocket Radio
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- Electronic Lab Kits
- Photoelectronic System, and many others

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- VOM's
- Tube Checkers
- Oscilloscopes
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- Signal Tracer
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- R/C Tester
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AMATEUR KITS

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- 100 kc Crystal Calibrator
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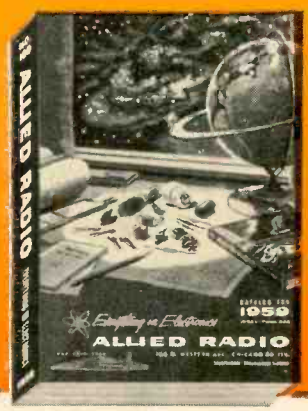

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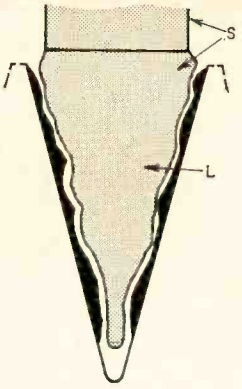

working on a record almost ½ inch thick which on the two sides of the groove can easily accommodate 50 sound channels (see illustration). The very long stylus (S) is made of a special *highly* flexible metal. It accommodates itself to all the hills and dales of the track on both sides. This is accomplished by a heavy liquid L (quicksilver, for instance) which blows up the needle in such a way that it follows faithfully *any* sound track. Consequently, the composites of the sound will all be faithfully transmitted.

The only difficulty so far is that I have not been able to work out a metal flexible enough for the needle. But don't worry, I'll get it sooner or later.

MOHAMMED ULYSSES FIPS

New York, N. Y.

METER ACCURACY

Dear Editor:

In your April, 1959, issue (page 32) in the article "Sensitive Wide-Band Ac Vtvm" by Philip Blais you state ". . . measure(s) ac voltages . . . with error of less than 2% . . ." I believe Mr. Blais is using a 2% Triplett meter with 50 scale divisions. Thus 2% happens to equal 1 scale division. On the .005-volt range .0001 volt also equals just 1 scale division. Thus, on this range, the error could go up to 100%!

The manufacturer's tolerance for the meter of 2% holds only for full-scale readings. 1/50 = 2% at full scale, 1/25 = 4% at mid-scale and so on, increasing down scale to 100%. Also, meter accuracy is added to by other factors such as input attenuator and line variations.

J. D. SHAW

Seattle, Wash.

(Statements regarding meter accuracy are customarily understood to refer to full-scale reading, as Mr. Shaw points out. Thus Mr. Blais' meter—or any 2% meter—may have an error much greater than 2% at low scale readings.—*Editor*)

KUDOS TO FIPS

Dear Editor:

Congratulations on Mr. Fips' remarkable new stereo system. I have no doubt it will cause a revolution in stereo circles.

A few suggestions to would-be constructors of this system may help. I have found that small portable parabolic heaters work better than Fips' speaker–reflector units. One simply connects the heater coils directly to the stereo cartridge. Since the heater produces 500 watts output, this system is very efficient. Too, the heaters may be plugged into the wall and used to facilitate focusing, thus eliminating the dangers of open flames.

I have also found that large dishpans will deliver reproduction similar to that of parabolic reflectors, and are easier to obtain.

My indebtedness to Mr. Fips for his original idea, showing how even those of us who have no money at all can enjoy naturally stereophonic sound!

DICK SPAULDING

South Pasadena, Calif.

(Mr. Spaulding's is only one of many thousands of enthusiastic letters we have forwarded to Mohammed Ulysses Fips, whose "Ultra-Steered-Stereo Projector" we published on page 76 of our April issue. Mr. Fips' contributions have appeared, usually on April 1 of each year, since 1908.—*Editor.*)

LISTENING TO STEREO

Dear Editor:

Reading your March Stereo issue with expectations . . . I found it interesting, but still (discussing) mostly false or semi-stereo.

Stereo should provide the sensation of being in the middle of the studio facing the orchestra or singers. Alternatively it should provide a good impression of the invisible orchestra spread out at one end of the room at home, but how often does it? Certainly not from studios using three microphones facing the entire orchestra . . .

When a vocalist is at left in the studio, only the left speaker at home should reproduce the voice, and the right-hand speaker should be *dead silent.* Which means that there can be no microphone on the right in the studio, otherwise the voice would issue at the same time from the right-hand speaker, and the artist cannot be in two places at the same time. Whispering ghosts from the other speaker in such case would spoil the stereo effect.

The left side of the orchestra and singers, with as many microphones as needed, should be in one studio, and the other half of the orchestra in another studio with other microphones. Artists in each studio would hear what is going on in the other studio by using headphones, and the two programs would be broadcast simultaneously. This would result in better reception at home on two loudspeakers.

Mixing acoustics (in both speakers) is of secondary importance; if the studios were free from echoes we could let the listening room at home do its worst.

CAPT. R. F. GRAHAM

Bedford, England

(There are a few objections to the above. Can any of our readers point them out?—*Editor*)

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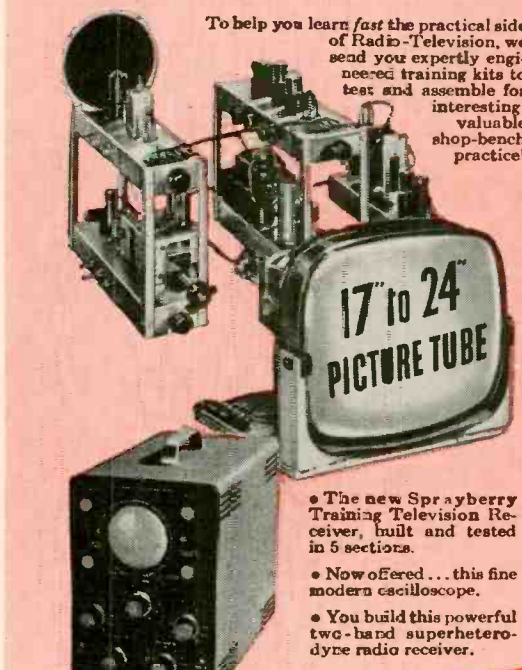

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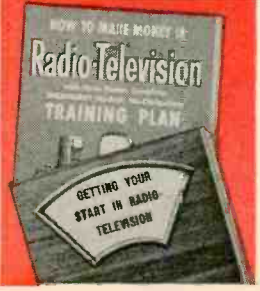

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"No man can improve an original invention..."

—William Blake

THERE are many scientists today who would argue this point with Blake.

At Bell Telephone Laboratories, for example, we have seen original inventions improved and re-improved countless times, the better to serve mankind.

But William Blake went on to say "... nor can an original invention exist without execution organized, delineated and articulated." Here Blake expressed ideas that apply with striking emphasis today. At Bell Laboratories organized effort is constantly aimed at fostering an environment in which inventions can exist and prosper, where they can be expressed either as ideas or in physical form, and where clear understanding of their principles can be achieved.

By helping scientists and engineers to reach for the things they seek, by organizing and coordinating their efforts, Bell Laboratories has made important contributions to the art of communications: proof of the wave nature of the electron, first research in radio astronomy, discovery of the transistor principle, invention of the feedback amplifier. Such ventures into the unknown have twice brought the Nobel Prize to Bell Laboratories scientists, and at the same time have helped create the most efficient and versatile telephone system ever known.

William Blake (1757-1827), a versatile genius, was famous for brilliant, sometimes prophetic, insights which he expressed with provocative beauty in drawing, painting, poetry and prose.

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Long life . . . in Explorer I, they lasted twice as long as anticipated. In transistor radios, they outlive ordinary batteries by as much as five times!

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Miniature size . . . this unique battery packs tremendous energy in a tiny, compact package.

Mallory also manufactures a complete line of Zinc-Carbon batteries with the same quality and dependability of Mallory Mercury Batteries. Your distributor has a stock of sizes of both Mercury and Zinc-Carbon batteries to fit all popular radios. See him today.

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Stravinski	. . . Infernal Dance of King Kastchei, Finale (Firebird Suite)
Beethoven	. . . Ode to Joy (Symphony No. 9 in D Minor)

DETAILS OF THE OFFER

This exciting recording is available in a special bonus package at all Audiotape dealers. The package contains one 7-inch reel of Audiotape (Type 1251, on 1½-mil acetate base) and the valuable "Blood and Thunder Classics" program (professionally recorded on standard Audiotape). For the entire package, you pay only the price of two boxes of Type 1251 Audiotape, plus $1. And you have your choice of the half-hour stereo program or the full-hour monaural version. Don't wait. See your Audiotape dealer now.

HERE'S a reel of musical excitement that belongs on *every* tape recorder. "Blood and Thunder Classics" is a program of great passages of fine music, specially selected for their emotional impact.

The makers of Audiotape have not gone into the music business. They are simply using this method to allow Audiotape to "speak for itself." This unusual program shows you how vibrant and colorful music can be when it is recorded on *Audiotape*.

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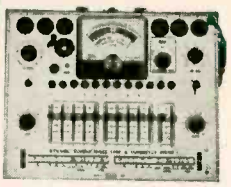

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KIT $69.95 WIRED $109.95

COMPLETE with steel cover and handle.

SPEED, ease, unexcelled accuracy & thoroughness. Tests all receiving tubes (and picture tubes with adapter). Composite indication of Gm, Gp & peak emission. Simultaneous sel of any 1 of 4 combinations of 3 plate voltages, 3 screen voltages, 3 ranges of continuously variable grid voltage (with 5% accurate pot). New series-string voltages: for 600, 450, 300 ma types. Sensitive 200 ua meter. 5 ranges meter sensitivity (1% shunts & 5% pot). 10 SIX-position lever switches: freepoint connection of each tube pin. 10 pushbuttons: rapid insert of any tube element in leakage test circuit & speedy sel. of individual sections of multi-section tubes in merit tests. Direct-reading of inter-element leakage in ohms. New gear-driven rollchart. Checks n-p-n & p-n-p transistors: separate meter readings of collector leakage current & Beta using internal dc power supply. Deep-etched satin aluminum panel; rugged grey wrinkle steel cabinet. CRA Adapter $4.50

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Entirely electronic sweep circuit (no mechanical devices) with accurately-biased inereductor for excellent linearity. Extremely flat RF output: new AGC circuit automatically adjusts osc. for max. output on each band with min. ampl. variations. Exceptional tuning accuracy: edge-lit hairlines eliminate parallax. Swept Osc. Range 3-216 mc in 5 fund. bands. Variable Marker Range 2-75 mc in 3 fund. bands; 60-225 mc on harmonic band. 4.5 mc Xtal Marker Osc., xtal supplied. Ext. Marker provision. Sweep Width 0-3 mc lowest max. deviation to 0-30 mc highest max. dev. 2-way blanking. Narrow range phasing. Attenuators: Marker Size, RF Fine, RF Coarse (4-step decade). Cables: output, 'scope horiz., 'scope vertical. Deep-etched satin aluminum panel; rugged grey wrinkle steel cabinet.

COLOR and Monochrome DC to 5 MC LAB & TV 5" OSCILLOSCOPE #460

KIT $79.95 WIRED $129.50

• Features DC Amplifiers!

Flat from DC-4.5 mc, usable to 10 mc. VERT. AMPL.: sens. 25 rms mv/in; input Z 3 megs; direct-coupled & push-pull thruout; K-follower coupling bet. stages; 4-step freq-compensated attenuator up to 1000:1. SWEEP: perfectly linear 10 cps-100 kc (ext. cap. for range to 1 cps); preset TV V & H positions; auto. sync. ampl. & lim. PLUS: direct or cap. coupling; bal. or unbal. inputs; edge-lit engraved lucite screen; dimmer; filter; bezel fits std photo equipt. High intensity trace CRT. 0.06 usec rise time. Push-pull hor. ampl., flat to 400 kc, sens. 0.6 rms mv/in. Built-in volt. calib. Z-axis mod. Sawtooth & 60 cps outputs. Astig. control. Retrace blanking. Phasing control.

5" PUSH-PULL Oscilloscope #425: Kit $44.95, Wired $79.95.
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NEW! RF SIGNAL GENERATOR #324

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150 kc to 435 mc with ONE generator! Better value than generators selling at 2 or 3 times its cost! Ideal for IF-RF alignment, signal tracing & trouble-shooting of TV, FM, AM sets; marker gen.; 400 cps audio testing; lab. work. 6 fund. ranges: 150-400 kc, 400-1200 kc, 1.2-3.5 mc, 3.5-11 mc, 11-37 mc, 37-145 mc; 1 harmonic band 111-435 mc. Freq. accurate to ±1.5%; 6:1 vernier tuning & excellent spread at most important alignment freqs. Etched tuning dial, plexiglass windows, edge-lit hairlines. Colpitts RF osc. directly plate-modulated by K-follower for improved mod. Variable depth of int. mod. 0-50% by 400 cps Colpitts osc. Variable gain ext. amplifier: only 3.0 v needed for 30% mod. Turret-mounted coils slug-tuned for max. accuracy. Fine & Coarse (3-step) RF attenuators. RF output 100,000 uv; AF sine wave output to 10 v. 50-ohm output Z. 5 way jack-top binding posts for AF in/out; coaxial connector & shielded cable for RF out. 12AU7, 12AV7, selenium rectifier; xmfr-operated. Deep-etched satin aluminum panel; rugged grey wrinkle steel cabinet.

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Half-turn of probe tip selects DC or AC-Ohms.

Uni-Probe — exclusive with EICO — only 1 probe performs all functions!

Latest circuitry, high sensitivity & precision, wide ranges & versatility. Calibration without removing from cabinet. New balanced bridge circuit. High Z input for negligible loading. 4½" meter, can't burn-out circuit. 7 non-skip ranges on every function. 4 functions: +DC Volts, −DC Volts, AC Volts, Ohms. Uniform 3 to 1 scale ratio for extreme wide-range accuracy. Zero center. One zero-adj. for all functions & ranges. 1% precision ceramic multiplier resistors. Measure directly peak-to-peak voltage of complex & sine waves: 0-4, 14, 42, 140, 420, 1400, 4200. DC/RMS sine volts: 0-1.5, 5, 15, 50, 150, 500, 1500 (up to 30,000 v with HVP probe & 250 mc with PRF probe). Ohms: 0.2 ohms to 1000 megs. 12AU7, 6AL5, selenium rectifier; xfmr-operated. Deep-etched satin aluminum panel, rugged grey wrinkle steel cabinet.

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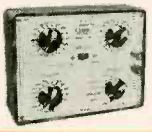

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KIT $34.95 Wired $49.95
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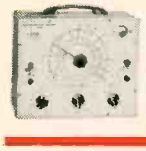

R-C BRIDGE & R-C-L COMPARATOR #950B
KIT $19.95
Wired $29.95
Reads 0.5 ohms—500 megs, 10 mmfd—5000 mfd, power factor

VTVM PROBES	KIT	Wired
Peak-to-Peak	$4.95	$6.95
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MILLIMETER WAVES

. . . Microwaves Are Opening a New Electronic World . . .

AS we ascend the scale of radio frequencies beyond the ultra-high range, we emerge into the millimeter waves. This band lies between 30,000 and 100,000 megacycles (10 and 3 millimeters). These have been under intense study for a number of years, yet they are still largely in the unutilized realm of electromagnetic radiation. The new waves can be generated by crystal-diode harmonic producers, klystrons, backward-wave oscillators and high-voltage beams.

The difficulty thus far has been that these generators are not very efficient transmitters at such high frequencies. As the transmitting power at present is microscopic —a few watts at most—the signal is weak, too. The range so far has been limited to between 10 and 20 miles.

So far, transistors can be used up to less than 2,000 megacycles, while millimeter waves start at 30,000 mc. It is possible, however, that some solid-state device for generating millimeter waves will evolve.

Millimeter radio waves approach light waves, and in many ways act like them. They are often called quasi-optical waves.*

When these waves are transmitted through the air, water moisture or vapor and oxygen, particularly, interfere with the transmission, making for poor reception. In this way, millimeter waves act very much like light waves in a dense fog—signaling for both becomes unreliable.

So far, at the lower limits of these frequencies, waveguides (hollow metal pipes) seem to work out best in transmitting these extremely short waves. Such guides are most efficient, at the present state of the art, causing comparatively little loss of power.

The waves are so short that they can be sent through what are essentially hollow wires. The opening in that case would have to be greater than ½ a wavelength, say ⅛ inch, for 5-millimeter waves having a frequency of 60,000 megacycles. The difficulty here is that transmission through such small holes creates losses, while very straight pipes 2 inches in diameter appear much more useful.

Unfortunately, ordinary solid wires cannot be used in transmitting millimeter waves because wires radiate too much power at the ultra-high frequencies. Ordinary antennas cannot be used. For best transmission, "horn" antennas and parabolic reflectors seem to give best results.

At a recent session in New York early in April, several hundred scientists and engineers discussed millimeter waves at great length. All admitted the great future of these waves if only a more satisfactory means could be found for their generation, transmission and, particularly, their control.

It will probably take a number of years before new instrumentalities have been invented to make millimeter waves as common as longer radio waves. In this respect, we have to go back to Heinrich Hertz and Marconi, who also had to grope along unknown paths to make wireless practical.

Yet we already know that millimeter waves are not only here to stay, but that they are the forerunner of vast changes in radio, electronics, television and other communication.

Whether we use waveguides or an entirely new means of transmission, millimeter waves are certain to be used intensively in the foreseeable future. The chief reason is that, at these quasi-light frequencies, we will eventually be able to handle with ease several hundred thousand millimeter-wave telephone channels, with hundreds of television channels, *simultaneously along a single transcontinental or transoceanic line.*

As a matter of fact, far more channels are available in the millimeter range than in the entire radio–television–radar frequency spectrum *combined.* And, as every technician knows, our present radio channels are practically exhausted now. Hence the urgency for opening the millimeter band.

In the space age now dawning, the new ultra-high waves will be especially useful. It is quite certain that millimeter transmitters can also be miniature in size, possibly as small as a matchbox, yet powerful enough to cover vast distances in space. According to Dr. John R. Pierce, physicist of Bell Telephone Laboratories, who kindly gave us considerable factual data used in this article—if one used parabolic antennas hundreds of feet in diameter, a few watts at millimeter frequencies could easily reach our nearest star, *Alpha Centauri,* 4 light years distant!

What is more, these microwaves are *not* affected in their transmission in free space, as they are in our dense oxygen- and water-soaked atmosphere. There is little doubt that spacemen of the future, as well as all spaceships, will be equipped with millimeter radio equipment.

Millimeter radar gear in space is quite feasible and will surely be used in the foreseeable future on the moon and spaceships. It should be particularly effective in detecting even small meteorites. This, as all future spacemen are well aware, is vital in "sidestepping" these lethal bodies, which travel at the rate of 5 to 10 miles a *second.* If they can be detected and intercepted early enough, the spaceship can easily change course and evade the celestial missiles.

There is also the possibility that millimeter waves may prove highly important in biology and in the treatment of diseases. Just as high-frequency radio waves have been used very effectively in radiothermy, so the new waves are certain to find other health uses, perhaps even more important ones. —*H.G.*

*See RADIO-ELECTRONICS March, 1952; January, 1957; April, 1957.

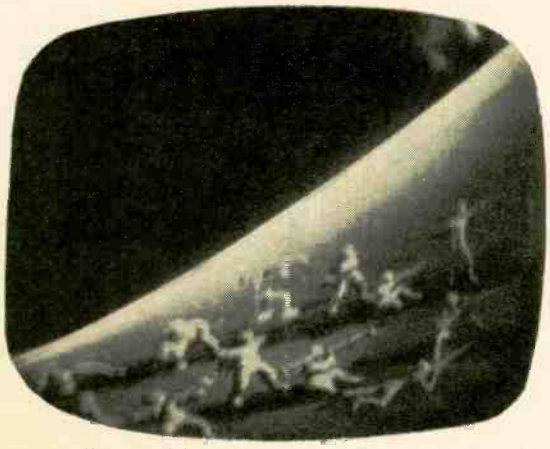
DIAGNOSE COMMON TV FAULTS

By A. V. J. MARTIN

A PICTURE is worth ten thousand words. To the technician, these photos are worth time and money—clearly illustrated TV troubles as seen on the screen, coupled with brief notes on where the trouble can be found, to speed servicing time. No matter how long you have been in business, you haven't seen anything yet!

Symptoms: Picture does not fill screen; vertical linearity poor.

Diagnosis:
1. **Insufficient height.** Adjust height and vertical linearity controls. Check vertical output and oscillator tubes and circuit components.
2. **Poor vertical linearity.** Adjust vertical linearity controls. Check vertical output tube and components.

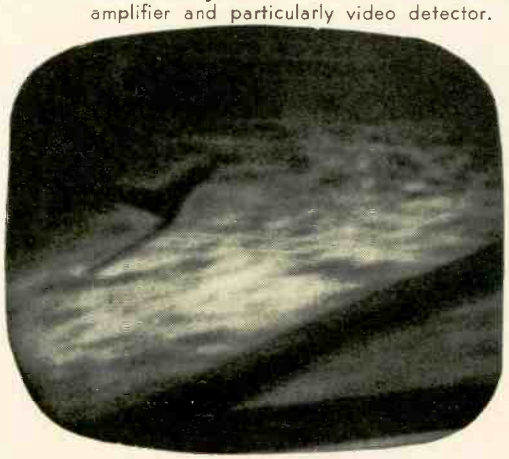


Symptoms: Trapezoidal picture. One of vertical sides is much smaller than other.

Diagnosis: **Shorted vertical deflection coil.** Check resistance of each coil separately. Frequently, short occurs in component connected in shunt across coil such as damping resistor or anti-ringing capacitor.

Symptoms: Lack of contrast; slanting white lines (retrace lines) across part or all of picture.

Diagnosis:
1. **Loss of vertical sync.** Picture may be slightly displaced vertically. Blanking bar does not show—blocked out by mask or slightly oversize picture. Adjust vertical hold. Turn up contrast control.
2. **No blanking.** Picture is steady vertically. Increase contrast, reduce brightness or do both. If fault persists, check vertical retrace blanking circuit. Usual culprit is coupling capacitor to one of picture-tube electrodes.
3. **Bad pix tube.** If everything else checks OK, and if pix seems to lack contrast and brightness, or tends to be muddy when turning up controls, check pix tube.
4. **Insufficient gain.** Check antenna, video if's, video amplifier and particularly video detector.



Symptoms: No coherent picture obtainable. Black-and-white moving pattern or streaks all over the screen.

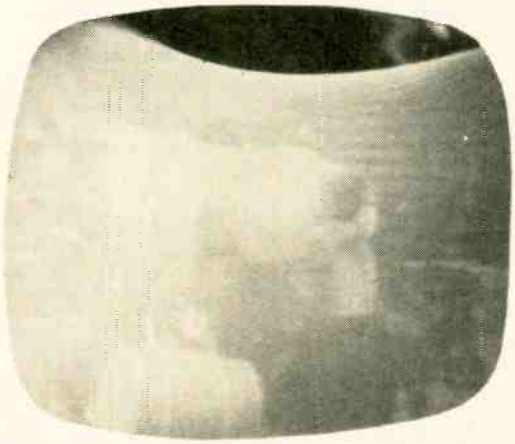
Diagnosis: **Loss of sync.** Adjust vertical, horizontal hold controls. Check sync circuits, particularly sync separator tube.

Symptoms: Horizontal white streaks following dark areas, or vice versa. Smearing.

Diagnosis: **Poor low frequency response.** Adjust fine tuning. Check video amplifier, especially coupling elements and low-frequency connecting networks. Check alignment.

Symptoms: Picture lacks sharpness. When looking closely at sceen, sweep lines cannot be distinguished.

Diagnosis: 1. **Poor focus.** Adjust focus control. Adjust ion-trap magnet.
2. **Bad picture tube.** Change tube.



Symptoms: Top of picture bent inward severely.

Diagnosis: **Pincushion effect.** Poorly designed, defective or misplaced deflection yoke. Correcting magnets misadjusted. Deflection yoke not made for this particular picture tube. If some components have been displaced, beware of parasitic dc magnetic field; for example, loudspeaker.

Symptoms: Whites not bright enough, and grays form solid black area.

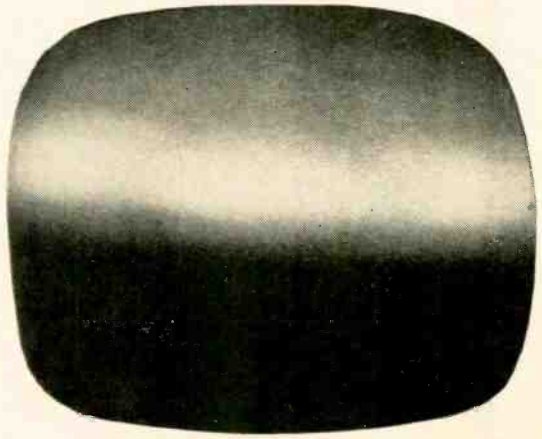
Diagnosis: 1. **Lack of brightness.** Adjust brightness and contrast controls.
2. **Misadjusted ion-trap magnet.** Try rotating and moving it forward and backward a little at a time.
3. **Incorrect voltages.** Check particularly the voltage between picture-tube grid and cathode. Brightness control should vary it between 100 and 0 (or a few volts) approximately. If this voltage does not go down to a low enough value, check components in grid and cathode circuits. If picture tube is direct-coupled, check video amplifier.

Symptoms: Whites bloom. As soon as brightness control is advanced, white parts of picture lose all detail and spread. If brightness is increased further, whole picture blows up.

Diagnosis: 1. **Poor high-voltage regulation.** Usual culprit is high-voltage rectifier. If not, check high-voltage circuit and particularly filter resistors and capacitors, if any. Look and listen for high-voltage losses (hissing sound, violet corona).
2. **Defective picture tube.** Change it.

Symptoms: Picture lacks sharpness. Upon close inspection of screen, horizontal sweep lines are sharp and clearly visible.

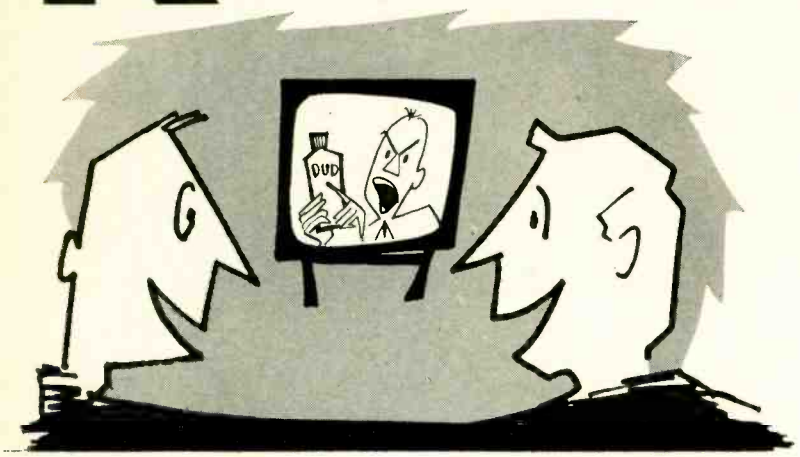
Diagnosis: **Loss of fine details.** Defect is in video section. Adjust fine tuning. Check tuner. Check video amplifier and particularly the high-frequency peaking circuits. A peaking coil may be open or short-circuited. Check alignment.



Symptoms: Screen divided horizontally into two wide black-and-white areas.

Diagnosis: **Hum modulation.** Parasitic signal at line frequency is modulating picture tube. Check filtering and decoupling circuits. Check for heater-to-cathode shorts. If some components have been moved, modulation may be due to parasitic ac magnetic field; for example, filter choke. END

Kill Commercials Fast



A flash of light triggers a neon flip-flop that shuts off unwanted TV commercials

By OTTO RELLING

IF your televiewing habits are anything like mine, most TV commercials sound like, "aspirin shampoo is better for your engine than any other cigarette" and you prefer to use the commercial break for conversation. This means either shouting at the top of your voice or getting up from your easy chair twice—once for off and once for on.

The commercial killer described in this article solves this problem neatly. It is inexpensive and easily built, offering simple wiring and noncritical parts layout.

Fig. 1 shows the basic flip-flop circuit which provides the necessary relay latching action. It uses two neon glow lamps (type NE-2) in parallel, with one end connected through a 1-μf capacitor. These lamps fire when the voltage across them exceeds 70 and go out as soon as the voltage drops below 60.

When the switch is closed, 135 volts is applied across the two neon glow lamps; one of them—let's say NE1—fires first. Current flowing through NE1 causes a voltage drop across R1. With properly selected components this drop will reduce the voltage between point A and ground to a level sufficient to keep NE1 conducting but too low to fire NE2. The current through R2 places a positive voltage at point B and the capacitor charges to this voltage.

If the voltage between point A and ground is momentarily reduced to below 60 volts—by quickly opening and closing the switch, for example—the capacitor begins to discharge through R3 and R2. This will make point C temporarily more negative than ground. If the switch is closed during that time, the

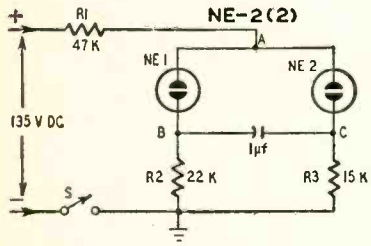


Fig. 1—Basic flip-flop circuit.

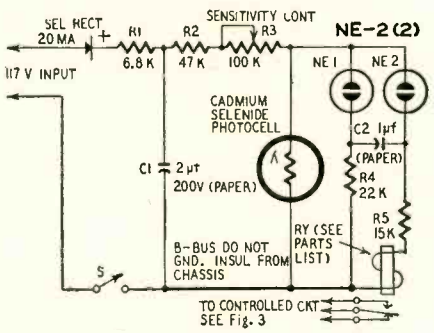


Fig. 2—Complete circuit of photosensitive control unit.

R1—6,800 ohms
R2—47,000 ohms
R3—pot, 100,000 ohms
R4—22,000 ohms
R5—15,000 ohms
All resistors ½ watt
C1—2 μf, 200 volts, metallized paper
C2—1 μf, 200 volts, paper
NE1, 2—NE-2, neon lamp
RECT—20 ma, selenium
RY—spdt, 4,000–8,000 ohms, operates on 0.5 ma (Sigma 4F or Kurman BK-7-B or equivalent)
S—spst, toggle
Photocell (Clairex Corp. CL-4 or equivalent)
Chassis
In-line phono jack (H. H. Smith No. 1237 or equivalent)
Knob
Miscellaneous hardware

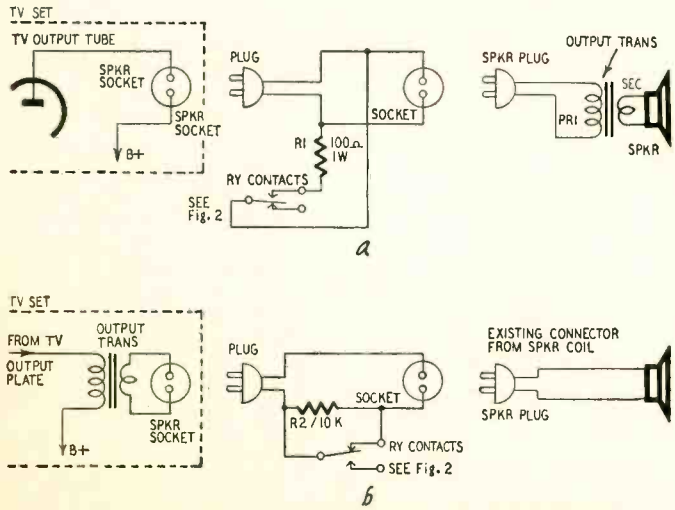
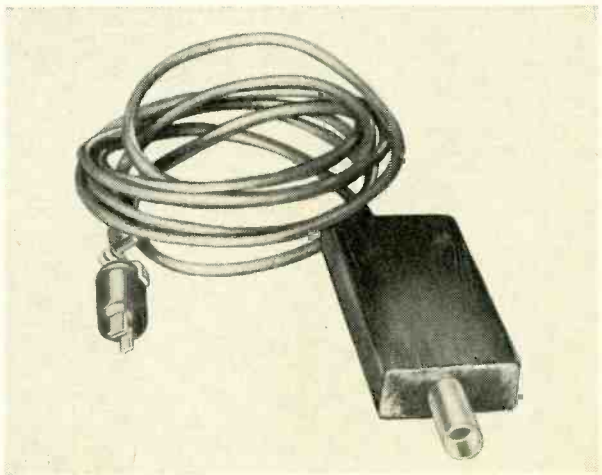


Fig. 3—Two methods of connecting control unit to a TV set.



Photocell is mounted on wood block and has an extension cord.

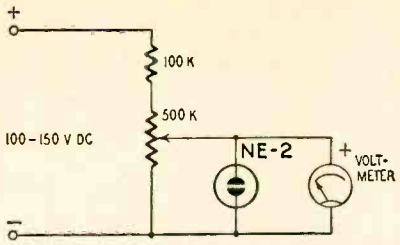


Fig. 4—Test setup for matching neon lamps.

negative voltage is added to the 135 volts of the power supply and NE2 fires first, preventing NE1 from firing. Successive operation of the switch fires the lamps alternately.

The circuit

Fig. 2 shows the complete circuit of the commercial killer. RECT, R1 and C1 for the power supply. V is a poly crystal cadmium selenide photocell (CL-4) manufactured by the Clairex Corp. The resistance of this cell varies inversely with the amount of light it receives. (As light intensity increases, the cell's resistance decreases.)

WARNING

The commercial killer's B-minus bus is connected directly to one side of the ac line. Be sure that no part of the unit's circuitry is connected to the chassis. If this precaution is not observed the unit may have a hot chassis, presenting a serious shock hazard. Placing the unit inside a TV console will provide additional protection for the constructor.

The photocell is wired in parallel with the two neon lamps, and the current flowing through it increases the voltage drop across R2 and R3. When sufficient light shines on the cell, its resistance decreases and the additional current through R2 and R3 forces the voltage across NE1 and NE2 to drop below 60. This extinguishes the conducting lamp and lights the other. Since the relay coil is in series with NE2 the relay will stay open or closed, depending on which lamp conducts.

It is necessary to adjust the CL-4 photocell to the background lighting of the room—the lighting that is normally used when the TV set is on. With the cell in its intended location, connect an ohmmeter to its leads; the resistance should be roughly 200,000 to 250,000 ohms. If necessary, the cell may be covered with one or more layers of paper or paperbacked adhesive tape. I terminate the cell leads in a miniature plug which is inserted into a socket on the commercial killer's chassis. This makes adjustments possible should the cell be used under different lighting conditions. To some extent, you can compensate for such lighting changes by varying the setting of R3. An ordinary two-cell flashlight can be used to trigger the unit, but it should be a prefocused type. A light beam quickly passing over the photocell switches the sound on or off.

RY is a sensitive relay operating on 0.5 ma. These relays are being offered as surplus (Sigma 4F, Kurman BK-7-B). Their coil resistance varies from 4,000 to 8,000 ohms. The Sigma 4F can be made sufficiently sensitive by carefully turning the pivot screw clockwise. The BK-7-B relay is adjusted with a lever.

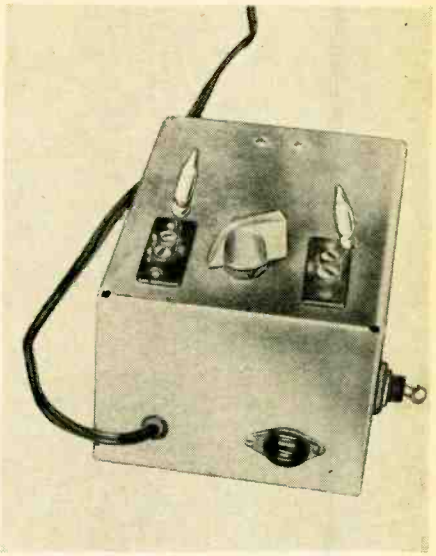
Hook it up

The connection to the TV set can be made without soldering if the speaker is connected to the TV chassis by a plug. If your set has the plug and socket between the output tube and the primary of the output transformer, follow the circuit shown in Fig. 3-a. Closing the relay places R1 in parallel with the primary, reducing the sound to a level low enough to be heard but not loud enough to be disturbing. This method of wiring the relay does not break the connection to the primary and prevents sparking.

If the plug in your TV set is located between the output transformer's secondary and the speaker coil, use the circuit shown in Fig. 3-b. Operating the relay puts R2 in series with the speaker coil.

The NE-2 neon lamp costs only a few pennies. Sometimes two lamps will differ in their firing and extinguishing voltages. For this reason I did not solder them into the circuit but wired them to screw type terminal connectors. The lamps were placed outside the chassis for the visual effect of the flip-flop.

To match neon lamps, use the simple circuit shown in Fig. 4. The voltage across the NE-2 varies with the setting of the potentiometer and the firing and extinguishing voltages of individual neon lamps may be quickly determined. Variations of 1 or 2 volts between lamps should not cause any difficulties.



The control unit. Neon lamps are connected to terminal strips for easy mounting. A much smaller case may be used.

The chassis and the CL-4 may be placed anywhere. I keep the chassis inside the TV console and the light-sensitive cell on top of the console. For a neat appearance, the photocell was mounted in the shell of an H. H. Smith type 1237 in-line phono jack and the shell was inserted in a piece of wood molding (see photos).

Now all you do when the commercial comes along is to flash a beam of light at the photocell and enjoy the silence. When the commercial is over another sweep with a flashlight restores the sound to its normal level. END

USE POLARIZED PLUGS

SHOCK hazards in TV sets, small radios and similar devices can be reduced drastically with a simple safety device already on hand or immediately available, reported representatives of General Electric Co. and the Underwriters Laboratories at a recent AIEE convention.

Several million hot-chassis TV receivers with metal cabinets are in use in American homes, they stated. Each could become a shock hazard with a failure of insulation or spacing.

Two methods, they said, appear to be attractive ways of reducing this hazard. The more obvious one is to employ a three-conductor supply cord and attachment plug, with a three-blade grounded receptacle, attaching the grounding wire to the cabinet.

A second method is to use the polarity provisions already built into modern 2-blade 120-volt receptacles. One slot of the ordinary wall receptacle is wider than the other, and the side of the line connected to that blade is grounded. Polarized plugs, with one prong wider than the other, are available, though not plentiful. If the supply-cord conductor to which the chassis of the receiver is connected goes to the wide blade of the plug, the chassis is grounded. Two failures are then required to produce a dangerous condition. Insulation or spacing must fail *and* the cord polarity be reversed.

At some future date, the experts reported, when the newly standardized 3-blade, 15-amp, 125-volt receptacle comes into common usage, the 3-conductor method may become the preferred one but, in view of the limited use of such receptacles at present, "the application of polarity grounding today is a definite step toward increased safety." (The great drawback of the polarity method is, of course, the placement of the switch between chassis and line found on some TV's and on many small radios. In such cases, a set may be perfectly safe when turned on and become hot when turned off.) END

Commercial Antenna Installation for FRINGE AREAS

It takes careful study and a lot of work to put up a successful community antenna system

By THE ENGINEERING STAFF, SCALA RADIO CO.

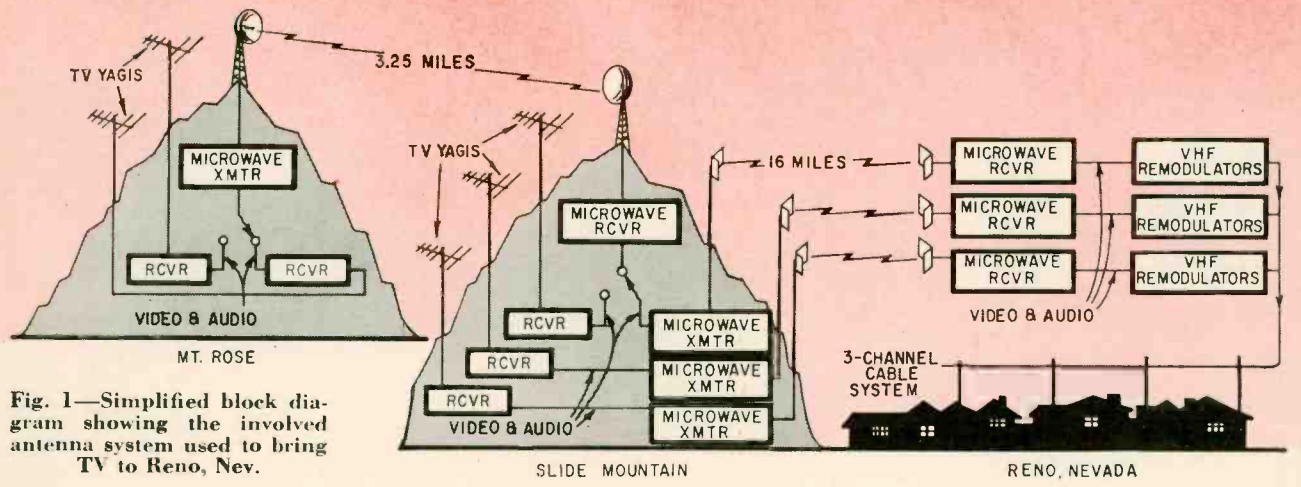


Fig. 1—Simplified block diagram showing the involved antenna system used to bring TV to Reno, Nev.

JUST as important as finding the signal when installing an antenna in a problem or fringe area is determining its stability under seasonal and climatic changes. Community-system, apartment-house and other types of commercial fringe antenna installations warrant greater antenna costs than normally spent for home reception. Regardless of whether cost is a factor, the site for a commercial installation must be selected with great care, since many people will be dependent on it.

Initial steps in choosing a site

The first step in planning an installation is to determine the best location. Ask local radio and television men where they think the best site is and, if possible, get a list of TV set owners in the vicinity of the recommended site from them. Signals have a tendency to fade with seasonal and climatic changes, so information from set owners on year-round conditions can prove valuable.

Data gathered in such a survey should cover: Is there fade? How rapid is it? Do the signals improve or deteriorate at night? What stations come in best in the daytime? How is reception in the winter? How is it in the summer?

It is important that the investigator keep good notes and ask as many neighbors as possible the same questions. If the answers all agree with each other, questioning four or five set owners can be sufficient. But if there is a sharp disagreement, more opinions are required. If adding to the sampling still brings no general agreement, the opinions may be of little assistance—although you must consider whether varying reports may come from hot or dead spots in a general area.

In the search for a signal, a broadband antenna is ordinarily used because of the ease with which it can be switched from channel to channel. If the signal is so poor that it is completely useless on a broadband antenna, we can be certain that higher-gain antennas will help little. The equipment normally used in such a search includes a good television receiver, a field-strength meter and a telescoping mast.

Exploring a wider area

When selecting a signal for an auto court or hotel, the area of exploration is usually limited. This is not the case when selecting a site for community systems. In such cases the demand for a satisfactory image may justify going a much greater distance. For example, Reno, Nev. picks up Sacramento channels 3 and 10, San Francisco channel 5, and Stockton channel 13, from Slide Mt. San Francisco channels 5 and 7, and Sacramento channel 10 are picked up on Mt. Rose (see Fig. 1). These signals are converted and relayed via microwave into town 16 miles away.

The Reno Community Antenna Corp. distributes three channels to the subscriber. With an ingenious method of switching, the engineers can select any three channels among channels 3, 5, 7, 10 and 13—the choice depending on programs and signal quality. The engineers select the location giving best reception. In Reno the sound and video is detected from the microwave carrier and used to modulate three crystal-controlled oscillators (remodulators) set for channels 2, 4 and 6. The outputs of these remodulators are then mixed together and distributed throughout Reno via a single coaxial cable. Viewers tune to channels 2, 4 and 6.

This procedure is quite expensive, but not uncommon, because cities like Reno have enough potential subscribers to warrant the expense. A community with fewer potential subscribers cannot afford this and must select its antenna site to conform to a smaller budget. The usual procedure, in such case, is to determine the longest possible distance between the antenna site and the distribution point and use this as the radius of the area to which the signal search will be confined.

As stated before, local technicians and set owners, if any, can help. If such

a source of information is not available, the best potential sites are determined by their elevation and distance from noise sources, such as highways, high-tension lines, factories and so forth. Nearness of the site to electric power and accessibility are important considerations.

Monitoring the signal

Once you find what appears to be an acceptable site, it can be improved with high-gain antennas. A Yagi is accepted as the most practical antenna since it gives the best gain for its size—which increases the signal level—and has good directivity—which reduces noise and other unwanted signals.

A broad-band antenna is permanently mounted where the optimum signal has been located, and the Yagi is then mounted on a telescoping tower. It can then be raised, lowered and rotated. With the Yagi in the vicinity of the broad-band antenna, the technician can compare signals by switching the field-strength meter from one array to the other.

The Yagi is moved around until the best position is obtained, and then elevated until maximum signal is noted on the field-strength meter. The technician should be continually comparing this signal with that from his broad-band reference antenna. As the signal's level may vary continuously, this comparison is important. It shows the technician whether he has the best possible signal or just happened to take a reading during a hot signal moment. A good average signal level is 100 μv. The minimum should exceed 50 μv.

Monitoring the signal cannot be overstressed. It is the only way to determine the true value of a reading. For example, if the signal should fade to 50 μv, but monitoring indicates that it never goes below that level, the area may be more acceptable than one where a signal goes to 500 μv but fades to less than 50 μv. The monitoring should be as comprehensive as possible. Not only should the level be watched for at least one week, but the picture quality should be monitored as well. Readings must be taken day and night and also during climatic changes.

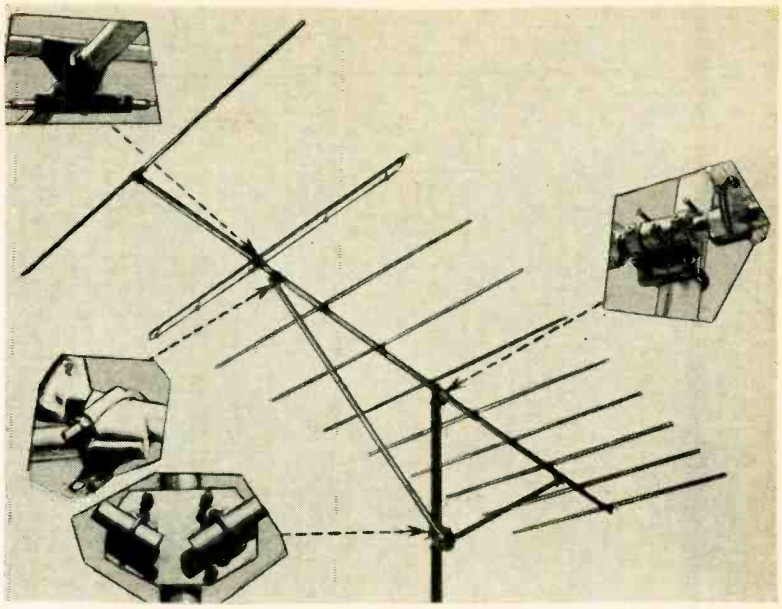


Fig. 2—A 10-element industrial type Yagi. Note the diagonal braces for added vertical strength.

The 50-μv signal is the minimum usable level. If one Yagi does not deliver this minimum, 2, 4 or more Yagis can be stacked for a single channel. Some installations use as many as 32. Again it is a question of economics. However, if a weak signal does not show substantial improvement when 1 Yagi has been increased to 4, the location is not to be recommended. If the signal is acceptable with 4 or fewer Yagis per channel, additional refinements can always be made at a later date by adding antennas to the stack.

Yagis with 3 to 12 elements are available, and sometimes even more are used. We have found that 8 db over a dipole is good gain for a 5-element Yagi with the necessary bandwidth. Usually 10 elements give about 2 db more, depending on the channel.

Choosing the Yagi

In constructing Yagis, manufacturers have a design problem. For example, a change of 2% in frequency at 50 mc represents 49 to 51 mc while the same percentage change at 200 mc means a range from 196 to 204 mc. So instead of considering gain only when designing the 50-mc Yagi, to get bandwidth the manufacturer must stagger the lengths of his elements and use other tricks that tend to lower the gain. This is why it is important to consider the bandwidth of low-band Yagis as well as the gain.

For example, one antenna may show a higher reading on the field-strength meter than another, yet the picture quality of the antenna with the lower reading may be better. This can happen with antennas designed for best possible gain (usually at channel center) instead of for the best average gain throughout the channel.

The most common Yagis have 5 or 10 elements. The choice is usually dependent on the physical limitations of the installation. For example, a 5-element channel-2 Yagi is approximately 8 to 10 feet long and 7 to 8 feet wide. A 10-element channel-2 Yagi has the same width but often exceeds 18 feet in length. Since the clamp for fastening the Yagi to the support tower is usually at the approximate center of the boom, the front director is over 9 feet from the support while the reflector is approximately 9 feet away from it in the opposite direction. This means that any load or wind thrust on the end has the mechanical force of a 9-foot lever at the support. This mechanical disadvantage can be overcome vertically with diagonal supports but cannot be protected against horizontally, as horizontal supports tend to detune the antenna.

Since the 5-element Yagis are much shorter, the problem of wind force or ice accumulation is not so great. For this reason, we suggest that 5-element antennas be used, especially on channels 2 and 3, if the weather is extreme. Fig. 2 shows a commercial type 10-element Yagi. This antenna was made especially for industrial use; its cost was a secondary consideration. Some

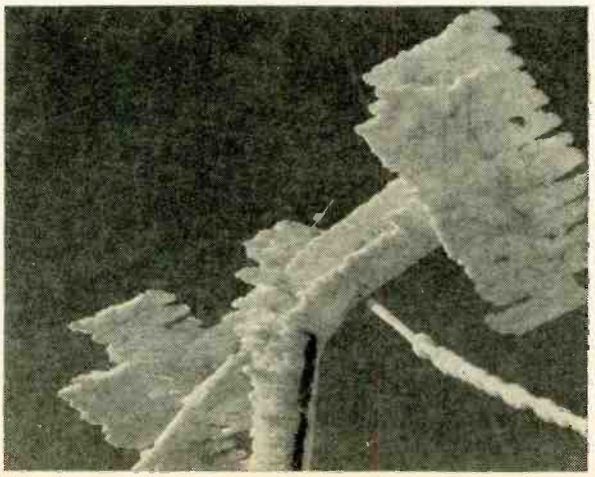


Fig. 3—An antenna array can collect a lot of snow and ice. This must be considered when choosing between 5- and 10-element Yagis.

Channel	Lbs Wind Thrust ¼-Inch Radial Ice 100-Mph Wind	
	5-Element	10-Element
2	157	323
3	143	294
4	130	269
5	115	236
6	106	218
7	52	108
8	50	104
9	48	101
10	47	98
11	44	95
12	43	92
13	42	90

manufacturers, however, recommend the use of 5-element steel antennas when the installation is exposed to extremely severe conditions.

Channel 7–13 10-element Yagis are approximately 6 feet long and 3 feet wide. On them the first director and the reflector are approximately only 3 feet away from the tower. A well-designed 10-element antenna of these dimensions is very sturdy and can be used under the most severe weather conditions (see Fig. 3).

Computing wind-thrust load

Home antenna failure inconveniences only one family, but failure of a commercial installation can bring the wrath of hundreds and even thousands of viewers upon the one responsible. The installer of a commercial antenna must therefore consider possible breakdowns from every angle. One particularly serious problem faced where ice is likely to form on the antenna, wind thrust, has already been mentioned, but it should be considered in more detail. The table lets the installer compute wind loads at 100 mph with ¼-inch radial ice.

The data in the table are based on Yagi antennas with ¾-inch elements. Thus, when ¼-inch of radial ice becomes affixed to the ¾-inch element, the total diameter of the exposed area is increased to 1¼ inches.

Wind-thrust loads of low-band Yagis are high, especially 10-element antennas. The observant installer gives careful consideration to wind loads when making a choice between 5- and 10-element Yagis.

Wind thrust is relatively unimportant, however, with a channel-7 Yagi, as the 10-element Yagi for this channel has a wind load of only 108 pounds. The 5-element channel-7 Yagi, of course, presents an even smaller load—52 pounds with 100-mph wind and ¼-inch radial ice.

The chart covers both aluminum and steel Yagis. Since steel Yagis use the same size tubing as the aluminum ones, the wind load at 100 mph with ¼-inch radial icing is the same. However, the tensile strength of aluminum is only 39,000 PSI, in contrast to 70,000 PSI for steel. So steel antennas may prove a better choice for areas where weather extremes are a problem. END

UNUSUAL TVI

By EUGENE W. KLEMM

I WAS called to service a Zenith portable TV an Air Force chaplain had bought for his family as a Christmas present. He lived on the base in one of the numerous temporary wooden barracks, and there in the living room I saw the new set resting on a cardtable, glittering like a jewel in front of the lavishly decorated Christmas tree. Standing in the doorway I could see nothing wrong with the picture on the screen, which was about as perfect as a pair of rabbit ears could make it. The chaplain walked across the room and then looked back at me. The picture went all to pieces with each step he took. "You see," he said, "everything's OK until one of us starts to walk around the room. Then, blooie! So what's wrong?"

I immediately suspected the antenna and examined it carefully for a loose segment or poor connection, but the trouble was not there. Probably in the set itself, I thought, taking the back off and plugging in my cheater. While the clergyman stood quietly before the set as an observer, I began a methodical tapping of each tube and all visible components, with no luck. The picture remained as stable as one would desire. The only thing that shook it was vibrating the floor. I raised the set, holding it in my arms, and stood perfectly still while my customer took several heavy steps about the room. With every step he took the picture practically disintegrated.

Suddenly my self-confidence (and a little of my dignity) returned. While replacing the back I told him that his trouble would disappear with the holidays. Standing up I pointed to the Christmas tree. I tried to explain to him that all of the hundreds of lead-foil icicles jiggled every time the tree shook, causing hundreds of little short circuits and interfering traps to the incoming TV signal. It was somewhat similar I supposed (rightly or wrongly) to the various devices used during the war to disrupt radar signals.

He was highly skeptical. "Frankly," he smiled, "I hope you're right. If you don't mind, I'll send you a check *after* we've taken down the tree!"

I received the check a week later with a friendly note.

A similar problem was solved very quickly not long after this, thanks to the Christmas tree. A flu patient complained that his 14-inch G-E portable suffered from intermittent jitters. When I was shown up to his bedroom, the set had a perfect picture . . "You just wait," he growled irritably, lying there in bed with his red eyes and runny nose. I waited. Just as I was getting the fidgets, the picture began tearing apart. He had an indoor antenna on top of the set. I went over and shook it, but quickly discovered the trouble did not originate there.

Remembering the other incident I looked about the room carefully before tearing down the set. A closet door was immediately behind the bureau which held the TV set. On the door were two or three metal racks about 2 feet long. Loosely hanging from the racks were a lot of metal hooks to which were fastened a dozen or two neckties. Right below was an open hot-air register, and the heat was blowing up, causing the ties to sway back and forth. By removing all the ties and thus quieting the little metallic contacts, the interference was stopped immediately. I reasoned that the heat coming on periodically caused the trouble to appear intermittently. I'm afraid I did the job a little too quickly and didn't exhibit the proper amount of befuddlement, because the patient gruffly announced that he was taking up TV himself if that was all there was to it! END

TV Service Clinic

conducted by

ROBERT G. MIDDLETON
RADIO-ELECTRONICS TELEVISION CONSULTANT

EXPERIENCED service technicians know that the response of the video amplifier is just as important to good picture quality as if or rf response. The video amplifier is the signal section between the picture detector and the picture tube. Poor video amplifier response causes fuzzy pictures, smear or circuit ghosts.

The best method of checking out the video amplifier is with a good video sweep generator. To get a look at some common faults in video-amplifier response, see Fig. 1.

The most common troubles are caused by damaged or incorrect-value peaking coils, or off-value load or damping resistors.

Other video amplifier faults also cause picture distortion. Typical are leaky coupling capacitors, open or defective screen and cathode bypasses, off-value screen resistors, or coupling between various peaking coils.

Dim raster

I have been working on a Westinghouse V2233-2 with a dim raster over the left-hand side of the screen. I am wondering if this could be picture-tube trouble. Voltages and resistances check out OK. Waveforms are all OK except at the agc keyer stage. Here there is a pulse with a spurious negative peak. If I remove the voltage from the cathode or grid of the picture tube, I get a complete visible raster.—W. A. P., Duquesne, Pa.

There are two possibilities to check out. The electron beam may have eroded the anode in the picture tube and distorted the electrostatic lens action. If so, a new picture tube is required. Or you may find on a scope check that spurious ac voltages are arriving at the picture tube with the dc supply voltages. The distorted pulse at the agc keyer points to a fault in the horizontal sweep system—possibly a defective capacitor.

Color convergence query

A couple of color TV receivers that are moved around a lot for different functions lose convergence. Is it absolutely necessary for us to adjust convergence with generators?—L. G., Chicago, Ill.

I have not been able to work out any satisfactory procedure for converging a set without a dot or crosshatch signal. No one I have spoken to has suggested any practical alternative. You can occasionally pick up a used dot or crosshatch generator at a reduced price. But, somehow, your shop must manage to acquire a generator.

Flyback burnout

In an RCA KCS-81 chassis, the drive waveforms have irregularities which appear to indicate parasitics. The flyback transformer is plagued with burnout; drive and linearity adjustments are critical. Drive lines are troublesome. —F. E. H., Kewaunee, Wis.

This report is typical of parasitic oscillation difficulties. Parasitics are fairly easy to control. The first approach is to connect 47-ohm resistors at the grid, plate, and screen-grid terminals of the horizontal output tube socket. By connecting these resistors in series with the socket leads, the Q of the parasitic loop is reduced. Connecting 47-ohm resistors in series with the leads to the damper socket may also help. In stubborn cases, small rf chokes can be placed in series with the resistors. Ordinary heater chokes are suitable. If necessary, also insert heater chokes in the heater leads of the output tube and damper.

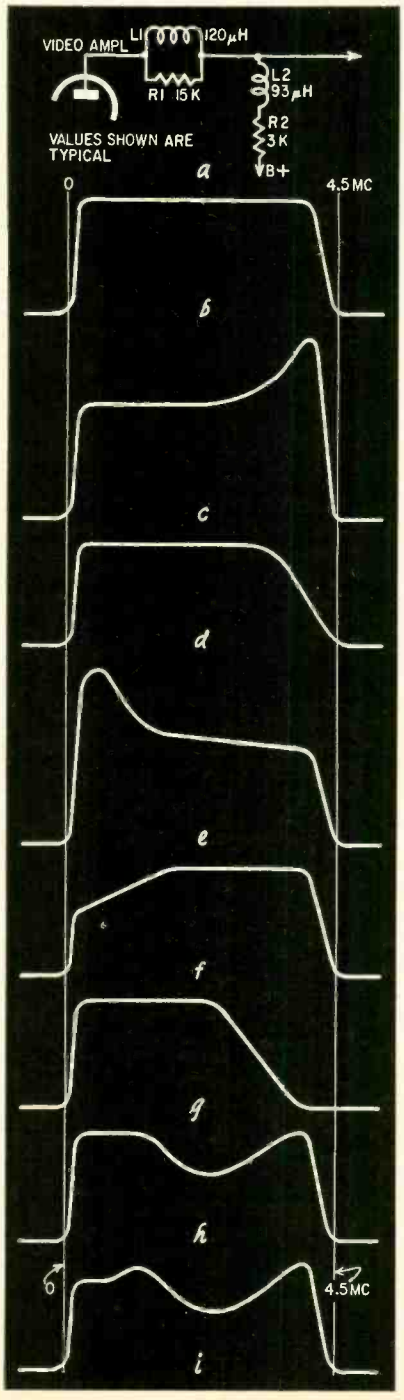


Fig. 1—Common faults in video amplifier circuits: a—Video amplifier load circuit. b—All load components have correct value. Response is flat to 4 mc. c—R1 too large or open. High-frequency peak causes ringing and circuit ghosts. d—R1 too small. High-frequency response poor. Picture lacks detail. e—R2 too large. Excessive low-frequency response. Picture has weak detail and tends to smear. f—R2 too small. Poor contrast in picture. Low-frequency response is down. g—L1 too large. Poor high-frequency response. Picture lacks detail. h—L1 too small. Poor mid-band response. Smaller picture areas smeared. i—L2 too large or too small. Uneven mid-band response. Smaller picture areas smeared.

Drifting tuner

In a Video Products 630 chassis, a Standard Coil cascode tuner drifts for 20 seconds whenever channels are switched. First a fairly good picture is displayed, without sound. But 20 seconds later, the picture is slightly deteriorated and the sound swings in. The customer's complaint is entirely justified. No offending parts or voltages are evident.—H. E. W., New York, N. Y.

The trouble is quite certainly in the local oscillator. I assume that the oscillator tube has been changed, perhaps several times. Plate-voltage variation in the local oscillator is sure to cause frequency shift. If you will check the plate voltage, you will probably find that its value changes during the 20 seconds after switching channels. An unstable component, such as an overheated or faulty resistor in the oscillator plate circuit, may be the cause.

Of course, an unstable leaky capacitor can cause the same difficulty.

Insufficient width

I am servicing an RCA KCS47A which has insufficient sweep width. Components and voltages check OK. There was a short in the power transformer, and I installed a separate heater transformer for the 6W4 damper. The picture is short about 3 inches on each side. If I disconnect the yoke lead from the damper heater, the picture is short only 1 inch on each side.—R. L., Hialeah, Fla.

This difficulty is caused by excessive stray capacitance to ground in the separate heater transformer. (See Fig. 2.) The dashed capacitor indicates the stray capacitance. The damper cathode is "hot" with 15,750-cycle pulses. Too much stray capacitance drains away the pulse voltage. A separate heater transformer is OK, if it has low capacitance from the heater winding to core and primary. The sweep width increases when the heater "floats" because the 6W4 heater–cathode capacitance is then in series with C. However, heater and cathode should be bonded to avoid breakdown of the heater–cathode insulation in the 6W4.

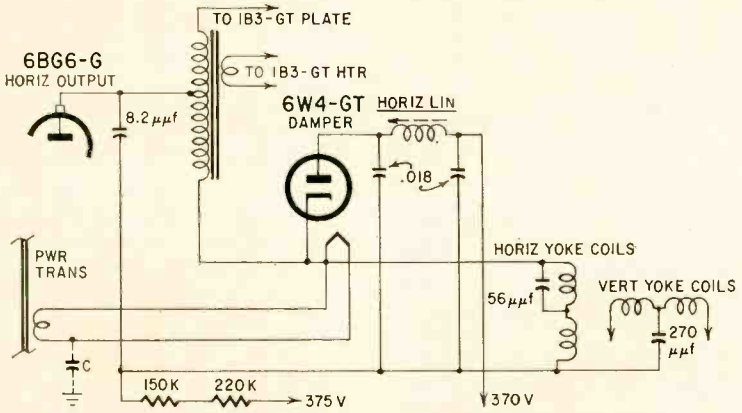


Fig. 2—The damper cathode is hot, and C must be kept small to avoid bypassing the ac sweep voltage.

Poor reception

I am having difficulty in getting satisfactory reception on a Zenith A2223Y when it is moved up or down stairs. The receiver seems to be OK otherwise.—H. A., Nevada, Ohio

The report does not state whether an indoor or outdoor antenna(s) may be involved. If the same antenna is being used, perhaps the lead-in is tapped, or is extended when the receiver is moved. If an indoor antenna, remember that field strength can vary considerably inside a building. On the other hand, if the lead-in is tapped, standing waves can cause different channels to respond differently at different tap points. A good two-set coupler should be used. In any event, attention to the antenna system is the answer.

Pix tube arcing

I have a DuMont RA-306-A14 on my bench that needed a new vertical output transformer and some capacitor replacements. Now, there is arcing in the picture-tube neck and under the yoke. There are flashing streaks horizontally in the picture and speaker noise as the brightness control is turned up.—J. E. G., Rio Piedras, Puerto Rico

The basic difficulty is probably a defective picture tube. Arcing to the yoke also breaks down the winding insulation and it is quite likely that the yoke will need replacement also. This is a more common complaint in color TV receivers, but it is not unknown in black-and-white chassis.

Vertical hold drift

I have an RCA 14-S-7052U in the shop. The trouble is vertical hold-control drift. The majority of components in the vertical section have been replaced. The peculiar thing about this difficulty is that the drift disappears when the chassis is on its side or upside down.—K. V. L., Madison, Wis.

This is pretty certainly a case of thermal drift. It would be advisable to check operation with a heat lamp radiating on the vertical circuit components. A soldering gun can be used to supply localized heat. This receiver has an extensive vertical oscillator circuit. The 6AQ5 output tube and its component parts are in the oscillator section. Heat checks should include these components.

Color trouble

Several technicians have tried to correct a dark vertical area on the right-hand side of the screen in an RCA CTC7A color receiver. The raster alone shows a dim greenish hue in this area, and with a picture present it becomes a brighter green than the rest of the screen. At times, with no picture present, the dark area is bordered by a distinct wavy line.—T. M. D., Fort Lauderdale, Fla.

From the report, it appears that there are spurious ac voltages in the dc supply lines to one or more of the picture-tube electrodes. This is definitely a job for a scope. Tune the receiver to a vacant channel, and check the dc supply lines for spurious ac. You can also apply a color bar signal to the receiver, and check the crankshaft signals at grids and cathodes of the pix tube for distortion. This signal-tracing approach should lead to the trouble without much difficulty (See Fig. 3).

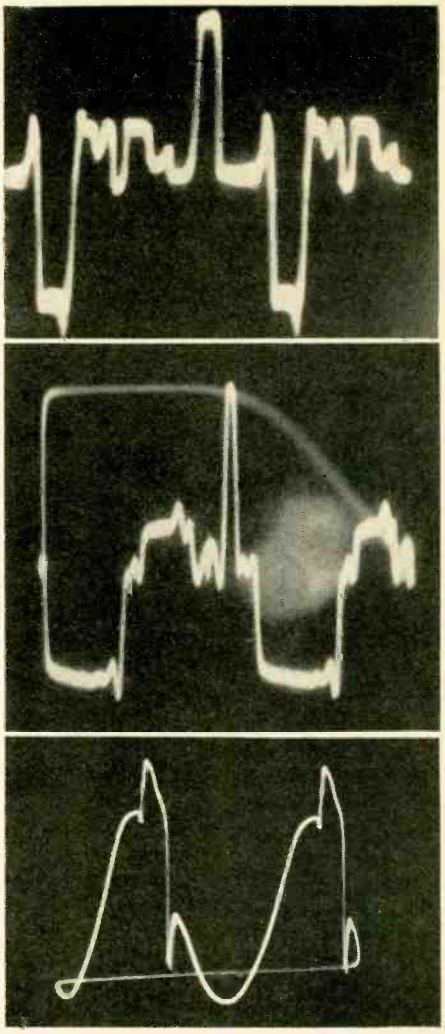


Fig. 3. Top—Distorted crankshaft signal at cathodes of picture tube. NTSC color bar signal. Middle—Distorted crankshaft signal at blue grid of picture tube. NTSC color bar signal. Bottom—Normal crankshaft signal at green grid of picture tube. Rainbow color signal.

Burning yoke resistor

A Motorola TS95 burns out the 100,000-ohm resistor in the yoke about once a year. The damper voltage is high, but within tolerance. I can't seem to find out why the resistor burns out.—(Initials withheld by request).

This trouble has a familiar ring. The 100,000-ohm resistor is shunted across the winding of the yoke (see Fig. 4). An intermittent open in the winding externally or internally places excessive voltage across the resistor, which then breaks down. If the open occurs in-

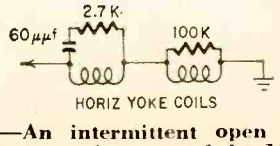


Fig. 4—An intermittent open in the winding causes burnout of the 100,000-ohm resistor.

ternally, the only solution is to replace the yoke.

Intensity-modulation markers

As an active technician, I should like to find out how to obtain intensity-modulation markers on a sweep response curve, using a separate marker generator.—E. R. D., Niles, Ohio.

The best method of developing intensity-modulation markers is shown in Fig. 5. The 1,000-ohm resistor from the sweep generator to the cathode follower provides isolation. The marker signal is mixed with the sample of sweep signal in the cathode circuit of the tube. The first 1N34-A circuit develops a "bug" voltage. The second 1N34-A converts it to a "blip." The blip has a low level and is stepped up by an audio amplifier to about 30 peak volts, for application to the scope's intensity-modulation (Z axis) terminal. Somewhat simpler configurations are possible, but they are not as free from interaction with the sweep signal.

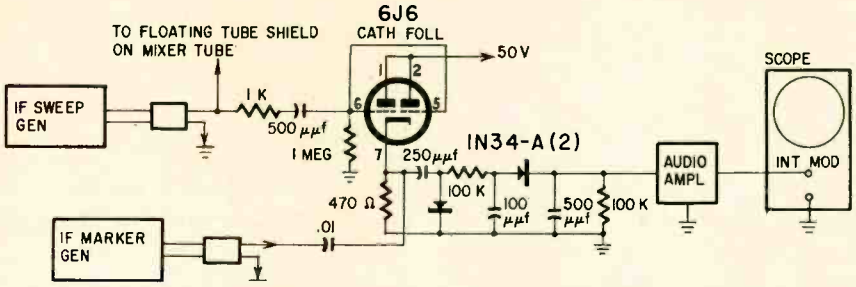


Fig. 5—An effective circuit to develop intensity-modulated markers.

Conversion question

Can the 16AP4-A in a Tech-Master 1930 be converted to a 21-inch picture tube?—J. M., Brooklyn, N. Y.

The 16AP4-A normally uses a 52° yoke, but you may find a 65° yoke in this receiver. If so, a 21EP4-B could be used with minor changes electrically. On the other hand, if a 52° yoke is present, you will need a standard conversion kit for the 21EP4-B. These kits have a schematic showing the necessary wiring changes. Try using the present vertical output transformer. It will give you full vertical height, if the B-plus voltage is ample. If height is lacking, you will require a heavier output transformer.

Probe stepup

How does a low-capacitance probe step up the input impedance to a scope without causing any frequency or phase distortion?—O. T., Los Angeles, Calif.

A low-capacitance probe works as illustrated in Fig. 6. The probe contains R1 and C1 in parallel. It works into the scope input circuit made up of R2 and C2 in parallel. We make time constant R1 times C1 equal to time constant R2 times C2. Or R1C1 = R2C2. We make R1 nine times larger than R2. Hence, C1 is only 1/9 C2. This gives a low-capacitance input and an attenuation factor of 10 to 1.

At low frequencies such as 60 cycles, we can disregard C1 and C2, noting that the attenuation is given by the ratio of R1 and R2. On the other hand, at high frequencies such as 1 mc, we can disregard R1 and R2, noting that the attenuation is given by the ratio of C1 and C2. Evidently, the attenuation ratio will be 10 to 1 at both low and high frequencies. To show that there is

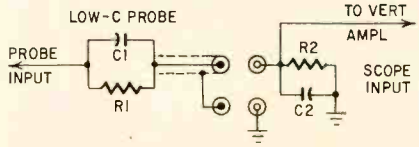


Fig. 6—Low-C probe uses a resistor and capacitor. When R1C1 = R2C2, we get low-capacitance input without frequency or phase distortion.

no frequency distortion or phase shift, you can set up the ac circuit equation, and note that the frequency term cancels out.

Demodulator probe

I would like some information on a double-ended demodulator probe, to make sweep-frequency tests. Can you give me a schematic of this type of probe?—J. V. F., Philadelphia, Pa.

A good configuration for double-ended rf test work is shown in Fig. 7. Keep the heavy leads short, for good rf response.

Conversion followup

Some time ago you suggested using a voltage-doubler high-voltage rectifier system to get more brightness on a 16-inch conversion, in an Olympic TV104. You noted that width might be reduced objectionably. It was as you said. I have an RCA 232T1 flyback. Could I use it to get additional width and maintain the brightness given by the voltage doubler?—E. L. H., N. Olmsted, Ohio

It would be advisable to use the components and wiring diagram specified for the Olympic 752. This uses the voltage-doubler circuit, and the components specified for the circuit will give you the desired width. The least amount of modification will be required, if this circuit is used.

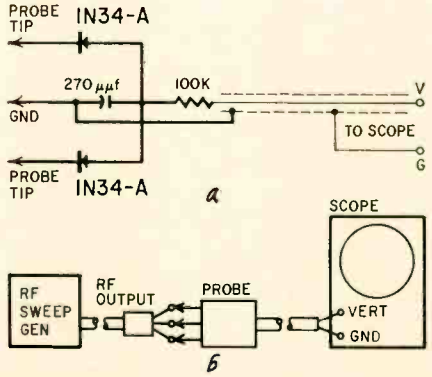


Fig. 7—a—Circuit for a double-ended demodulator probe. b—Typical application for probe in checking output from a double-ended rf sweep generator.

Dc restorer makes trouble

I installed a dc restorer circuit in a Hoffman receiver, but it made retrace lines much more prominent. The receiver uses B-plus to the picture-tube cathode. I dug up the enclosed dc restorer circuit (Fig. 8). Is it suitable? —W. L. J., Pasadena, Calif.

A dc restorer will make retrace lines more prominent if wired into the circuit with incorrect polarity. The circuit shown in Fig. 8 is a good one to use

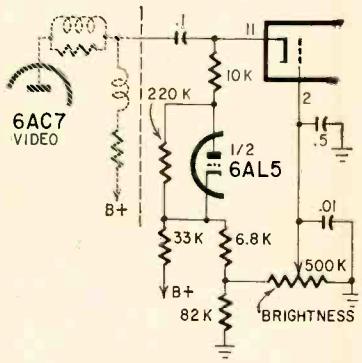


Fig. 8—A good dc restorer circuit for a cathode-driven picture tube.

with a cathode-driven picture tube. A correctly operating dc restorer reduces the prominence of retrace lines. END

DEAD LANGUAGE

By Anita Raskin

I remember, I remember,
In the dear old days gone by,
When a *screen* was meant to hinder
The intrusion of a fly;

I remember when *antennas*
Were the things we used to see
Waving gently from the forehead
Of a butterfly or bee;

And I recollect when people
Spoke of *snow*, and likely meant
Little flakelets, wet and chilly,
Swirling whitely in descent.

I remember, I remember
What those words once meant to me.
Ah! Those dear old definitions
In the days before TV!

COVER FEATURE

NUVISTOR
New kind of Electronic Tube

New construction technique leads to the nuvistor, a vacuum tube that can compete with transistors

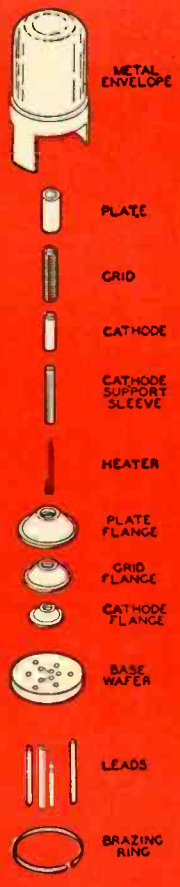


Fig. 1—Exploded view of the nuvistor triode.

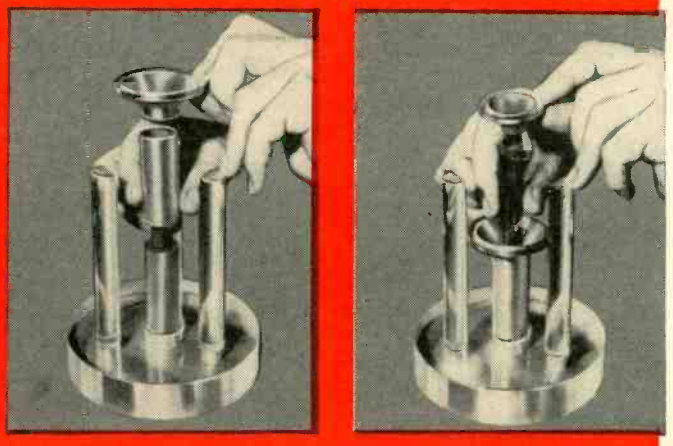


Fig. 2—Initial steps in the assembly of a nuvistor triode. An enlarged model is shown.

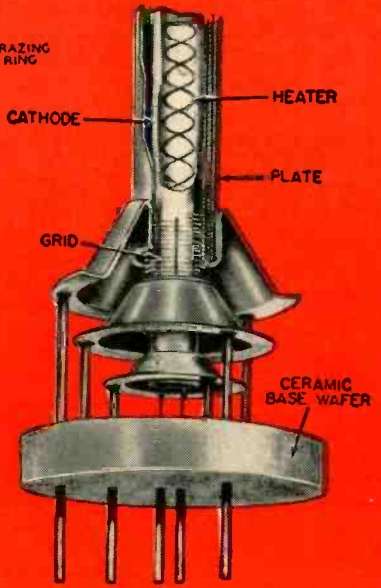


Fig. 3—The brazed assembly looks like this.

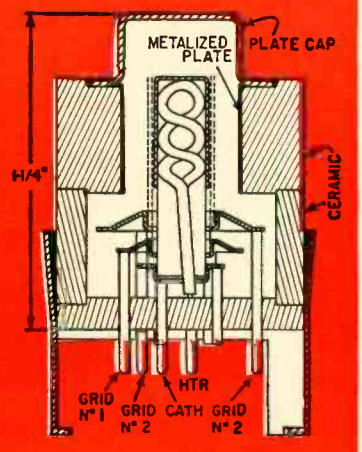


Fig. 4—Cutaway view of a nuvistor beam-power amplifier.

By LARRY STECKLER
ASSOCIATE EDITOR

A STANDARD electron tube with some new twists—the *nuvistor*—is expected to last longer and do a better job, while using less power. The glass envelope is replaced by a metal ceramic envelope. No mica supports are needed. It has no getter—doesn't need one. It lends itself to completely automated construction much more readily than a conventional receiving tube. In a TV tuner, it has operated satisfactorily with as little as 5 volts on its plate.

Let's start with what the nuvistor is. It is simply a vacuum tube in a new envelope, put together in a new way, that has been developed by RCA. The electrode elements slip into place on a simple jig. All electrodes are cylindrical and fit into each other. They are supported only at the bottom, in cantilever fashion—a technique which eliminates the need for mica support discs or spacers. All electrodes are small, light cylinders, and the assembled unit can withstand a lot of shock (850 G's) and vibration (2 G's at 5 kc) because of its shape and low mass.

Spacing between tube elements remains constant as spot-welding techniques used in the manufacture of standard tube types are eliminated. Spot welding is a source of residual strains that can twist tube elements. Its elimination reduces the possibility of shorts developing in the tube during operation. Eliminating spot welding also gets rid of a potential source of failure and an operation that requires a high degree of manual skill.

Assembly technique

The job of putting a nuvistor together is simple. You start with the parts shown in Fig. 1 to assemble a triode. An inexpensive jig is used to simplify and speed assembly. First the plate is slipped into place on the jig. The plate flange is placed over it. Next comes the grid and grid flange. (For greater detail, Fig. 2 shows some of the steps in assembling a large-scale model of the nuvistor triode.) The cathode support sleeve and flange follow. Now the heater is inserted in the base wafer

and the heater–base-wafer assembly is slipped into position. All leads and support rods for the elements are dropped into their respective holes in the base wafer.

Three evenly spaced supports (120° apart) are used for each electrode. Two of them end in the base. The third one continues through and becomes a tube pin. To aid in tube-element support and to insure an airtight seal, the ceramic base wafer is metallized. Then its top and bottom metallized surfaces are ground off, leaving a metallized surface on its edge and in the holes in the wafer. During the brazing operation, the walls of these holes fuse with the tube leads and element supports.

The brazing process is performed in a hydrogen-filled oven. Flanged edges where they contact the tube elements and the leads have a thin copper coating. In the brazing oven (at a temperature of about 2,060°F), the copper melts and fuses the various connections. Fig. 3 shows the brazed assembly in detail.

After brazing, the coated cathode is slipped over the cathode sleeve. The tube envelope, a metal shell, is placed over the internal element assembly and a final brazing ring is dropped into place. The unit is then placed in an evacuation oven. Air in the chamber is exhausted to a level equal to one-billionth of an atmosphere. Temperature in the chamber is about 1,600°F. As this outgasses the tube at a high temperature (a glass envelope would melt), the tube can be operated at a temperature in excess of those permitted conventional types. The high temperature also makes the getter unnecessary. (The nuvistor has withstood tests in the temperature range from −320° to 660°F.) After a suitable interval, the temperature is raised another 100° to about 1,700°F. At this temperature, the brazing ring melts, fusing the shell to the ceramic base, forming a hermetic seal.

Where to use it

Because of the nuvistor's high shock and vibration capabilities and low power consumption, smaller size and lighter weight, it will be especially useful in missiles, airborne, mobile and miniaturized equipment. However, it is also suited for portable radios, home and portable TV's and just about any other place a vacuum tube is used.

Triodes, tetrodes and beam-power types are in the works. Rectifiers, damper tubes and others are expected to follow. If the cold cathode (see "The Cold - Cathode Tube," RADIO - ELECTRONICS, April, 1959, page 98) becomes practical, it can be incorporated to lower necessary operating power further. For a size comparison between nuvistors and the tubes they are intended to replace, see the head photo.

Miniature vs nuvistor

Let's take the triode first and compare it to the 6BN4-A, a vhf, TV rf amplifier tube. Used for channel 13 (210–216 mc), the nuvistor delivers about 3 db more gain and has from 0.5 to 1 db better noise figure. This places the nuvistor in the same category as available TV tuner tubes using frame grids. Other experimental triodes having 0.5-mil grid wire are about another 0.5 db quieter. For this operation, the nuvistor had 40 volts and 7.5 ma on its plate, about one-third the voltage and current required by a 6BN4. The table compares some of the characteristics of the two types.

Nuvistor triodes also make excellent oscillators. Normal oscillator efficiency extends to 450 mc and oscillation is still strong above 1,000.

To get an idea of tube efficiency, tests were run with a 435-mc oscillator. Oscillation started with 7 volts at the plate. With a 15-volt supply, plate current was 1.6 ma and a grid bias of −0.55 volt was developed across a 3,300-ohm grid resistor. A lower-mu version (mu = 20) starts oscillating at 2.5 volts and gives similar performance with 5 volts at its plate.

The tetrode nuvistor follows a slightly different design. Its elements are assembled in the same manner, except that grid 2 is now where the triode plate would be located. The plate, connected to a metal cap, surrounds the cathode–grid assembly. The tetrode's walls are ceramic.

Performance data indicate that the tetrode nuvistor is suitable for use in if and rf amplifiers of TV receivers. The 6.3-volt heater draws only 140 ma and, while used as a class-A amplifier, only 70 volts need be applied to the plate and 30 volts to the screen grid. Transconductance under these operating conditions is 9,000 μmhos at a plate current of 5 ma.

Beam-power version

The tetrode just described is similar to the beam-power nuvistor (see Fig. 4). However, because of the tube's small size, heat dissipation becomes the major problem. Electrode areas in this size envelope are just too small for adequate heat radiation, so unique measures are required. The plate in the beam-power tube is a metallized surface bonded to the inside wall of a ceramic envelope. The ceramic conducts the heat from the plate to the outside of the tube. For additional heat dissipation, a heat sink, which could probably be the set's chassis, is needed.

Research seems to indicate that it is feasible to use a nuvistor beam-power tetrode as the horizontal output tube in a color TV receiver. This tube, rated at 30 watts, would measure only 1 inch in diameter and 1½ inches high. Such a tube would also have obvious applications in hi-fi amplifiers. As it would need a comparatively low-voltage supply, a rectifier connected directly to the line might do.

Other calculations predict efficient performance to about 400 mc, so rf tubes of this type become practical. A single class-C amplifier could handle about 100 watts (more with a special heat sink).

Current drawn by the heater of such a tube at 6.3 volts would be approximately 800 ma, noticeably lower than the 1.2 amps of heater current drawn by the 6DQ6. As the tube could take up to 5,000 volts of peak-positive pulse plate voltage, it is extremely well suited for use as a horizontal output tube.

COMPARATIVE TRIODE CHARACTERISTICS

(Class-A1 amplifier service)

	6BN4-A	Nuvistor	
V_P	150	40	75
R_G	500K	1 meg	—
R_K	220Ω	—	150Ω
μ	43	32	32
g_m (μmhos)	6,800	10,700	10,500
I_P (ma)	9	7	9
V_G	−6 for 100-μa I_P	—	−6 for 10-μa I_P

Interelectrode capacitances (μμf)

	6BN4-A	Nuvistor
Grid to plate	1.2	2.4
Grid to cathode heater and shell	3.2	5
Plate to cathode heater and shell	—	2.2
Plate to cathode	1.4	0.5
Heater to cathode	2.8	1.8

Transistor competitor

RCA's nuvistor also provides new competition for the transistor. It is only a little larger than some types and, since heater current has been reduced, it becomes practical in portable equipment applications. Then, too, spacings in the tube can be 50 times greater than those in a transistor and still give comparable performance. This makes the tube a lot more economical, as tolerances are not as close or as difficult to meet, making rejects less likely.

As the nuvistor operates at moderate voltages, components used in nuvistor devices are less expensive than those in ordinary tube circuits (higher voltage ratings make them larger and more expensive) or those in transistor circuits (high capacitances at low voltages call for expensive parts).

Unlike a transistor, which will break down completely and irreparably as soon as any one of its maximum ratings is exceeded, the nuvistor is capable of handling momentary overloads, just like any other vacuum tube.

In many amplifier circuits, the power required to run a nuvistor (heater, plate, grid current) scaled down to half of its present size can be reduced to 5% of that required by conventional miniature tubes. So while you may think that the transistor is putting an end to the vacuum tube, there is still a lot of tube life left. You'll be seeing vacuum tubes in your TV receiver for many years to come, although they may take on a new shape.

Although the nuvistor is only in the early advanced development stage, samples are expected to be sent to equipment manufacturers by the end of the year and limited production is expected to be in progress by the middle of 1960. END

SPACE RELAY STATION

A new era in electronic communications opens with this first out-of-the-world rebroadcaster

By JORDAN McQUAY

SUCCESSFUL orbiting late in December, 1958, of an Atlas missile–satellite carrying a communications relay station was more than a step forward in space exploration—it was the first advance in the science and techniques of global communication via a relay station in outer space.

Not merely a quasi-propaganda stunt of broadcasting a taped message by the President, it was a carefully planned and singularly successful experiment by military and industry engineers and technicians. It marked the beginning of world-wide communications using satellites in space as relay stations.

For the first time, voice and teletypewriter messages were accepted by a satellite in space, carried thousands of miles and, on command, broadcast directly to ground stations. For the first time, signals from earth were received by an orbiting relay station and rebroadcast over a greater range than possible with conventional ground-based facilities. For the first time, both the feasibility and importance of space relay communications were proven dramatically and conclusively.

Though the gigantic size of the Atlas missile that became an earth satellite was impressive, engineers and technicians were even more concerned with the scientific significance and historic importance of the first space relay station.

Known as Project SCORE—*S*ignal *C*ommunications by *O*rbiting *R*elay *E*quipment—the space relay station was an Army-designed communications "package" (Fig. 1) carried aboard an Air Force Atlas missile–satellite. During the 13-day life of Project SCORE, a variety of technical tests—using both a voice signal and as many as *seven* teletypewriter signals, singly and in groups—were conducted between the orbiting space station and ground stations of the Army Signal Corps.

First in space

The Atlas missile which placed the relay station in orbit was technically a 1½-stage rocket. In addition to its single engine, it used ground-fired booster engines which dropped off when the 4½-ton missile gained sufficient height and momentum. Equipped with an elaborate internal guidance system, the Atlas followed a calculated path, broke through the earth's lower atmosphere and went into orbit at a height varying between 120 miles at perigee and 620 miles at apogee.

Once in its elliptical orbit, the missile–satellite traveled at about 17,000 miles an hour, making vast loops around the earth once every 100 minutes.

After a dozen orbits, the space relay station aboard the satellite was triggered by an Army ground station and, for the first time in history, man's voice was broadcast to earth from outer space. It was a brief message by the President, previously fed to the relay station and stored for that broadcast.

Thereafter, the same message was transmitted from the ground to the orbiting relay station, where it was either rebroadcast immediately or stored by a magnetic tape recorder and rebroadcast later "on cue" from the ground.

Subsequently, single- and multichannel teletypewriter signals replaced the voice message. Using a bandwidth of 300 to 5,000 cycles, the space relay station continued to operate as either a "real-time" relay or a delayed repeater.

All signals broadcast by the orbiting relay station were transmitted on a frequency of 132 mc. The FM signals could be heard by anyone with suitable receiving equipment.

Control of the space station from the ground, however, was not a public matter. This control—loading, switch-

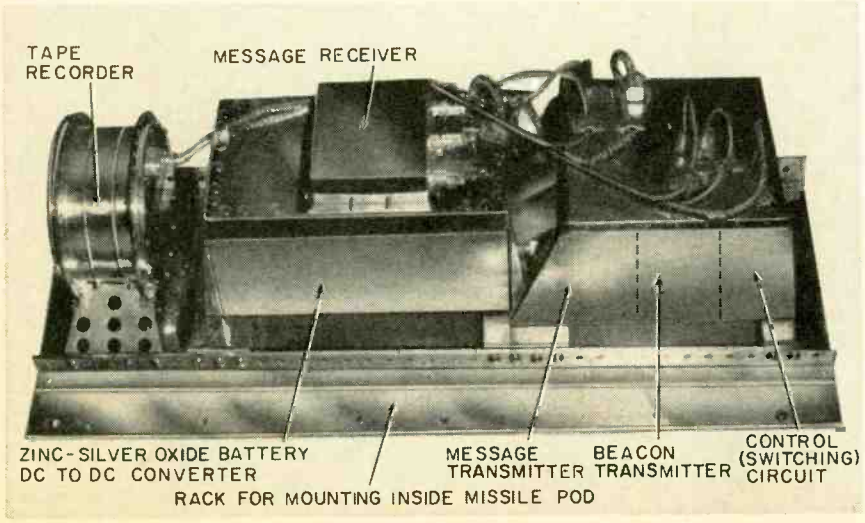


Fig. 1—Communications relay station: project SCORE.

US Army photo

ing and triggering—was limited to any of four ground stations of the Signal Corps strategically located at sites in California, Arizona, Texas and Georgia.

To prevent jamming or unauthorized use of the space relay station, the ground stations used an unpublicized frequency for transmitting orders and messages to it. In addition, a specially coded signal switched circuits within the relay station to establish any of three modes of operation:

1. Receive signals from the ground, and record them on magnetic tape;
2. Broadcast previously stored signals to earth;
3. Receive signals from the ground and rebroadcast them immediately.

With various types and volumes of traffic, testing each of these three modes of operation continued until the space station's only source of power—a battery of zinc–silver oxide cells—was exhausted. By that time, all scheduled tests of the entire system had been completed successfully.[1]

The space station

A complete space relay station is contained entirely within *part* of one of the two *pods* or elongated "fins" on either side of the main body of the Atlas. The main body, containing mostly fuel, is 10 feet in diameter and about 80 feet long. The entire payload is divided between and enclosed within the two flanking pods or fins.

Most important part of this payload is the space relay station—a single "package" about 25 x 9 x 10 inches (Fig. 1), weighing about 35 pounds. Controlled remotely and equipped with its own power supply, it is electronically independent of other parts of the Atlas. (See Fig. 3.)

The complete space relay station includes an FM message transmitter, an FM message receiver, a control or switching circuit, a magnetic tape recorder, a beacon or tracking transmitter, a dc-to-dc power converter and a zinc–silver oxide battery. Communications components are shown in Fig. 2. The outputs of the two transmitters and the input of the receiver are connected by a diplexer to a *single* slot type antenna in the housing of the pod or "fin."

The FM message transmitter operates nominally at a crystal-controlled frequency of 132 mc. With a complement of nine tubes, the transmitter delivers 8 watts of output power into an impedance of 50 ohms. Bandwidth limits are 300 to 5,000 cycles. Required input operating power is 39 watts at dc voltages of −6, 135 and 270.

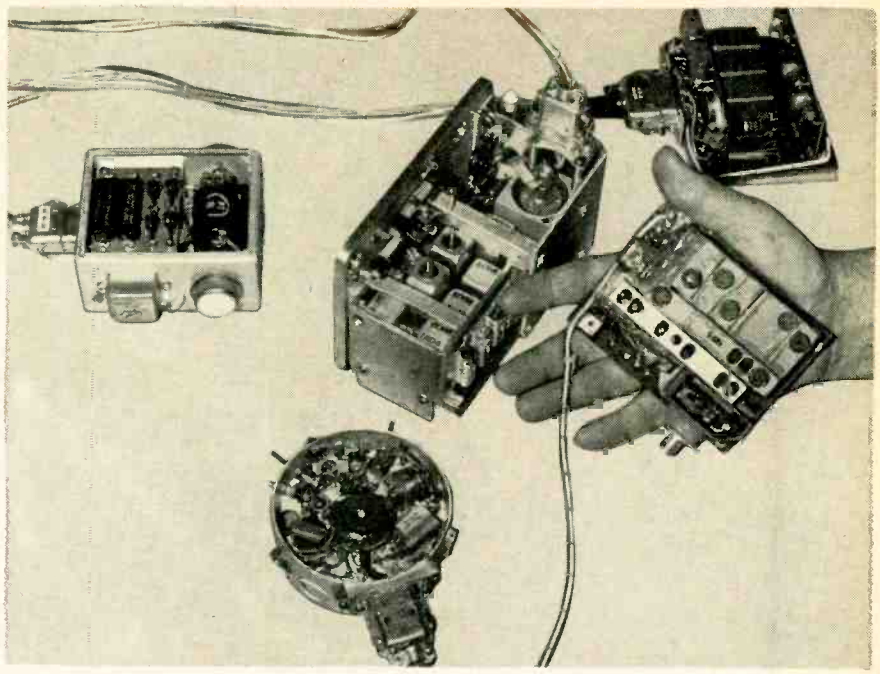
The FM message receiver operates at nominal frequency of 150 mc, in direct contact with the transmitter of each ground station. Receiver sensitivity is 2 microvolts. Its output level is 0.5 volt across 1,000 ohms—for a fully deviated signal. The receiver is an all-transistor unit and requires only 25 mw of input power.

The control or switching circuit is essentially an arrangement of selective filters that provide the three basic modes of operation. It is fully transistorized. When activated by appropriate command signals from a ground station, it provides any of four types of switching (Fig. 3).

The magnetic tape recorder is conventional, with a 4-minute storage capacity for audio signals or analog data within bandwidth limitations. This storage capacity can accommodate seven 60-word-per-minute teletypewriter channels, for a total of about 1,680 telegraphic words.

A second transmitter—known as a beacon or tracking transmitter—transmits a telemetered signal at a nominal frequency of 108 mc and is crystal-controlled. It has an output power of about 20 milliwatts into an impedance of 50 ohms. An all-transistor unit, it requires an input operating power of 250 mw at dc voltages of −6 and 18. The steady signal output of this transmitter permits tracking the satellite by Minitrack and other ground monitoring stations—including amateurs with appropriate converters for their receivers.[2] The output signal is also telemetered with temperature data from within the pod-enclosed space relay station. Temperature variations between 0° and 200°C are recorded directly and broadcast by this transmitter independently of other operations of the space station.

Primary power source for the station is a battery of zinc–silver oxide cells which provides dc voltages of −6,



RCA photo

Fig. 2—Electronic components of satellite: In hand, all-transistor FM receiver. Behind it, control or switching circuit. Large unit (center), 8-watt FM message transmitter. Left, power converter. Round unit (foreground), beacon transmitter.

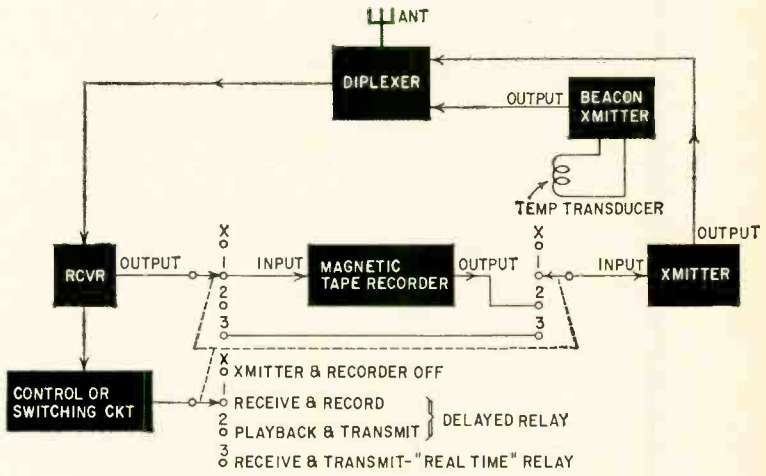
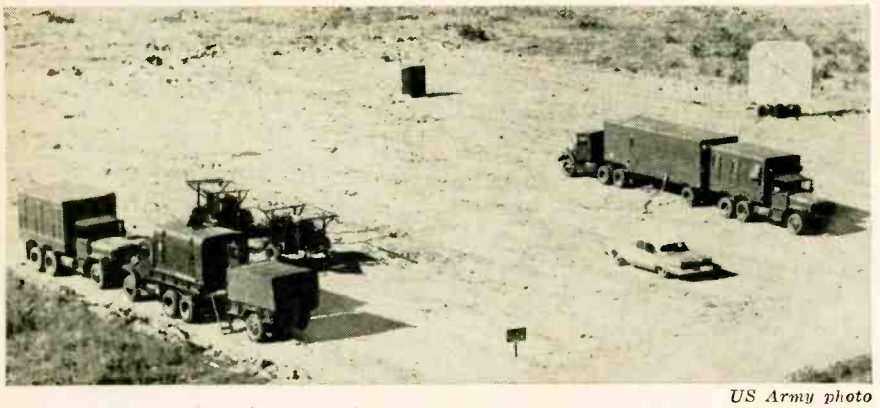


Fig. 3—Block diagram of space relay station.

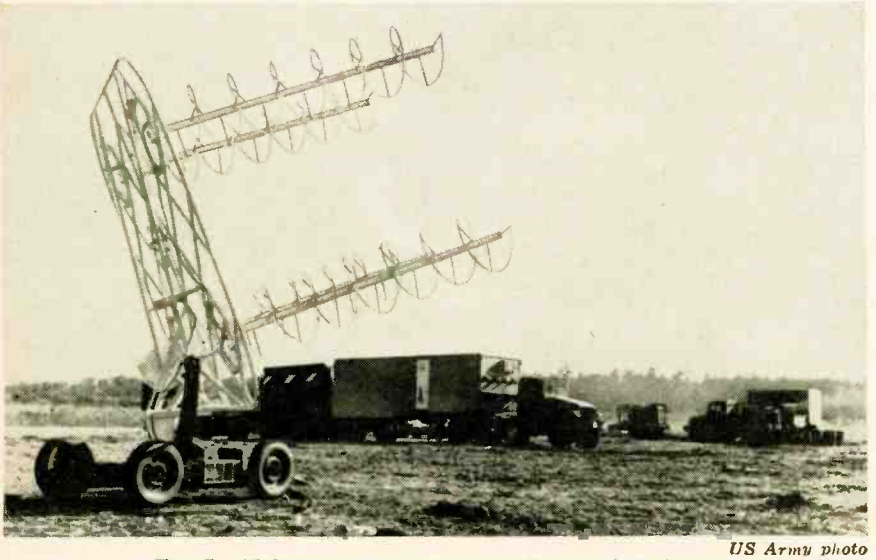
[1]Because its great weight could not resist the slight but continual pull of earth's gravity, the 4½-ton missile satellite gradually lost altitude and speed until, nearly 2 months later, it was consumed by frictional heat and disintegrated in the atmosphere above the earth.

[2]"Tracking US Satellites" by Jordan McQuay, RADIO-ELECTRONICS, December, 1957.



US Army photo

Fig. 4—Typical ground station of the system.



US Army photo

Fig. 5—Helix type antenna array of ground station.

−7.5, −12 and −18. Although these have a limited operating capacity of about 950 watt/hours, they were selected because of the anticipated short life of the missile–satellite and the relatively short duration of the planned communications experiment. Supplying higher voltages, an all-transistor dc-to-dc converter delivers 135 and 270 volts dc.

RCA developed most of the communications equipment of the space relay station in coordination with the US Army Signal Research and Development Laboratory at Fort Monmouth, N. J.

Relay of messages

The FM message receiver in the space relay station operates continuously. But the FM message transmitter and the magnetic tape recorder are switched on and off, as required, by the control or switching circuit. This circuit is actuated by a special coded signal, transmitted to the satellite by any one of the four Army ground stations.

Upon reception, this special signal causes a multiple switch to move to one of four positions (Fig. 3) to select any of three modes of operation.

In position 1, the magnetic tape recorder is turned on and its input connected directly to the FM message receiver's output. In this mode, signals received from the ground are recorded and stored on magnetic tape. With a continuous capacity of 4 minutes, the signals may be stored indefinitely for later use. Also, when directed by a ground station, all or part of a previously recorded message may be wiped clean from the tape in preparation for a new recording. After position 1, the control circuit moves the switch to position X. In this position, the output of the FM message receiver is disconnected from the recorder's input, and the recorder is turned off.

In position 2, the recorder's output is connected to the input of the FM message transmitter, and the tape recorder and FM transmitter are turned on. Messages stored on the magnetic tape are fed to and broadcast by the FM transmitter. After position 2, the switch moves to position X, which disconnects the tape recorder and the transmitter, and turns off both.

In position 3, the FM message receiver output is connected directly to the input of the FM message transmitter, and the transmitter is turned on for instantaneous relay of all signals. All signals received from a ground station are rebroadcast immediately by the FM message transmitter of the space station. After position 3, the control circuit moves the switch to position X, which disconnects the transmitter; but not the receiver, which operates continuously.

The sequence of positions 1 to X to 2 allows the space station to function as a delayed repeater or "courier" of messages. Between positions 1 and 2, there is usually a period of inactivity—a few minutes, a few hours or even longer. This permits a high degree of selectivity of transmission by withholding signal transmissions until the satellite is over or near the intended recipient.

In position 3, the space station functions as a "real-time" or instantaneous repeater. This permits the station to rebroadcast signals over greater ranges than possible for a ground station depending on conventional means of propagation of radio waves. With a space station sufficiently high in the sky, line-of-sight transmission is possible to most of the facing globe—nearly one-half the world. With several stations strategically placed in space, it would be possible to broadcast signals to the entire world.

The ground stations

Controlling the various operating modes of a space relay station and thereby functioning as key elements of the complete communications system are the several ground stations.

During the experimental tests, four mobile ground stations were operated by the Army Signal Corps: at Prado Dam near Los Angeles, Calif.; at Fort Huachuca, Ariz.; at Fort Sam Houston, Tex., and at Fort Stewart, Ga. All are similarly equipped.

Each ground station is housed in five trucks (Fig. 4), which collectively contain all communications, recording, control and power equipment. The antenna array is a separate unit (Fig. 5). See the block diagram (Fig. 6).

A *single* helix type antenna array is used for transmitting control signals and messages, and for receiving messages and beacon or tracking signals from the orbiting space station. Most of the other equipment, essentially conventional, is provided largely by RCA and other industrial firms.

A 1-kilowatt transmitter is used for sending messages and control signals from the ground station. Specially coded control signals are fed from a *programmer*. For messages, either a voice signal or from one to seven teletypewriter signals are used to modulate the FM transmitter. Multiplexing equipment can handle up to 60 words per minute, or a total of 420 wpm *plus* a voice or aural signal.

Messages broadcast by the space relay station are picked up on a highly sensitive but conventional communications receiver, and fed to a magnetic tape recorder, an aural reproducer or teletypewriter printers.

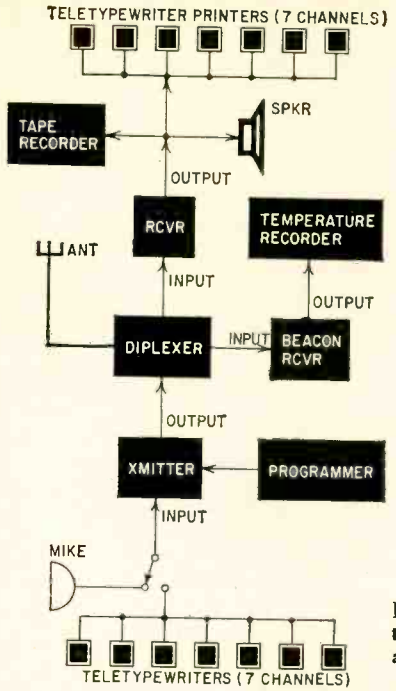
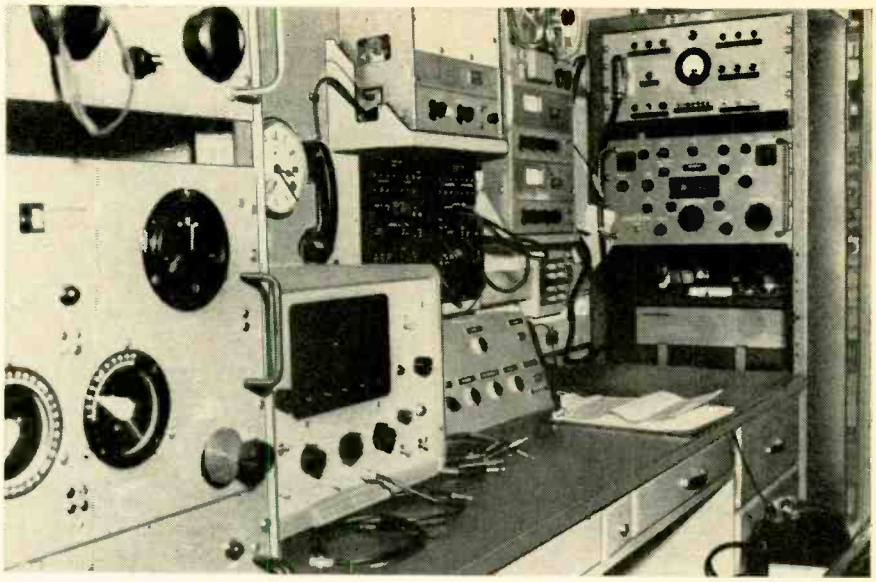


Fig. 6—Block diagram of typical ground station associated with space relay system.



US Army photo

Fig. 7—Control desk of ground station. Left: remote-control equipment for orienting helix type antenna array. Right: FM message receivers.

Beacon signals are received and recorded on facilities separate from the message-handling equipment. Telemetered data—temperature readings—are plotted graphically.

All operations of a ground station are monitored from central control desk (Fig. 7). The control points at all ground stations are linked together by wire and radio circuits to facilitate the rapid exchange of data.

Messages destined for an orbiting relay station can be fed to these ground stations over commercial facilities from any place in the United States. Then, when the satellite passes overhead or within range of a particular ground station, messages are transmitted to the space relay station for either storage and subsequent controlled broadcast, or immediate relay to other ground stations.

Into the future

Tests concluded by the Army Signal Corps prove the complete feasibility of space communications stations.

As delayed relays, future stations could provide highly selective transmissions to specific geographical areas. For long-range or global communications, such "courier" stations would require less operating power and fewer operating frequencies than now necessary. With improved space communications systems, tremendous volumes of messages can be stored, carried thousands of miles and released to ground receiving stations anywhere on earth. All this with greater security of transmission than is now possible.

As "real-time" relays, future stations could provide greater global coverage from fewer broadcasting "points." More extensive use could be made of the existing frequencies of the radio spectrum to provide world-wide communication during an entire 24-hour period rather than for optimum periods of favorable propagation between ground-based stations.

Thus, future space relay stations offer an important solution to the growing traffic jam in the radio-frequency spectrum. Messages can be transmitted easily on high frequencies that cannot be used for long-range or global communication between ground-based stations. Eliminated will be "skip effects" and day–night propagation problems of conventional long-range communication operations.

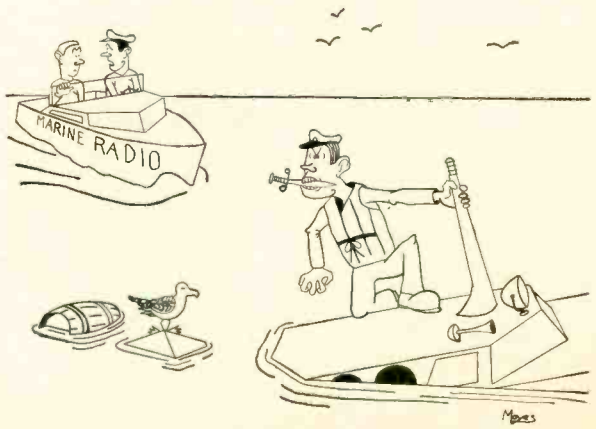
When required, future satellites can be controlled to hover as *fixed* radio relay stations. Four or five of these at strategic locations in space will assure communications with any part of the earth, no matter how remote or inaccessible.

Successful testing with a bandwidth of 300 to 5,000 cycles means that facsimile, telemetry and other signals can be handled by future space relay stations. And many messages multiplexed on a single operating frequency will also mean more available channels for ground-based radio communications.

With improved space facilities, television signals can be similarly relayed to any part of the globe by space relay stations. Such stations would require larger, and more complex and powerful equipment, and would require solar power units and appropriate converters for indefinite operation in outer space.

Future applications of space relay stations seem unlimited. And all of them loom suddenly into the immediate range of present possibility as a direct result of the Army Signal Corps' experiments with the world's first communications relay station in outer space.

A whole new era is heralded by this practical application of satellites—a major breakthrough in global and space communications! END



"I sure hate these callbacks on electrolysis!"

1959 convention plays up medical electronics, traffic safety and the human factor in industrial electronics

IRE Stresses Human Side

By ERIC LESLIE

STEADY advancement was the theme of the latest and largest convention of the Institute of Radio Engineers and of the engineering exhibition that accompanied it, held in New York City at the end of March. Revolutionary new ideas and startling gadgetry were at an all-time low. The engineers had taken outer space and machines that learn in their stride, and were turning back to earth for new worlds to conquer—the worlds of industrial electronics and the domain of man himself.

Foremost among the human-oriented engineers was Dr. Vladimir Zworykin, whose report on medical electronics stressed the triumphs of organization and the building of a bibliography. Greatest immediate field of progress in the medical field, he believed, was the use of computers as an aid to medical diagnosis. A properly programmed computer, he pointed out, could remember *all* the diseases to which a particular set of symptoms could be ascribed, whereas the best human mind is limited, fallible and affected by specialization.

On the gadgetry side, a dollar-bill changer was the most interesting item. The sponsors gave few details about the machine, either for patent reasons or possibly because they didn't want to help anyone make "bills" that might fool it. Since the device uses Hoffman solar cells, best guess is that a number of these "eyes" look at certain portions of the bill and contrast these portions with others. Selection of the points must be critical, since the changer accepts bills face up or down, and turned either way. It returns a $5 bill after pondering a few seconds, and is said to have rejected counterfeit $1 bills that passed cashiers. It also occasionally kicks back a good $1 bill that has a wider or narrower than normal margin.

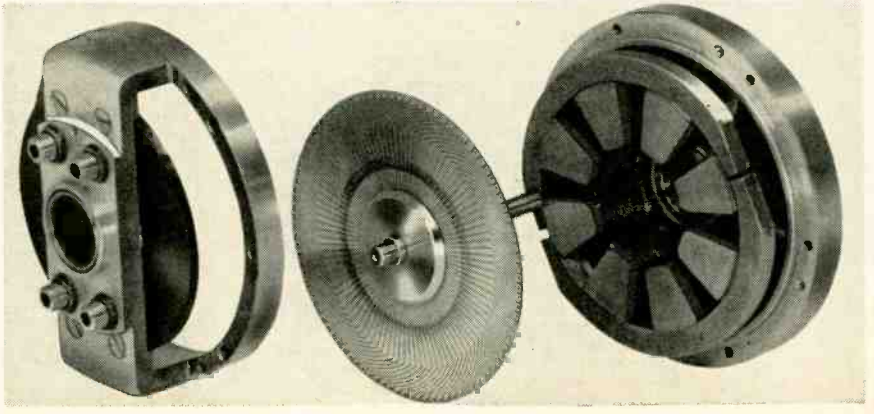
A new electric motor

Possibly the most interesting and important single item was a nonelectronic one—a printed-circuit motor. Its armature is a disc of heavy plastic in the order of 3/16 inch thick. Circuits are engraved on each side and connected through the disc at the edges. A dc machine, the commutators ride the flat portions of the printed strips, about halfway in from the edges. A disc about 18 inches in diameter was exhibited as the armature of a 30-hp motor. Motors of up to 1 horsepower were operating (at reduced voltages) at the show. Ac motors are also being developed.

New types of amplifiers were discussed in terms of the work they had already done. The use of a parametric amplifier in tracking our recent satellite beyond the moon was described. Representatives of the Signal Corps spoke of an airborne gas maser, which would bring the benefits of low-noise amplification up into the stratosphere. It would be applied to scientific work, and might even be used to check Einstein's general theory of relativity.

Traffic safety, too

An automatic system that might make it possible to drive a car from coast to coast without touching the steering wheel was described by two Westinghouse engineers. Radar equipment on the car would follow a guide line of conductive paint running down the center of the road. This line could be broken up into a dot-and-dash or other code, with different codes for branching roads, and the car radar programmed to select its own route.



The printed-circuit motor, showing armature, pole pieces and housing.

No tearing up of the road would be necessary, and the guiding radar would also act as an anti-collision device and handle the passing of, and being passed by, other cars.

Entertainment radio and television, once an important feature at the convention, was not entirely forgotten. A simplified system of color TV that would use two instead of three color cameras was described. One of the cameras is a luminance camera, the other picks up a red and a blue field alternately, and a memory device "holds" each field during the time the next one is being taken. Green is obtained by subtracting the red and blue from the total luminance field. The system, which is in experimental use at Iowa State College, simplifies the problems of color TV recording, would make it possible for a station to install color equipment much more cheaply, and might make it possible to convert existing monochrome cameras to color. Microcircuitry was carried almost to the molecular point, with "glob" circuitry and composite semiconductor units, some of which could be threaded through a needle's eye. One unit described in a conference paper is a semiconductor diode-triode with a common n-type base. The direct connection between diode and base, the RCA engineers who developed the unit explained, makes it possible to design circuits which provide an amplified agc voltage and contribute to a high agc figure of merit for the receiver. An experimental six-transistor superheterodyne using the new device as a detector-driver had a sensitivity of 200 μv/meter and a power output of 50 mw.

Human engineering

On the human side, communications between engineers and between them and the rest of the world was again stressed with a complete session devoted to engineering writing and speech. The papers were of a more practical and down-to-earth nature than those of the first session—held last year—and seemed to add up to the thesis that clarity equals good engineering writing. Two other sessions devoted to the non-electronic problems of the engineer were those on engineering management problems and techniques.

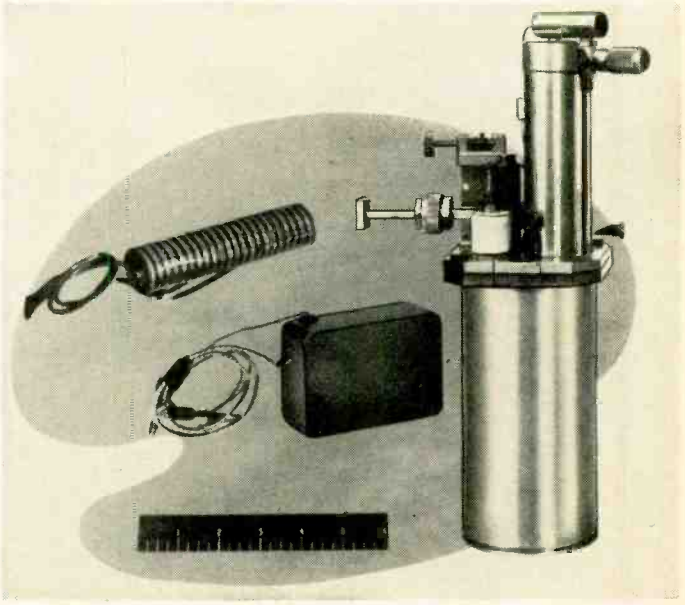
Another session was devoted to electronics in education. Electronic educators reported successes ranging from coast-to-coast television teaching networks to the successful use of electronic teaching machines in psychology courses. Greatest obstacle to be overcome, they reported unanimously, was the inertia of the professional educator, whose methods, one authority on both electronics and education reported with some bitterness, had not been changed much, even by the invention of the printing press.

Engineers and the future

The important half-day session "Frontiers of Industrial Electronics" pointed up the importance of the human factor more than any other. The triumphant electronic machines were mentioned only in passing. The problems of industrial electronics are problems of the people who will order, install, operate and maintain them. Psychological attitudes of plant management, labor organizations, even (in banks) of the customer, were discussed with considerable seriousness, as were other social implications of industrial electronification. Bank automation's chief concern, for example, is to get bankers to standardize check sizes and put the same information in the same places on all checks.

Even equipment reliability depends at least as much on people as on machines. An example of two banks with identical equipment was given. In one, the management was convinced that electronic equipment would never work—in the other, that it would introduce welcome efficiencies and savings. Both were right. In one of the banks roughly 25% of the electronic equipment was out of order at any given time—in the other, maintenance was negligible.

It appears that the electronic engineer will in the future have to take account of human beings at least as much as of circuitry and components if his work is to progress and succeed. END

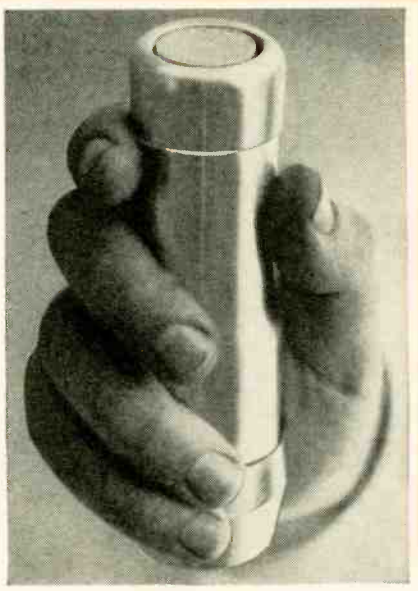


The airborne gas maser, a unit that will operate for hours without pumping, is a fraction of the size and weight of earlier ones. Battery and power supply at left.

Simply insert a dollar bill in the rack on top, push it into the machine, and the change is returned in the cup below.

ELECTRONICS HELPS THE MUTE TO SPEAK

A laryngectomy—removal of the vocal cords—literally, leaves a person speechless. But, with the aid of an artificial larynx, voice can be created



Artificial larynx made by Kett Engineering is a conduction type held against throat. Battery is built in.

By AARON NADELL

A NEW and expanding series of electrical and electronic devices has come into existence. It is flowering into still newer and even more ingenious varieties because surgical science is now saving the lives of victims of one variety of cancer. Formerly they died. Ex-President Grant did. Even with all the resources of a nation at the disposal of his physicians, they could not save him. Nowadays, however, sufferers from cancer of the larynx are often saved. If the diseased larynx is removed before the blight has had a chance to spread, the victim may live indefinitely. But he cannot speak. His vocal cords have been taken out. Various forms of artificial larynx—some illustrated here—have been developed to substitute for the vocal cords.

As the number of survivors of that particular operation increases, so does the demand for artificial larynxes. And with a growing market for them, inventors and manufacturers have found it economically possible to devise new and improved variations. Some of the latest use very recent electronic circuitry and devices. Earlier models were electrical rather than electronic, and the very earliest were not even electrical but mechanical only.

The vocal cords create an audio-frequency vibration in the air of the mouth cavity. The frequency is a few hundred cycles, varying according to whether the person has a bass, tenor or soprano voice. In short, the vocal cords can *sing*, but they cannot *speak*. Speech modulation is added by the lips, cheeks and tongue.

An artificial larynx supplies the audio-frequency vibration that was formerly furnished by the vocal cords of the larynx. Once this has been done, the tongue, lips and cheeks modulate the vibration in the ordinary way. The resulting speech is easy to understand, both directly and over the telephone. It has no inflection and therefore is a monotone, because none of the devices currently available is equipped for the continual change in tone frequency so easily obtained from natural vocal cords. Some existing devices have no tone adjustment at all. In others the tone can be reset, but not continually varied.

Learning to use an artificial larynx, regardless of its kind, is easy. The user simply talks. It is more difficult for a normal person to use one of the devices because he naturally adds the sound of his vocal cords and has to restrain himself consciously.

Types in use

All artificial larynxes available today fall into two general types with respect to the method used to get the air vibration into the mouth. Going by the method used to create the vibration, artificial larynxes fall into three general types.

Conduction or injection puts the vibration into the mouth cavity. For the latter, an audio vibration, however generated, is injected into the mouth cavity through some form of air tube, which the user holds between his lips—preferably in the corner of his mouth. In the conductive method, a vibrating surface is pressed against the throat underneath the chin. The vibration is mechanically conducted by the flesh of the throat to the base of the mouth underneath the tongue. The air inside the mouth is thus set into vibration. Since transmission loss in the flesh conductor is high, battery drain is also high in these devices. One such unit I measured operated at 1.5 watts. The demand of any injection type would be far lower, since normal speech power in ordinary conversation is in the order of 0.1 watt.

In the injection type of artificial larynx, the injector—the device held between the lips—is a rubber tube, a plastic tube, or some kind of disguised device. One of these, currently available in the US but manufactured in Italy, looks like a pipe, and the user appears to be smoking. There is no smoke but a simulated dull red glow shows inside the bowl. An American manufacturer of an injection type of electrolarynx, one which uses a plastic tube injector, has under consideration an artificial cigarette which will similarly disguise the injector. Many other variations are possible.

The conductive type of artificial larynx is manufactured in two forms. Both are convenient in size, roughly 1½ inches in diameter and about 4 inches long. One version is powered by a 6-volt dry cell carried in a jacket pocket and cable-connected, while the other is roughly half again as long and a cylindrical battery case forms part of it. The battery for this unit is a nickel-cadmium rechargeable type, and

a suitable charger is sold with the instrument.

Operating principles

The earliest form or prototype of the artificial larynx is not even electrical—it is mechanical. It is actuated by the user's breath, and depends on a vibrating reed, which is supplied in either of two pitches; one for men, another for women. The breath-operated reed produces air vibrations which are injected into the user's mouth through a rubber tube or similar means. There are at least two suppliers of this form of artificial larynx—the New York Telephone Co. and the Mayo Clinic in Rochester, Minn.

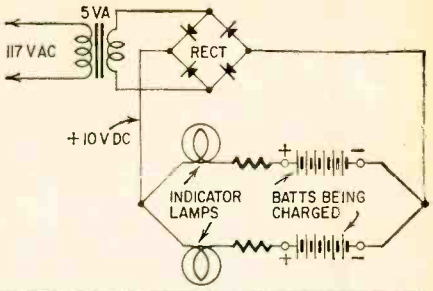
The artificial larynx manufactured by Aurex, Inc., of Chicago is electrical but not electronic. Basically, it is a solenoid with a free flying-shuttle armature. The excursions of the solenoid are limited by an adjustable stop. The frequency or pitch of the vibration is altered with this adjustment. The battery is a conventional 6-volt zinc-carbon dry battery, specially shaped to fit in a pocket. Formerly, the manufacturer also offered a 4.5-volt battery, but this has been abandoned. In earlier models, the connecting cord was permanently wired to the instrument and plugged into the battery. In more recent models, there are plugs at both ends. Standard radio type Cinch-Jones plugs and jacks are used.

Since the special battery with its Cinch-Jones connectors is sold only by Aurex, some users, especially when they find their batteries are weak and no replacements are close at hand, have made their own batteries. This is done by wiring four standard flashlight cells in series, breaking the connector away from the exhausted battery and wiring it to the four-cell substitute. The average user may not be able to do this for himself, but any RADIO-ELECTRONICS reader could do it for him.

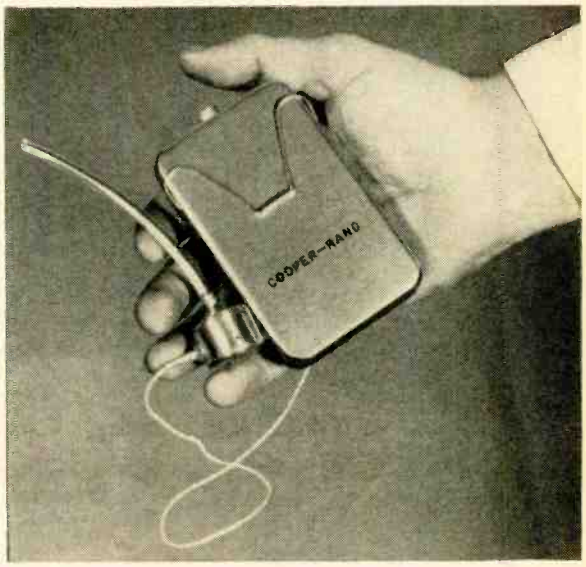
Naturally, the special battery sells at a special price, leaving an extremely substantial margin between its cost and the cost of four flashlight cells. The larger ones last longer, but are heavy and clumsy. The smaller penlight cells are lighter and more convenient, but have a shorter service life.

Aurex also makes a battery eliminator which conserves battery life, by letting you use the 117-volt line for power in office or home.

A similar instrument, with battery case part of the hand-held unit, is made by Kett Engineering Corp. of Santa Monica, Calif. Its batteries are made by Gulton Industries, Inc., of Metuchen, N. J. The cordless electrolarynx is sold as a package with a carrying case adapted to contain the instrument, a battery, two spare batteries and a battery charger. The charger plugs into any 117-volt ac line, and the user is cautioned to leave the cover of the carrying case open during recharging. On the other hand, batteries may be left on charge as long as 3 months with no harmful effect on their lives. According to the manufacturer, the charger uses "less power than one Christmas tree bulb." The size bulb is not stated.

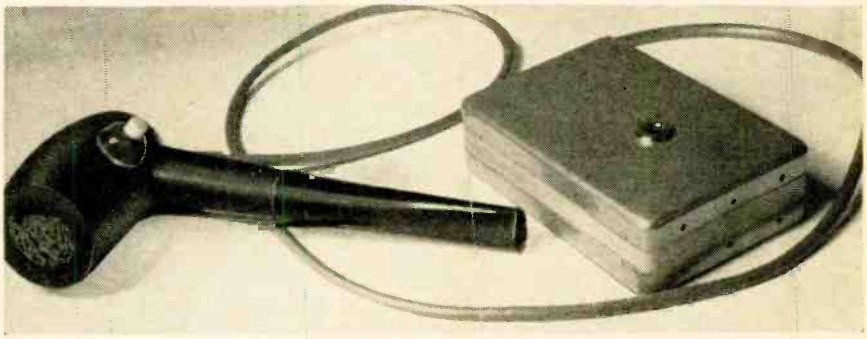


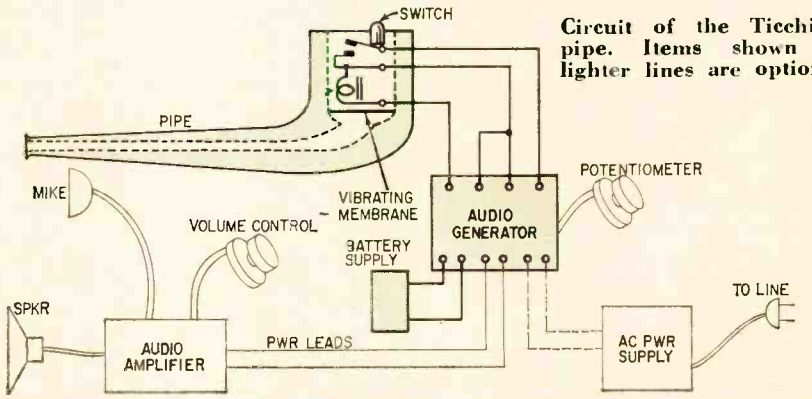
Battery charger that accompanies the Kett Engineering artificial larynx uses this circuit. The charger will supply the recommended charging current for either one or two batteries.



Cooper-Rand makes this injection type unit.

Disguised as a pipe, the electrolarynx is made in Italy by Ticchioni.

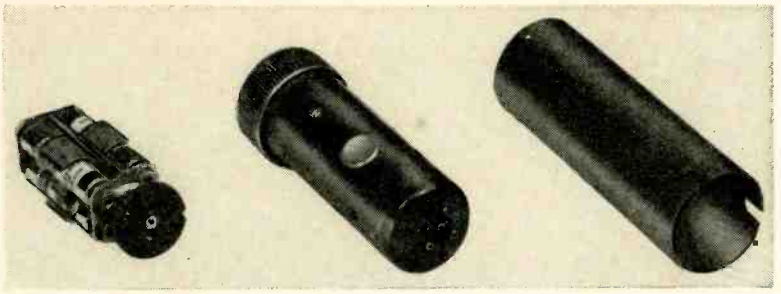




Circuit of the Ticchioni pipe. Items shown in lighter lines are optional.

Of very late design, the Cooper-Rand Speech Aid combines transistors, miniature components and printed circuitry. It consists essentially of two components. One is an electronic pulse generator, measuring 4¼ inches in its largest dimension and weighing 7 ounces. It is carried in the pocket or the hand. The other component is the tone generator or loudspeaker, 1 inch in diameter and 1 inch deep. A 4-foot length of light thin cord interconnects the two. A plastic tube fits into the tone generator and conveys the air vibration to the mouth cavity.

Among its other features, the Cooper-



User-devised battery case for Aurex electrolarynx using four No. 912 penlight cells and eliminating heavy pocket battery and its cord.

Rand instrument has miniature, radio type tone and volume controls. The tone control can be set to suit the user's preference but does not provide the continual tone variation of the natural vocal cords. The volume control is an important improvement from the user's point of view, since without it the artificial speech is sometimes inaudibly weak in noisy locations and embarrassingly loud in quiet ones. The Cooper-Rand volume can be adjusted with a touch of the thumb.

The Speech Aid is supplied in a simulated leather-covered partitioned box measuring 6 x 4 x 3 inches. It consists, complete, of the transistor pulse generator, the tone generator, the interconnecting cord, a spare cord, 10 plastic tone-generator tubes, two spare batteries and an instruction booklet. Price is $200. It is manufactured by the Rand Development Corp. of Cleveland.

Camouflaged unit

The Ticchioni pipe, product of Ticchioni of Milan, Italy, consists of a battery-driven electronic frequency generator and a magnetic transducer that converts the electrical frequency into audio or air vibrations. The transducer is concealed in the bowl of the pipe. The press-to-talk button is located at the side of the pipe just where a smoker's thumb naturally rests. The frequency generator is worn in the pocket. The tone of the Ticchioni pipe seemed to the present writer superior to—more natural and more pleasing than—the tone of any of the other speech aid devices described here, excellent though some of them are. The complete unit includes both a battery charger and a battery eliminator. The most recent price quotation in my files is $350, FOB, New York.

The extent of the need for these devices is difficult to estimate. The pharmaceutical house of Pfizer estimates that 6,000 patients yearly develop this disease of the larynx in the United States. Some of these are treated by lesser operations that do not completely deprive the subjects of their power of speech, others cannot be saved. Still others learn to speak without instruments by a process called esophageal speech—a kind of artificially induced, controlled belching which supplies the air vibration for a monotone speech output.

This is a very difficult process to learn and some patients never do. No source questioned has been able to supply estimates of the number of surviving "laryngectomees" in the United States nor of the rate at which their number is increased each year by new operations. Some very rough guesses, based on the Pfizer estimate and on some other data—such as instrument serial numbers—suggest that there may be 30,000 surviving American victims; that at least 15,000 of them have not been able to learn esophageal speech or at best can use it only in an indistinct, bubbling way, and that fewer than half of these have recourse to any kind of artificial speech aid.

These aids would be used by more who need them if their price could be reduced, but the prices reflect insurmountable distribution costs. Potential users exist everywhere; they are not concentrated for economical sales approach. There is no specialized publication in which manufacturers can advertise specifically to them. But electronics technicians who number one or more such persons among their neighbors or friends may wish to give them some assistance. END

Service Techs Report on Printed Boards

LACK of accessibility is the greatest fault of today's printed circuitry, followed closely by board breakage. This is the majority opinion culled from 1,870 questionnaires returned to the National Alliance of TV & Electronic Service Associations (NATESA). Of 90,660 service calls made the week previous to the survey, about 0.5% were reported to be due to failures of printed wiring boards. What those answering would most like to see would be better instructions from the manufacturers on repair techniques.

Specific complaints were led by poor accessibility, followed by difficulty of pinpointing just which component on the boards has failed. Conductors lifting off the boards, and boards breaking were also mentioned frequently.

Questioned about the boards appearing in radio and TV sets recently, those answering split evenly as to whether or not they represented improvement over earlier boards. And slightly over half said that printed-board sets require more servicing than sets without boards.

These and other responses to questions indicate serious concern, on the part of working technicians, over the printed circuitry now found in a large portion of the radio and TV sets being made. The technicians were asked what changes they'd like to see in current printed circuitry. Their answers are interesting in the light of changes that manufacturers state they are making or will make in the near future (see Technicians' News, page 91)

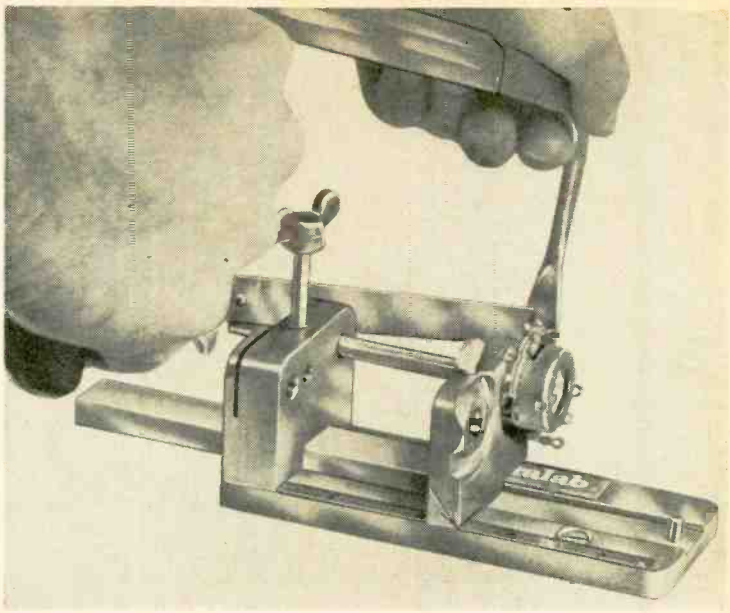
Of those answering, 90% said it's harder to trace the circuit through printed boards than through conventional construction. And the majority also said that the most important change they'd like would be to have better or more complete service instructions on printed-board sets. Over half of them would like to see receivers use three or more small boards instead of one or two larger ones. This is apparently related to the problem of accessibility of the boards and ease of circuit-tracing. And 57% of the technicians would like to see all components mounted on just one side of printed boards. Almost 60% preferred terminal-strip construction to printed-board circuitry in TV sets, but one-fourth felt that it didn't matter which construction is used.

It was pointed out that printed wiring of the B-plus circuit makes tracing trouble there much more difficult than it is in conventional circuitry because it's almost impossible to lift components one at a time, isolating the trouble by narrowing down the area. One manufacturer, Westinghouse, has already indicated its cognizance of this problem in announcing it will use wire jumpers to connect various branch circuits in the B-plus system.

Other companies promising specific improvements include RCA, G-E and Philco, who along with Westinghouse have stated they'll print schematics on one side of the boards. And Sylvania has announced a printed board which is extremely flexible to help reduce breakage problems.

Of the 1,870 technicians returning the questionnaires, 1,400 were NATESA members and 460 were not. There was little variation between the answers of these two groups. Two-thirds of the men who answered the questionnaire felt that the percentage of printed-board failures during that week were normal and would have happened even if standard wiring had been used. END

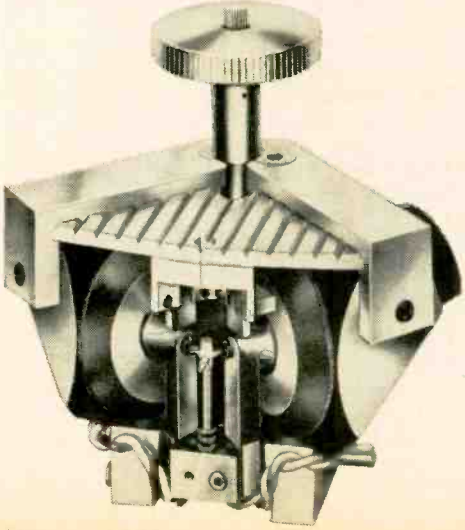
what's new?

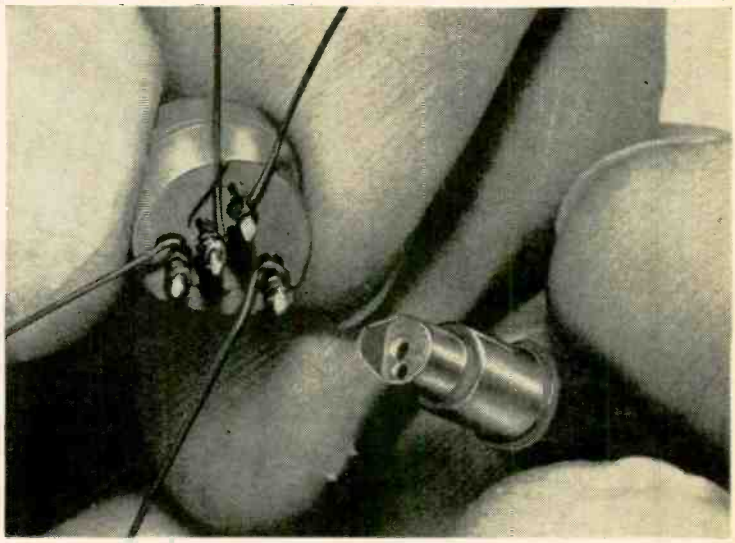


SHAFT-KUT, a new jig for the busy repairman, is designed to save time while promoting accuracy and workmanship in cutting control shafts to length. It has a rule for exact measurement of the shaft and a slot into which the hacksaw blade is inserted when cutting the shaft. A smooth, square cut and a shaft of the correct length are thus guaranteed. Manufactured by Centralab.

MINIATURE HEARING AID worn inside user's ear is size of man's thumbnail, has no external cords, connections or parts. Weighing ½ ounce, using three transistors, it amplifies 400 times. Sound is reproduced by small headphone (integral with aid) whose coil has 1,100 turns. Made by Sonotone Corp, Elmsford, N.Y.

STEREO DISC CUTTER viewed from below shows clearly how two coils suspended 90 degrees apart inside powerful magnets move the business end of a cutting diamond to cut 45/45 grooves. Feedback from head to power amplifiers corrects for mass resonance of stylus assembly, flattens response to 20 kc. The large knob enables recording engineer to position the head precisely for angle and depth of cut. Developed by Bogen-Presto, Paramus, N.J.





WIRING SUBMINIATURE SOCKETS is eased and speeded by new "solderless" wrapping tool which spins wire around each terminal of socket. Three quick motions are needed to do the job. This leaves a secure connection requiring no soldering. Tool is made by Winkler Laboratories, Phoenix, Ariz.

TWO-WAY STEREO AMPLIFIER

...uses only 3 tubes

By EDWIN BOHR

FOR about $25 you can build this good-quality, push-pull stereo amplifier. Despite its small size, quality is good, output is adequate, and inverse feedback is used to good advantage.

The chassis will fit into most portable player cabinets, making the unit an ideal replacement amplifier. Completely compatible operation with monaural records is built in—no stereo–monaural switch is needed.

A high ratio of quality per dollar results, since this is a *single* push-pull amplifier (handling *both* right and left stereo channels) and not just two separate single-ended amplifiers mounted on the same chassis.

This is possible, since 45-45° record cutters produce a groove in which lateral movement represents the sum of the two channels, and vertical movement corresponds to the difference between the two channels.

A four-terminal 45/45 stereo cartridge or a special out-of-phase three-terminal CBS ceramic cartridge can be connected to provide push-pull output for lateral movement and parallel output for vertical movement. Two output transformers, one connected in push-pull and the other in parallel, recombine the sum and the difference signals into right and left signals through suitable voice-coil connections.

Play an ordinary *laterally cut monaural* record and the amplifier acts like a conventional push-pull unit, feeding the same signal to both speakers. Play a *vertically cut monaural* transcription and the amplifier becomes a parallel type, but again feeds the same signal to both speakers.

Lateral signals (push-pull) do not appear in the parallel output. They are cancelled at the center tap of the push-pull output transformer T1. Similarly, vertical (or parallel) signals flow equally through the two halves of the push-pull transformer and appear across only T2.

Place a stereo record on the turntable and the combined lateral and vertical stylus movement will cause each speaker to be driven by a particular combination of the sum and difference signals. The two combinations of sum and difference signals, of course, correspond to the left and right stereo sound channels.

Readers interested in more detail should consult the article "2-Way Stereo Amplifier" in the December, 1958, issue of RADIO-ELECTRONICS.

Construction steps

The circuit is simple and uses few parts. Once the chassis is punched, construction time should not exceed a couple of hours.

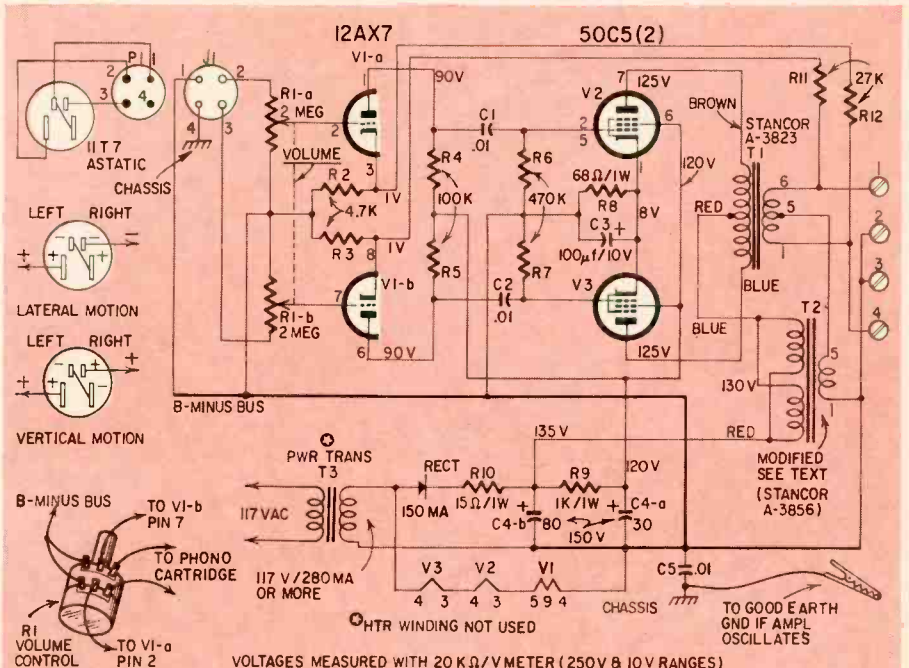
The output transformer wiring, however, will not be obvious unless you are completely steeped in stereo theory.

BENCH TESTED

Used with relatively high-efficiency speakers, this unit could give good performance at moderate cost.

Working into resistance loads, the amplifier delivers about 1.3 watts into each of two 4-ohm outputs before serious clipping starts.

Although frequency response and distortion level do not meet high-fidelity standards, the unit is satisfactory for its purpose—a simple, inexpensive, low-power stereo amplifier.



R1—pot, 2 megohms, two gang, linear taper
R2, 3—4,700 ohms
R4, 5—100,000 ohms
R6, 7—470,000 ohms
R8—68 ohms, 1 watt
R9—1,000 ohms, 1 watt
R10—15 ohms, 1 watt
R11, 12—27,000 ohms
All resistors ½ watt 10% unless noted
C1, 2, 5—.01 μf, 400 volts
C3—100 μf, 10 volts, electrolytic
C4—80–30 μf 150 volts, electrolytic
J1—4 prong female connector
RECT—130 v, 150 ma, selenium
T1—universal-output transformer, 8 watt (Stancor A-3823 or equivalent)
T2—universal-output transformer, 4 or 8 watts, modified, see text (Stancor A-3856 or A-3823, or equivalent)
T3—power transformer, 117 v, 280 ma (Stancor P-8336, Merit P-2871, Stancor P-6410 or equivalent)
Chassis (see text)
V1—12AX7
V2, 3—50C5
Tube sockets, 7-pin miniature (2)
Tube socket, 9-pin miniature
Miscellaneous hardware

Fig. 1—Two output transformers give the circuit an unusual appearance. If a shielded cable is used between the cartridge and J1, connect the shield to pin 4 of the jack.

For example, assuming the center tap of T1 cannot be connected wrong, there are four possible combinations of voice-coil wiring (or phasing) and three of these are wrong.

For this reason, complete connection details are shown, including terminal numbers and color codes (Fig. 1). Use the parts specified, follow the diagram exactly, and there should be no trouble.

The exact terminal numbering and phasing for the specified transformers is in the diagrams. It is possible that another manufacturer, producing an equivalent transformer, may use different terminal markings for the start and end of the windings.

The parts layout is shown in the photographs. The chassis is bent-aluminum channel 2 x 6 x 3 inches and represents a minimum size. A regular 2 x 6 x 4-inch chassis will give more working room. If you intend to modify an existing amplifier to this circuit, and space is cramped, the output transformers can be mounted someplace other than the chassis. In any event, keep all output-transformer and voice-coil leads well away from the input and phono leads. Otherwise, ultrasonic parasitic oscillation may develop. Connecting the chassis to the B-minus bus at the point where R1 ties to the bus will reduce possibility of hum or oscillation.

Make sure that resistors R11 and R12 are connected to the voice coil and cathodes of V1 as shown in the schematic.

Deposited-carbon resistors are used in several places and may be visible in the photographs. However, they are not necessary. We simply had plenty in stock and did not worry about the cost.

Wire the volume-control sections so the resistances from the moving contacts to the negative side of the power supply change in unison.

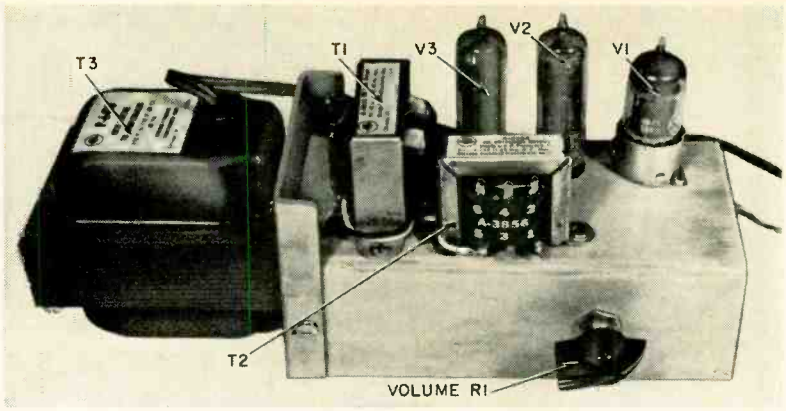
To preserve the push-pull amplification balance, the volume-control sections should match as closely as possible, both total resistance and resistance vs rotation. Off-the-shelf sections normally vary in total resistance about 25%. A front and back section, closely matched in resistance, may be chosen if the jobber will let you check several with an ohmmeter.

Even then, the two sections may not track very closely. Linear pots seem to track better than audio-taper units and are recommended. There is nothing objectionable about the volume-control characteristic of a linear potentiometer.

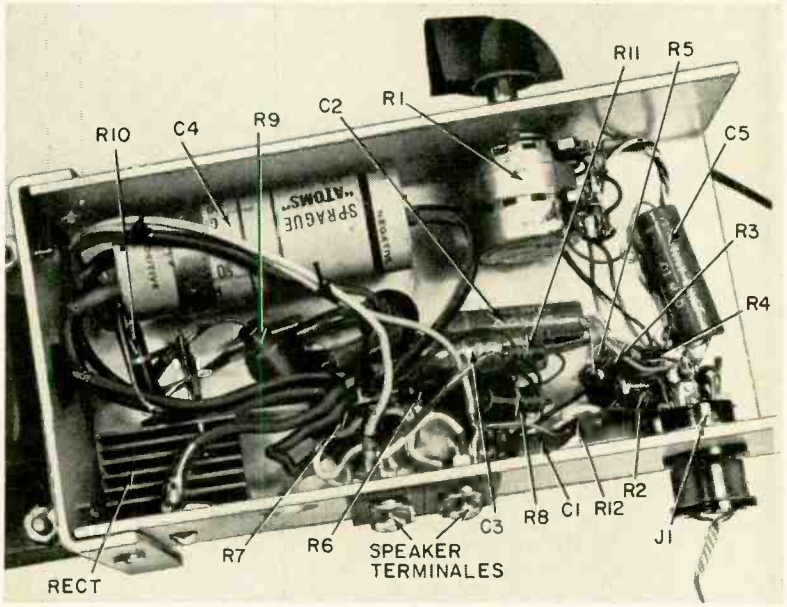
A 2-megohm volume control is listed. If you have a really good speaker system, increasing this resistance to 5 megohms will noticeably extend the bass response.

Use a four-terminal cartridge, such as the Astatic 11T7 series, with at least 0.5-volt output. The four-terminal cartridge must be wired for sum-and-difference operation.

One pair of wires, for 45/45 use, is marked "left" and the other pair "right." Fig. 1 shows the proper sum-and-difference connections for the 11T7 Astatic. Two supplementary diagrams illustrate the cartridge output for both lateral and vertical motion. Notice the output is push-pull to the grids for lateral movement and parallel (same instantaneous polarity) for vertical movement.



Both transformers on the chassis are audio output types. Note the power transformer on the left.



Wiring under the chassis resembles that found under any standard three-tube phono amplifier.

Transformer modification

The two output transformers, which are really the heart of the circuit, require further discussion. Transformers specifically designed for this circuit were not available when this amplifier was built. Therefore, the most suitable commercial units, which happened to be universal-output types, were used.

For example, output transformer T1 should be center-tapped as accurately as possible. However, looking at the A-3823 specification sheet, we see the impedance from terminals 1 to 5 is slightly less than terminals 5 to 6. But the error is not at all unreasonable.

Transformer T2 must carry the plate current of both output tubes through a single winding. Since we need only half the primary winding, we could simply connect to the blue and red terminals. However, there would be excessive voltage drop and heating of the single winding.

For this reason, the two halves of the primary are reconnected in parallel. This reduces the voltage drop and heating by a factor of two.

Fig. 2 shows how this modification is made. First, pull up the tape covering on the *top* of the transformer at the side where the primary leads enter. This exposes the connections between lead wires and the windings.

Very carefully pull this tape away. Do not use sharp instruments; you may prick or cut one of the wires to the windings.

Notice that two wires are soldered to the red center-tap lead wire (Fig. 2-a). Unsolder the wire that appears to continue to the winding that terminates in the brown lead. When it is unsoldered, check it with an ohmmeter for continuity to the brown lead. If there is no continuity, resolder this wire and remove the other wire.

Now, splice the free end to the blue-wire junction and connect a jumper from the brown wire to the red center tap. The two windings are now in parallel. Insulate any exposed connec-

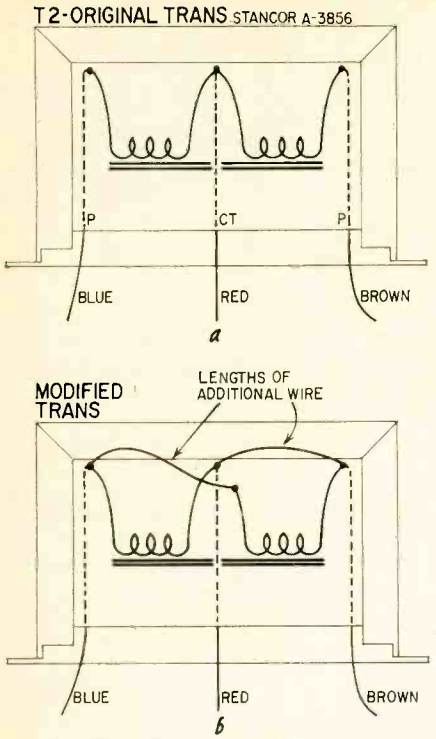


Fig. 2—Transformer modification: a—original transformer has center-tapped winding; b—the modification breaks the center tap and connects the two halves in parallel.

tions with bits of electrical tape and press the original tape covering into place.

If you have room, use A-3823 Stancor transformers for both T1 and T2 (a larger chassis would be needed). Connections and numbering are the same for the A-3823 and A-3856, but the A-3823 can handle more power.

The two 50C5's generate considerable heat. Be sure to allow for adequate ventilation when mounting the chassis.

If you wish to have a power switch ganged with the volume control, be sure to add this to your parts list. We used a separate toggle switch for power.

Put it to work

Connect a speaker to each pair of output terminals. Best impedance match occurs with speakers of approximately 4 ohms. Using 4-ohm speakers, about 3 watts of power is available. With 8-ohm speakers, 2 watts maximum may be obtained.

It will be useful, initially, to place a reversing switch in series with one pair of speaker leads to select the proper phasing. Stand some distance from the speakers and quickly throw the switch from one position to the other, thus swapping the leads of one speaker. One position will obviously give a fuller-sounding bass and this is the correct position. You can make this test with either monaural or stereo records. When the correct position is found, connect the leads permanently.

A good ground to the chassis will stabilize the amplifier and reduce any tendencies toward ringing or oscillation.

Whether a particular speaker is placed on the left or right nearly always makes no difference.

Most difficulties with any stereo system can be traced to the tone arm. Satisfactory tracking is very difficult to obtain. For playing either monaural or stereo records, the stylus must be absolutely perpendicular to the record surface.

The pickup arm must be completely free and almost frictionless to all movement. Electrical leads to the cartridge cause trouble in this respect. By all means, use the special very fine leads made for stereo cartridges and see that there is plenty of slack.

We are almost tempted to label all record-changer arms unsuitable. Certainly, the best of them will have to be checked and adjusted for best tracking.

You have made progress when the stylus no longer tries to jump the groove. But it is not really tracking properly unless the highs are smooth, sweet and clean. This is not easy to accomplish. More than likely, the highs will sound harsh initially—typical of early LP pressings or a worn-out stylus.

Nevertheless, if you spend the time and effort to make an inexpensive arm track properly, or buy an expensive stereo arm, a few hours of stereo listening will create a new taste for the added presence of two-channel recording.

Separate amplifiers for the right and left channels are, in a way, rather primitive. Future stereo amplifiers will nearly all be the sum-and-difference type, we believe. END

200-Kw High-Fidelity Amplifier

THE world's largest audio amplifier uses only 11 tubes, not counting the power supply, and has an output transformer of conventional design driving a transducer at frequencies from 30 to 6,000 cycles.

In many ways, this monster power amplifier is just like any ordinary home amplifier for playing back music. It has a standard 6SN7 first amplifier (a 5692 is actually used, for reliability) resistance-coupled to two more of the same. These terminate with the final triode section an ordinary split-load phase inverter which puts signals on the grids of a pair of 450TH transmitting triodes. These big bottles, familiar to hams, are the driver stage of the 200,000-watt amplifier.

The 450TH triodes are R-C-coupled to the grids of four big tubes hooked up in push-pull parallel to drive the output transformer. The output tubes are 6379's carrying cathode current of about 5 amps each with 15,000 volts on their plates. The plate loads work out to about 6,000 ohms, well within the usual home amplifier range, and this is stepped down by the output transformer to about 1 ohm. The output tubes are water-cooled by a system which moves 60 gallons of water a minute past their plates!

Coupling capacitors between the plates of the 450TH's and grids of the 6379's are 2-μf oil-filled units rated at 10,000 volts. They are each 4x12x16 inches. Plate load resistors for the last R-C-coupled stage are 200-watters!

The output current goes from the transformer secondary to the transducer through copper wires over 1 inch in diameter. About 500 amperes flows in this cable.

The transducer which this amplifier drives is a shaker table for testing missile and airplane parts. The table is a steel platform, spring-suspended, with a coil under it much like the voice coil of a conventional loudspeaker. This coil is driven in and out of a magnetic field created by a strong field coil. Current for the field coil is 88 amperes at 264 volts.

One common use for the amplifier is to play back tape recordings of missile motions so that the shaker table reproduces the complex and often violent motions of the missile in flight. Thus components for incorporation into missiles can be shock- and vibration-tested without getting off the ground and perhaps ruining the flight of a missile.

If a normal musical tape recording were played through the amplifier, it could be heard emanating from the steel shaker table, though it would not sound like high fidelity. Response of the table is from about 30 to 6,000 cycles. But the amplifier goes down to 5 cycles flat. At 200,000 watts, it produces less than 5% distortion, and it can put out up to 600,000 watts on instantaneous peaks.

A high-fidelity amplifier is used in this application because telemetered tape recordings of missile flights often contain very complex waveforms which represent complicated physical motions or vibrations. Failure to reproduce these complex movements accurately would nullify the usefulness of the shaker table.

Two Westinghouse engineers, Thomas Hayes and Ray Clifford, worked almost 2 years designing and building the amplifier, which is housed in four large closed racks 7 feet high and 3 feet deep with a total length of 24 feet. They're at work now on a similar amplifier which will produce over 1,000,000 watts of audio power. END

ALL ABOUT THE REFLEX ENCLOSURE

Part IV—The effect of enclosure size on the upper and lower resonance peaks

By P. G. A. H. VOIGT

LAST month we found that cabinet volume has an important effect. As it increases, coupling to the cone decreases. However, coupling to the room increases because of the large port that goes with a large cabinet. The increased coupling to the room lowers the cabinet Q and is highly desirable. But the reduced coupling to the cone, if the cabinet is large enough, may make the cabinet too big for effective reflex action. Therefore, theoretically, reflex enclosures can be too large. Whatever the cabinet volume, the upper peak in the impedance curve always occurs above the box baffle peak frequency. Since small cabinets drive that peak up more than larger ones, **the smaller the cabinet, the higher the upper impedance peak falls.**

So much for the upper impedance peak. But what about the lower one? At the frequency of the lower peak in the impedance curve, an altogether different state of affairs exists. Some of the details are shown in Figs. IV–1-a and -b. Now there is no sign of the imaginary boundary which corresponds to a region of little motion between two spheres of influence. Instead, all the air in the cabinet between cone and port is included in the oscillating motion.

As the cone moves inward, the air cushion is compressed slightly. The cushion reacts by pushing back, but since pressure spreads in all directions it also acts on the air at the port and sets it in motion. So the cone, via the air in the cabinet, pushes the port air as though all three were in series. That is why this is called the series condition.

Not only is the cone's inertia involved, but also that of air in the cabinet and at the port. The mechanical stiffness of the coil–cone support has not been changed but, under these series conditions, the stiffness is associated with far more inertia than originally. The result is a slowing down—lowering of the resonant frequency.

As the cycle continues, it is not long before the cone starts moving outward. Because of the low frequency involved, this happens when cabinet air and port air have both had plenty of time to get moving. The air at the port has been moving outward while that in the cabinet has been moving toward the port and away from the cone. Therefore, the pressure inside the cabinet has dropped and the air at the back of the cone is sucking instead of pushing as it did at first. The air, instead of behaving as a compressed cushion and adding to the cone-support stiffness, now does exactly the opposite and by sucking, counteracts the mechanical restoring force of the coil–cone supports.

At the port, the reduced pressure within the cabinet causes first a deceleration of the port air flow and then an inward flow. When that has been going on long enough for pressure within the enclosure to go up again, the end of the outward cone movement comes along. So when the cone should be moving inward again at this lower frequency and the restoring action of the mechanical supports is helping, we have the buildup of internal air pressure opposing the efforts of the elastic support of the coil–cone system.

The effect on the cone when it should be changing to outward or inward motion is an effective weakening of the overall elastic supports. So, whether we think of the cone as associated with more inertia than originally or as acting with supports which are weaker, or as both in combination, the end result is a lowered resonant frequency.

Take a closer look

So far, this is the ordinary explanation of the series peak and it is obvious

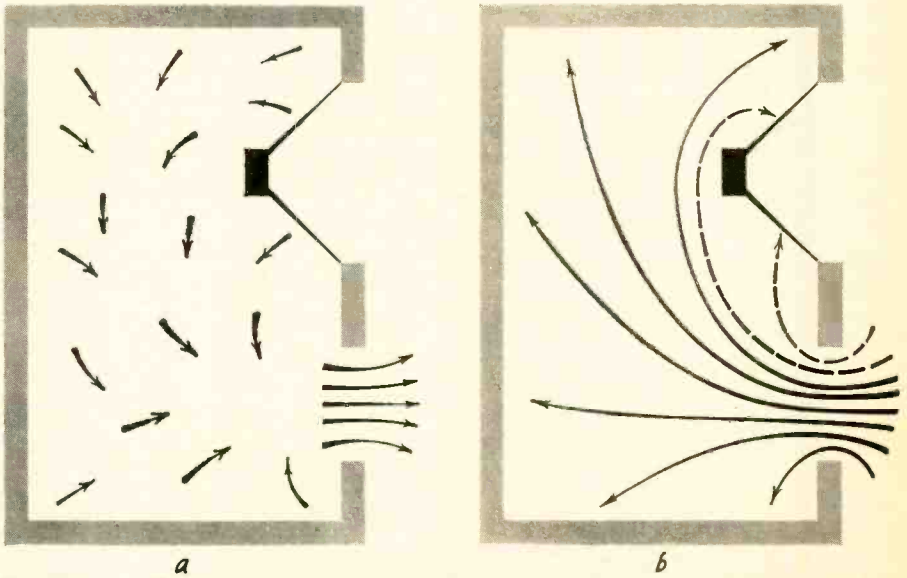


Fig. IV—1—The series condition. a—At the port, air flow is a combination of flow caused by pressure changes in the cabinet and pressure changes caused by cone displacement. The arrows show the flow direction when port flow is outwards. b—For analysis, imagine the port flow as consisting of separate portions, represented by separate sets of curves. The solid lines represent flow due to pressure changes in the cabinet. The dashed lines represent pressure changes due to cone displacement.

why the peak always comes below the free-air resonance of the cone. However, there is another explanation which tells us a few things which are not always brought out.

If we take another look at the arrows of Fig. IV–1-b, we will see that some (dashed lines) correspond to the air which goes in and out at the port and is due to the air displaced by the cone motion. Other arrows (solid lines) represent the flow necessary to compress and rarify the air inside the enclosure. (There must be a pressure change inside the enclosure if air at the port is to be set in motion.)

In the parallel case, it was the *volume* of the air cushion which divided itself between cone and port. This time, we have a division again, but it is air flow, especially at the port which now has the double function. Its two duties are to provide:

1. Air requirements of the cone motion.
2. Air necessary to produce the compression and rarefaction of the air cushion inside the cabinet.

Port air at any one moment cannot be flowing one way to satisfy the cone motion and the opposite way because of the air volume. The two flows are inextricably mixed and must have the same frequency and be in phase. The flow caused by the air-volume compressibilty can be regarded as a passenger riding on the flow caused by cone motion. Maximum effect is obtained when there are the most passengers, and that occurs when the passenger resonance frequency—caused by cabinet volume interacting with its part of the port flow—coincides with the series resonant frequency of the cone system. So once again we have maximum effect when two resonances coincide.

At the series resonance, the part of the total flow which corresponds to the inward cone displacement flows *outward* at the port when the cone moves *inward*, and vice versa. For this reason, the audible output of that part of the flow is cancelled by the cone, except for the effect due to the difference in cone and port location as discussed before (April page 83). The fraction of the port flow which provides for the volume compressibility within the cabinet —the passenger flow—is *not* cancelled. It is this flow which is responsible for most of the useful audio output at that lower peak frequency. And it is this supplementary flow at the port which makes it possible for the port to dominate at the series resonant frequency. Consequently, it is very important.

The supplementary flow naturally depends upon the cabinet volume and diminishes if the volume is reduced. Cabinet volume also affects the frequency of the series resonance. To find that common frequency, matters can be considered either from the cone with its added inertia or weakened supports, or from the port with a fraction only of its flow concerned with the air cushion.

The series resonant frequency

The simplest starting point is to imagine a plain cabinet with no speaker opening used as a Helmholtz resonator. The port air flow is concerned solely with satisfying the air volume. Assume that this Helmholtz resonator has been excited in some way, so that air is flowing in and out at the port. At the resonance frequency of the Helmholtz resonator, the flow at the port during each half-cycle produces the internal cushion-pressure change which is required at that frequency for acceleration and deceleration of port air.

Now suppose a speaker opening is cut into the cabinet wall and a speaker fitted. What was once solid wall has just been replaced by a light cone, flexibly supported. If air flows in through the port now, any pressure produced in the enclosure will act, not only on the air volume inside and on the cabinet walls as usual, but on the back of the cone as well. Therefore, the cone is driven outward till the displacement is counteracted by the elastic coil–cone supports. Because of this, pressure inside the cabinet does not back up as quickly as it would have with a solid-wall Helmholtz resonator of equal volume, and extra air has to flow in and out at the port to satisfy the cone compliance. To the port air, it seems almost as though the cabinet volume had been increased. If air-cushion compressibility and cone compliance are known, extra flow and proportion of one flow to the other can be calculated.

Since the port area is no greater, we can imagine that area divided, the flow in one part being concerned with air flow corresponding to cone displacement, and the flow in the other with the air flow needed to satisfy volume compressibility. Although the port air flow is shared between the volume compressibility and the cone compliance, we must not make the mistake of regarding the port air inertia factor as divisible, for port area is like inductances in parallel. The flow concerned with the air volume is now sharing the total port area and is crowded into a smaller area, giving it a greater inertia factor. Therefore, the air resonance frequency drops below the initial Helmholtz resonance frequency.

The port flow concerned with the cone is crowded too, so again there is an increased inertia factor. An increase in air inertia factor also exists inside the cabinet where the air flow velocity

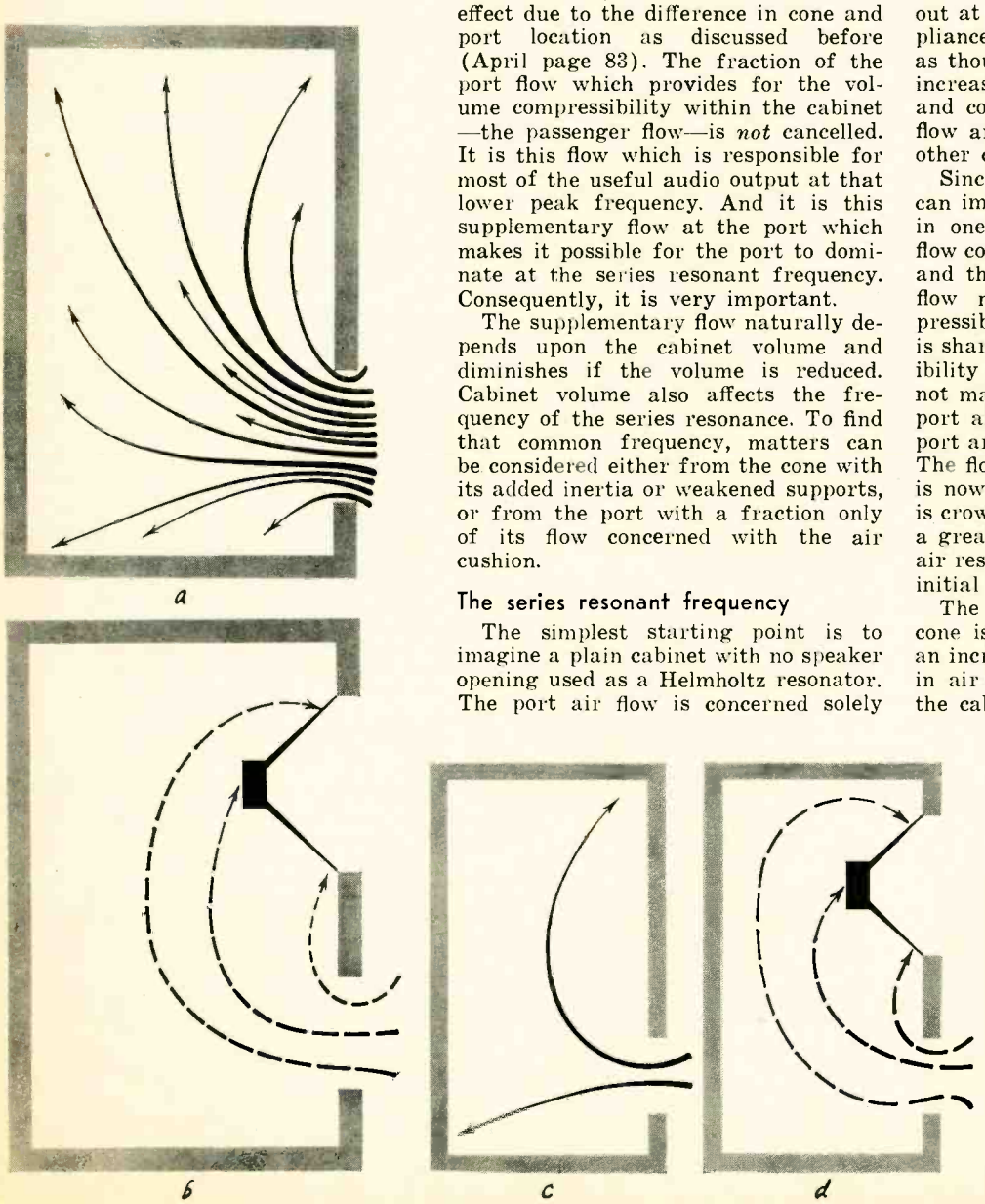


Fig. IV—2-a—With large-volume Helmholtz resonator, flow through large port to provide for internal pressure change is considerable. b—With speaker in place, extra port flow necessary to satisfy cone displacement at lower peak frequency may be slight compared to flow needed to satisfy cabinet volume alone. c—If we start with small Helmholtz resonator, with correspondingly slight port flow and convert to reflex, extra flow (d) needed to satisfy cone motion tends to be large by comparison.

is now greater than in the corresponding Helmholtz resonator oscillating to the same internal pressure variations. Each of these increases contributes to a lowering of the cone's resonance with its series air system. Thus the resonance frequency of the cone system as well as that of the cabinet–port air system is shifted downward.

In both cases, the downward shift is greatly influenced by cabinet volume. We know that when cabinets of differing volumes are matched to a certain speaker the air inertia factors of the ports have to be different, and large ports having low inertia factors go with large cabinets. Suppose we have a very large Helmholtz resonator. The air volume, because of its size, has plenty of compressibility (see Fig. IV–2-a). So port flow for a given internal pressure will be considerable. If a speaker opening is now cut and a speaker fitted (Fig. IV–2-b), the extra flow due to the additional compliance makes only a slight difference, so to the port the change is not great and lowers the resonant frequency only slightly.

The cone, under series conditions, with a large cabinet, is concerned with part of the flow which takes place in the large (low inertia factor) port. Although under working conditions the port area is effectively divided and the flow concerned with the cone is crowded into less than the full area, increasing the relevant air inertia factor, it is still low enough to insure that the cone series resonance frequency is not moved down the scale very much by the effect of that air inertia.

Effect of a small cabinet

With a small cabinet, the small port has a large inertia factor to start with and the division of the flow causes the inertia factor with which the cone is concerned to increase still further. The downward shift of the cone series resonance frequency is therefore much greater than with a large cabinet.

To the port in a small cabinet, before the speaker opening is cut, the air cushion is fairly stiff (see Fig. IV–2-c). If speaker opening is cut and a speaker fitted, the added compliance due to the speaker may be great compared with that of the air cushion and often exceeds it. So air flow at the port goes up considerably (Fig. IV–2-d) and the change greatly increases the air-inertia factor involved there. The air resonance frequency in consequence drops considerably with a small cabinet.

Whether we look at reflex series action from the cone or from the port, air flow within the cabinet as well as the flow at the port are involved, for air flow couples the two systems. It insures that, at the frequency of maximum air motion at the port (the lower peak), both cone and port are affected to a maximum.

In the parallel case, nature has her own way of determining the common frequency at which the upper peak occurs. In the series case, it is determined by the way the flow at the port (and to a lesser extent inside the cabinet) is divided. With any one cabinet, the full effect will be obtained only at the frequency at which the resonance of the series air system matches the resonance of the series cone system. The common frequency shows up in the impedance curve as the lower resonance peak. Since with large cabinets the lowering of both cone and air resonances is slight, the common frequency falls only a little below the natural resonant of either frequency. For small cabinets in which the resonant frequencies are depressed considerably, the common resonance frequency falls much lower down.

The effect of cabinet volume on the air inside the cabinet is also interesting. With cabinets of similar shapes, those with larger volumes have larger internal areas. **The internal velocity, for a specific volume of air, is less in a larger cabinet.** The kinetic energy content, which determines the effective inertia factor, depends upon the *square* of the velocity as well as on the mass. The total mass within the larger cabinet is greater but, when we are thinking of cabinet air inertia in the series flow case—of the flow between the cone and the port—we are not concerned with the total volume at all. Usually when a larger cabinet is used, the effective mass involved in the series flow has gone up by less than the square of the velocity has come down. So the natural assumption that with a larger cabinet the inertia factor will be greater is incorrect.

The flow paths inside a cabinet are not easy to estimate accurately. Trying to calculate the cumulative effect of the several changes in the air inertia factors exactly and from this the precise position of the lower peak in the impedance curve tends to be a waste of time. Such waste can be dodged by using the following very rough rule:

When the Helmholtz resonance and the cone's free air resonance agree, the lower peak is displaced downwards about as much as the upper peak is moved up.

If this rough rule produces an answer considered satisfactory, a trial cabinet can be made up and tested to see just where the lower peak really does fall.

Whether we use the rough rule or something much more accurate, the result when we consider both the peaks is that **with a small cabinet which couples closely to its cone, the upper peak is pushed well up and the lower one well down, giving a wide spread.**

When a large cabinet which couples loosely to its cone is used, the peaks are not displaced as far in either direction and are relatively close together.

Thus, with reflex cabinets we are concerned not only with marrying a cabinet to a speaker of the same natural resonance, but also with choosing such a volume that the offspring of that marriage—the upper and lower peaks—behave like properly trained children and are useful rather than a nuisance.

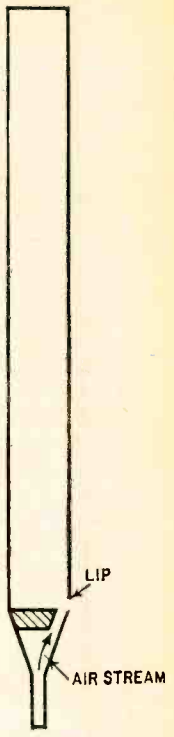


Fig. IV—3—When the air stream in an organ pipe impinges on the lip, slight lateral variations set up a stationary wave in the organ pipe. This increases the variations. So by a cumulative process, occupying several cycles, the tone builds up to full strength.

Peak spacing

In electrical bandpass circuits with very close coupling, the tuning curve has two peaks spread apart with a wide trough between them. If the coupling is made looser, the distance between the peaks is reduced.

The result of coupling a speaker to a correctly tuned reflex cabinet is almost the same. With large, loosely coupled cabinets, the frequency spread is slight, but the smaller the cabinet—the closer the coupling—the greater the spacing between the series and parallel peaks in the impedance curve. Thus, with the close coupling of small reflex cabinets, just as with overcoupled bandpass circuits, we have two widely spread peaks.

Tested with an organ record, the results of such a spread can be surprising. The output at some point in the low bass is materially increased over what could be achieved with that speaker either in an open back cabinet or with a box baffle of equivalent volume. Also the previous one-note-bass trouble may now be cleared up and the output spread over a wider range which is consequently smoother. So why not encourage the use of these small and convenient cabinets with their very close coupling as a method of band spreading?

Well, all music with bass does not consist solely of organs. When an organ pipe speaks, the air volume is set in motion by the action of an air stream impinging on a lip (Fig. IV–3). The process is cumulative and it takes several cycles for the organ tone to build up fully. When the air supply is cut off, the tone dies gradually too.

Most organs are in large buildings where reverberation helps to prolong rise and decay periods. In those circumstances, it matters little if the back wave from the speaker cone is delayed half a cycle to start with, and there is then a period of many more cycles, depending on the system, while port air inertia and cushion compressibility have a private game during which they build up enough swing to produce the maximum effects. The game continues after drive power to the speaker ceases and adds to the time required for the sound output to stop after the organ pipe has ceased to speak.

With small cabinets which couple very closely to the speaker, coupling to the room is low. Therefore, they may have a high Q with a corresponding unwanted, long hangover, which however is of little consequence with organ music. The single high peak in the speaker's free-air or box-baffle impedance curve, where there is the greatest danger of overrun, is replaced by two lesser ones with correspondingly less danger of distortion and consequent ability to accept a signal which previously would have caused trouble. Also there is an important gain in the average low-note efficiency.

No wonder some people become so enthusiastic about the capabilities of small reflex cabinets, especially when these first disclose, on organ records, low tones which the owner did not even know were there.

But what about other bass sounds? Drum, string or brass? Each of these has its characteristic modulation. Such modulations are low-frequency transients and are just as important as the high-frequency transients of the cymbal crash if lifelike sound is desired. The concertgoer can tell, with his eyes shut, what kind of instrument is producing the bass that reaches his ears, but if hangover irons out these transient modulations and makes the bass sound just like the indefinable woolly bass that one associates with loudspeakers—well, it just proves reflex cabinets can be too small!

It is a fortunate thing that nature takes a hand and prevents small cabinets from being quite as objectionable as I have suggested. Somehow, these small wood cabinets, with their close coupling to the speaker and their little ports, have proportionately greater frictional and other losses than their big brothers. The overall Q does not rise to quite such "church steeple" heights. However, unless something is done, it still remains at an undesirable level. Nor is there anything which prevents the tight coupling between speaker and air cushion from producing a very wide spread between the impedance curve peaks, which may push the upper peak well into the speech-boom region.

Fortunately the impedance curve does not represent the audio output under normal conditions, but there is some relation between the two. The region of the upper peak in the impedance curve usually corresponds to a peak in the audio output, and such a peak in the speech-boom region is very undesirable. If at all possible, it should be kept below 100 cycles. The lower peak in the impedance curve corresponds to another, but weaker, audio peak. It becomes very weak if the spacing between the peaks is great.

In the trough between the two peaks, there is an interesting region of maximum voice-coil current. This corresponds to maximum force on the coil. As this occurs around the frequency of the cone's free-air resonance, that force is readily transmitted to the air in the cabinet. Internal pressure and air oscillation at the port then tend to peak. The audio output there relative to that at the upper peak depends on the magnet–coil–cone system.

With most speakers, the end result of all this is simply that, **when the impedance peaks are spread too widely, speech is liable to become boomy and the audio response may be poor and irregular even to the extent of having holes in the lower part of the scale.**

Therefore, as far as size is concerned, are you an organ-music enthusiast condemned to using a speaker with a small, stiffly mounted cone, operating at low volume levels, and a simple cabinet occuping little space? Well, then the small reflex cabinet—in spite of hangover, boomy speech or even possible holes in the response—can give a quite astonishing account of itself, by providing some output below the free-air resonance of your speaker.

If, however, you are concerned with other sounds as well—especially male speech—a small cabinet with its irregular response and one peak pushed unduly up into the speech region will spoil the naturalness. A larger (lower Q) cabinet, preferably with a better (lower Q) speaker and perhaps additional means of damping the various resonances, should be the target. Such a combination will produce an all-round improvement in naturalness—even on organs—and will handle a greater average sound output without distortion.

Damping and matters affecting the Q of reflex cabinets will be discussed next month.

TO BE CONTINUED

NEXT MONTH

Don't Let Your Scope Mislead You!

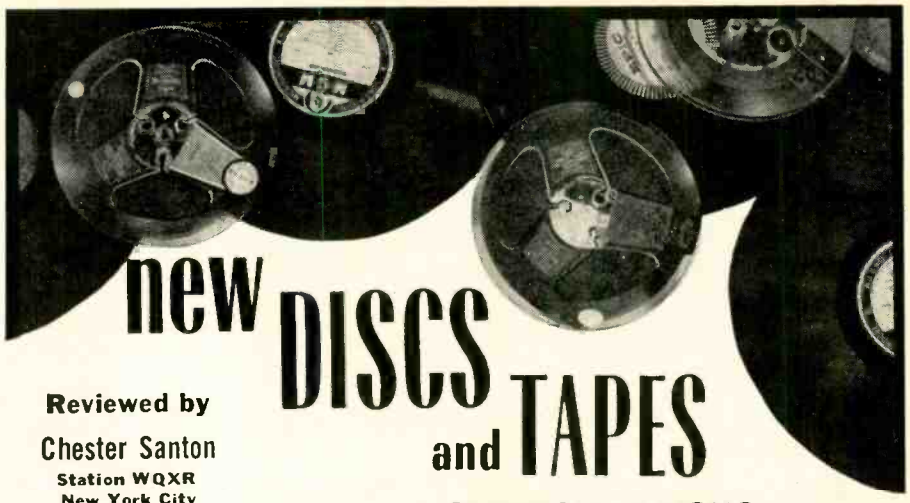
The information you get from your scope can be very helpful—but if you don't read it right, it can send you a long way down the wrong trail. Some very common conditions can produce unexpected scope indications—Cyrus Glickstein tells when they can be expected and how to interpret them.

Building the Harkness Folded Horn

Complete details on constructing the JBL C40 enclosure, a 6-foot rear-loading exponential horn designed in lowboy style.

Truths and Half-Truths about Transistors

Will putting a transistor in the socket with reversed polarity destroy it immediately? Can transistors handle large amounts of power? Do you really think so? Then see "Orient Your Transistor Thinking" by Lou Garner in our next issue.



new DISCS and TAPES

STEREO and MONO

Reviewed by
Chester Santon
Station WQXR
New York City

STEREOPHILES are by now well aware of the convenience of ganged volume controls. Some stereo discs, however, still require separate volume or balance control even in cases where the two playback channels have similar characteristics. Occasionally, one discovers specific problems in the original stereo recording that can be minimized through use of individual channel controls. Several recent problems are discussed in detail in the reviews of the following two records.

MAHLER: *Das Lied Von Der Erde*
Grace Hoffmann, contralto, and
Helmut Melchert, tenor
Hans Rosbaud conducting Symphony Orchestra of Southwest German Radio, Baden-Baden
Stereovox (2) ST-PL 10.912

Someone decided to try an unorthodox placement of the soloists in this latest recording of Mahler's song-symphony based on the verses of a Chinese poet of the eighth century. A tenor and a contralto are heard alternately in these six songs of unusual tonal color. The singers are located at left of center with the predominant weight of orchestral sound in the right channel. Because the orchestra's score exceeds mere accompaniment, overall balance is a challenge to conductor as well as recording engineer. In playback, a single balance control or separate volume controls are very useful. The tenor sounds more comfortable when the right-hand channel is brought down a peg. The London and Epic mono versions are available on three record sizes. To attain the unfettered sound displayed here, Vox has extended the recording onto four record sides. That decision, coupled with use of the rapidly improving Fairchild stereo cutter, explains much of the success of this project.

Stereo Concert
Kingston Trio
Capitol Stereo Record ST-1183

This record provides another illustration of the advantage of a balance control. In their first stereo effort, the record-breaking Kingston Trio entertains an audience in El Paso, Tex. A bright, clean-sounding disc captures the spontaneity of their performance. Balance and audio

quality are fine while three voices, two guitars and a banjo are hard at work. During the patter that precedes these distinctive arrangements of some of their most popular tunes (including *Tom Dooley*), the right channel reveals the presence of gremlins that seldom appear until a recording engineer is far from home. With no opportunity for retakes, a slight noise developed somewhere in the right channel and is audible on the finished record. In playback, judicious handling of a balance control or individual volume controls can minimize this noise problem in one channel.

Music for Trumpet and Orchestra
Roger Voisin and Armando Ghitalla
Harry Ellis Dickson conducting Unicorn Concert Orchestra
Kapp Stereo Record KCL-9017

Originally released on Unicorn disc 1054, this definitive performance by first-string trumpet players of the Boston Symphony is now available on a stunning stereo disc. I've heard these identical spaciously recorded performances on 15-ips stereo tape. This disc almost matches the tape. It's free, clear and easy all the way. The highs have a sweetness rarely found in recordings of brass instruments. Particularly effective are Vivaldi's *Concerto for Two Trumpets* and the famous *Trumpet Voluntary in D* played here on the long straight English coronation or herald trumpet.

Love Is a Gentle Thing
Harry Belafonte
RCA Victor Stereo Tape CPS-152
(7-inch; playing time, 25 min. $8.95)

The material offered here does not demand wide-range response in playback. This two-track 7.5-ips reel conveys with warmth and subtlety the smooth Belafonte style in a collection of soothing ballads and love songs. Great strides have been made by RCA during the past year in the reduction of distortion in their tapes. So realistic is the reproduction here that, at several points in this tape, a good playback system will reveal a switch in recording locale. Some of the tunes were taped in Hollywood, others in New York. Response is uniform; only the acoustics are different.

DEBUSSY: *Images for Orchestra*
Charles Munch conducting Boston Symphony Orchestra
RCA Victor Stereo Record LSC-2282

The Bostonians offer an ingratiating treatment of music found on an earlier London-Ansermet stereo disc (CS-6013). Debussy's gossamer scoring moves with greater ease under Munch's guidance, his key men are wizards executing orchestrations of this sort, and the concert hall perspective adds a finishing touch. Ansermet's disc conveys superior presence and slightly greater frequency range, but this one has the magic.

MENDELSSOHN: *Italian Symphony*
HAYDN: *London Symphony*
Leonard Bernstein conducting New York Philharmonic
Columbia Stereo Record MS-6050

The Italy Mendelssohn described in his buoyant symphony was a happy place. Bernstein brings to his stereo depiction of the work the unforced optimism of a conductor schooled in the ways of Serge Koussevitsky, who used to play it with such zest. The new esprit de corps of the Philharmonic is doubly evident under stereo analysis.

Sheer Flamenco
Anita Sheer
Riverside Stereo Record RLP-1116

This one's a scorcher. It should mark 1959 as the year flamenco music hit its stride on stereo discs. The placement of the troupe is straightforward. Excellent stereo depth is assured through use of one of the larger Reeves sound studios in New York City. The voice and guitar of Anita Sheer, a pupil of the celebrated guitarist Carlos Montoya, originates on a plane with the two speakers. The mikes furnish maximum presence yet are high enough to avoid blasting on peaks. The truly exciting test of transient response comes in the sound of the two dancers in the background. This record surpasses flamenco tapes in my collection. According to Bill Grauer of Riverside Records, some of the credit for this exceptional disc goes to the West Coast outfit responsible for the pressings. At present, only a handful of listeners may notice the difference in stereo pressing exhibited here but that's what makes an early landmark interesting. Don't miss this one.

Flamenco España
Bernabe de Moron, guitar, and Flamenco Troupe
Hi Fi Stereo Record SR-811

Flamenco guitars are heard in closeup here. The audio level, as in the Riverside disc above, is unusually high but the recording as a whole misses the mark. Artificial reverberation is wholly out of place here. Who wants to listen to castanets in an echo chamber?

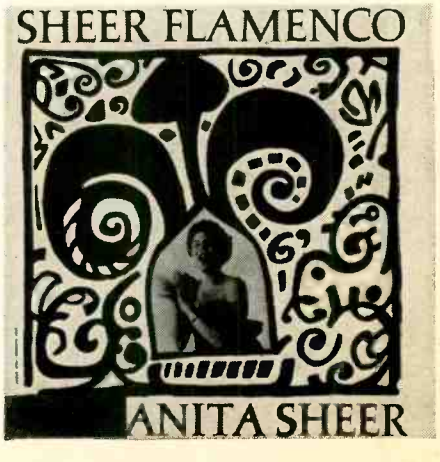
GRIEG: *Peer Gynt Suites, Nos. 1 and 2*
Odd Grüner-Hegge conducting Oslo Philharmonic Orchestra
RCA Camden Stereo Record CAS-480

The stereo Camdens may surprise you. Despite the $2.98 price tag, overall audio quality matches that of the early RCA Victor stereo discs. Competent stereo miking bespeaks modern facilities in Europe. The artists, I admit, are better known in the Scandinavian Peninsula than they are here. This does not detract from their performance of Norwegian music. Good value for the money.

Demonstration and Sound Effects Record
Audio Fidelity Stereodisc AFSD-5890

A brief explanation of stereo and samples of Audio Fidelity's stereo catalog occupy side one of this disc. Side 2 offers stereo sound effects of more recent date of recording. Most of the material is off the beaten path. The 12 episodes include close-order drill, a 35-ton tank and firing of weapons at the Army's Aberdeen Proving Ground in Maryland. The crash of a stunt driver's car, a bullfight crowd and the felling of a Douglas fir tree share honors with the more conventional demonstration-record sounds of fire apparatus, sports cars and a subway train. Recording level is on the cautious side. The pressing almost matches the best obtainable today.

(*Continued on page* 68)



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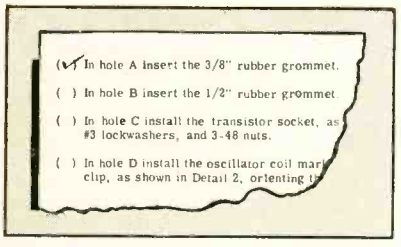

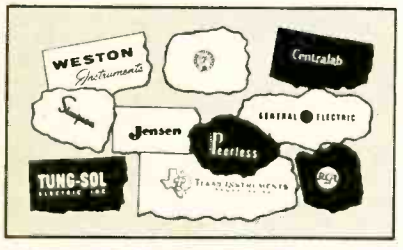

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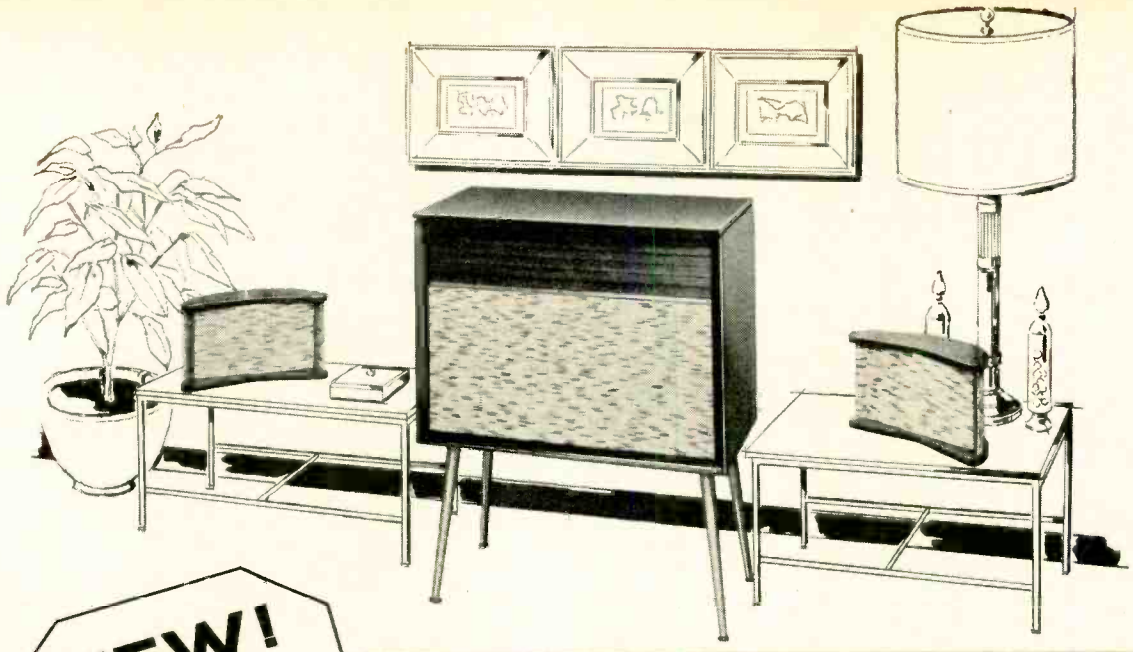

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(cabinet legs included; end tables not included)

HI-FI STEREO SYSTEM KIT

For the first time anywhere . . . a stereo-kit package, ready-to-play after only a few hours assembly time and complete with cabinet, stereo amplifier, stereo record changer, bass woofer and stereo speaker wings. And the unbelievably low price sets an unprecedented record for stereophonic systems of this quality anywhere on the market. One of the factors behind this phenomenal achievement is the introduction of the revolutionary stereophonic "sum and difference" amplifier used in this kit—licensed in kit form exclusively by Heath Company from CBS Laboratories. This unique development in audio science employs a new principle of stereophonic reproduction. The single chassis amplifier separates the individual stereo channels by utilizing the sum and difference of the total signal and directing the sound to the appropriate right and left channels, reproduced by the stereo wing speakers. The centrally located woofer reproduces the non-directional bass frequencies. The result of this modern stereo reproduction is a breath-taking experience of sound coming to you with depth and direction seldom achieved by conventional stereophonic methods. The beautifully styled console cabinet houses the stereo amplifier, stereo record changer and low-frequency woofer. Controls on the handsome black and gold amplifier panel consist of: on-off switch, bass and treble tone controls, input selector switch and level balancing control. The new CBS sum-and-difference or matrix-type circuit employs only four tubes and is extremely easy to assemble. The woofer, mounted behind the attractive grille cloth, is a high compliance 8" speaker capable of 30 cycle response when housed in the acoustically designed ducted-port enclosure. The specially designed crossover employs a dual bass-mixing 250 cycle network. The twin stereo speakers are 6" x 9" extended range dual cone oval speakers. The completely automatic, four speed record changer employs a ceramic stereo cartridge with micro-groove diamond stylus capable of obtaining the best from the latest stereo or LP monophonic recordings. A 45 RPM spindle is also included for 45 RPM monophonic or stereo records. Separate inputs are provided for AM/FM tuners or multiplex. Both in styling and performance, the all-new SD-1 Stereo offers you the greatest Heathkit value in years. Shpg. Wt. 88 lbs.

- Complete—No "Extras" to Buy
- Revolutionary Stereo Amplifier
- Assemble in Just a Few Hours From Easy Step-By-Step Instructions
- Beautifully Styled Cabinetry
- Stereo Sound With Such Impact You'll Find It Hard to Believe!

SPECIFICATIONS—Overall System Frequency Response: ±5 db, 30-16,000 cps. Amplifier: (push-pull conditions except where specified). Power versus Distortion: 10 watts, less than 3% THD from 30-16,000 cps. 9 watts, less than 2% THD from 30-16,000 cps. 1 watt, less than 0.7% from 30-16,000 cps. Peak Power: 20 watts: Mid-range individual channel power, 5 watts. Frequency Response: Tuner input, tone controls in mid-position, 1 watt level, ±1 db, 30-16,000 cps. Ceramic cartridge input—equalized for RIAA characteristics. Input Sensitivity: 0.1 volt at 1000 cps to each tuner input for 10 watt output. Hum and Noise: 70 db below 10 watt level with inputs shorted. Channel Separation at Significant Frequencies: (2 watt level on operating side). 250 cps—29.0 db. 1 kc—34.0 db .2 kc—35.0 db. 2 kc—35.0 db. 5 kc—36.0 db. 8 kc—37.0 db. 12 kc—35.0 db. 16 kc—29.0 db. Overall Channel Separation: using RCA test record #1427-1, cartridge supplied. 1000 cps, 20 db. Bass Tone Control 50 cps: accentuation 8 db. Attenuation 9 db. Treble Tone Control 10 kc: accentuation 9 db. Attenuation 7 db. Power Requirements: 117 volts, AC, 60 cycles, 75 watts. Crossover Network: crossover freq.—250 cps. Attenuation rate 12 db per octave. Power rating—5 watts per channel. Changer: speeds—16, 33⅓, 45, 78 rpm. Cartridge: ceramic stereo, out-of-phase connected (.0008" diamond stylus). Cabinets: dimensions—main cabinet, 30" wide x 34½" high x 15" deep. Satellite speaker, 14¼" wide x 8" high x 6½" deep.

EASY TIME PAYMENTS

The thrills of stereo sound from this New Heathkit Stereo System can be yours NOW . . . while you pay in easy installments.

a complete line of stereophonic and monophonic

NEW! from the HEATHKIT AUDIO LABS

HEATHKIT Tape Recorders

Field Tested for One Year

SPECIFICATIONS—Tape Speed: 7.5 and 3.75" per second. Maximum reel size: 7". Frequency response: (record-playback): ±2.5 db, 30-12,000 cps at 7.5 IPS. ±2.5 db, 30-6,500 cps at 3.75 IPS. Harmonic distortion: 1% or less at normal recording level; 3% or less at peak recording level. Signal-to-noise ratio: 50 db or better, referred to normal recording level. Flutter and wow: 0.3% RMS at 7.5 IPS, 0.35% RMS at 3.75 IPS. Heads (3): erase, record, and in-line stereo playback. Playback equalization: NARTB curve, within ±2 db. Inputs (2): microphone and line. Input impedance: 1 megohm. Outputs (2): A and B stereo channels. Output levels: approximately 2 volts maximum. Output impedance: Approximately 600 ohms (cathode followers). Recording level indicator: professional type db meter. Bias-erase frequency: 60 kc. Timing accuracy: ±2%. Power requirements: 105-125 volts AC, 60 cycles, 32 watts. Dimensions: 15½" W. x 13½" D. total height 10¾". Mounting: requires minimum of 8½" below and 1½" above mounting surface. May be operated in either horizontal or vertical position.

NEW PROFESSIONAL-TYPE TAPE RECORDER KITS

Designed to take their place in the finest of hi-fi systems, the new models TR-1C and TR-1D Tape Recorders will provide superb performance for years to come. These completely field tested, precision engineered instruments provide monophonic record and playback in the TR-1C or monophonic record and playback plus stereo playback in the TR-1D.

The mechanical assembly, with fast forward and rewind, is completely finished and adjusted—you build only the tape amplifier. Easy to assemble, the amplifier features two circuit boards which virtually eliminate wiring errors and assure the high stability necessary for consistently good results.

Low noise EF-86 tubes in input stage and push-pull bias erase oscillator assure maximum freedom from hum and noise in recording and playback.

Two inputs are provided (mike and high level line) for recording from microphone, preamplifier, tuner, phono, or TV. In the TR-1D, a separate playback channel with cathode follower output is provided for each stereo track—one of the stereo channels is used for monophonic playback.

Separate record and playback heads and amplifiers allow monitoring from tape while recording. Built-in sound level meter indicates proper recording level and bias for top quality recordings. A pause control allows instant starting and stopping of tape for accurate cueing and tape editing. Kit includes counter for cueing and editing ease.

The precision tape mechanism features heavy duty fan cooled motor, balanced flywheel, long-life bearings, and positive acting braking system. Push button provides instant selection of 3¾ or 7½ IPS tape speed. Safety interlock on record switch minimizes the possibility of accidental erasing. The handsome styling includes plastic escutcheon in soft gold mounted on semi-gloss black panel with black knobs with gold inserts. Complete instructions provided for assembly and operation. This outstanding kit offers a combination of features found only in higher priced professional tape decks selling for $350 to $400.

MODEL TR-1C Monaural Tape Deck: Has all features of model TR-1D with the exception of stereo playback. **$159.95**

MODEL TR-1D Stereo Tape Deck: Provides monaural record and playback and stereophonic playback of the pre-recorded tapes (stacked). **$169.95**

MODEL C-TR-1C Conversion Kit: Converts model TR-1C to include stereo function of model TR-1D. **Price to be announced.**

NOW! TWO NEW STEREO-MONO TAPE RECORDERS IN THE TR-1A SERIES

Our most versatile tape recorder kit, the model TR-1A now can be purchased in any one of three versions. You can buy the new half-track (TR-1AH) or quarter-track (TR-1AQ) versions which record and play back stereo and monophonic programming, or you can buy the original monaural version (TR-1A) and add either half-track or quarter-track stereo provisions later using the MK-4 or MK-5 Conversion kits. The tape deck is extremely simple to assemble and uses precision bearings throughout the rugged mechanism assuring long and faithful service. One control lever selects all tape handling functions on the deck, greatly simplifying operation. Speeds of 7.5 or 3.75 IPS are available. Flutter and wow are held to less than 0.35%. Each tape preamplifier features NARTB playback equalization, separate record and playback gain control, cathode follower output and provision for mike or line input. Record level is indicated on "magic eye" tube. A safety interlock is provided to minimize accidental erasure of tape. Filament balance control allows adjustment for minimum hum level. Cathode follower output from playback channel is approximately 600 ohms impedance. Two circuit boards are used for easy assembly. Supplied with attractive vinyl-clad steel cover in black leather texture, with inlaid gold design. Templates and instructions provided for panel mounting or equipment enclosure installation.

NOW AVAILABLE IN THREE MODELS!

MODEL TR-1A: Monaural record/playback with fast forward and rewind functions. Shpg. Wt. 24 lbs. **$99.95**

TR-1A SPECIFICATIONS—Frequency Response: 7.5 IPS ±3 db 50-12,000 cps. 3.75 IPS ±3 db 50-7,000 cps. Signal to Noise Ratio: Better than 45 db below full output of 1.25 volts/channel. Harmonic Distortion: Less than 2% at full output. Bias Erase Frequency: 60 kc (push- pull oscillator).

MODEL TR-1AH: Monaural and half-track stereo record/playback with fast forward and rewind functions. **Price to be announced.**

TR-1AH SPECIFICATIONS—Frequency Response: 7.5 IPS ±3 db 40-15,000 cps. 3.75 IPS ±3 db 40—10,000 cps. Signal to Noise Ratio: 45 db below full output of 1 volt/channel. Harmonic Distortion: Less than 2% at full output. Bias Erase Frequency: 55 kc (push-pull oscillator).

MODEL TR-1AQ: Monaural and quarter track stereo with record/-playback fast forward and rewind functions. **Price to be announced.**

TR-1AQ SPECIFICATIONS—Frequency Response: 7.5 IPS ±3 db 40-15,000 cps. 3.75 IPS ±3 db 40-10,000 cps. Signal to Noise Ratio: 40 db below full output .75 volts/channel. Harmonic Distortion: Less than 2% at full output. Bias Erase: 55 kc (push-pull oscillator).

NOW! FULL STEREO CONVERSION FOR TR-1A OWNERS

MK-4 Half-Track Stereo Conversion Kit: Modifies TR-1A monaural tape recorder to include function of record and playback of half-track stereo program material. Consists of a TE-1 tape preamplifier, a stereo head array plus components and instructions to convert TR-1A to TR-1AH. **$62.95**

MK-5 Quarter-Track Stereo Conversion Kit: Modifies TR-1A monaural tape recorder to include function of record and playback of quarter-track stereo. Allows playing stereo both ways on standard tape for twice the playing time or four times playing time with monophonic recordings. Consists of a TE-1 tape preamplifier, a stereo head array plus components and instructions to convert TR-1A to TR-1AQ. **$62.95**

HEATHKIT

monophonic or stereo Hi-Fi

HEATHKIT®

Program Sources

NEW

MODEL FM-4

$34.95

SPECIFICATIONS—Tuning Range: 88—108 mc. Quieting Sensitivity: 2.5 uv for 20 db of quieting, 3.5 uv for 30 db of quieting, 25 uv for maximum quieting (45 db). IF Frequency: 10.7 mc. Image Ratio: 45 db. AFC Correction Factor: 75 kc per volt. AM Suppression: 25 db. Frequency Response: ±2 db 20-20,000 cps. Harmonic Distortion: Less than 1.5%, 1100 uv, 400 cycles 100% modulation. Intermodulation Distortion: Less than 1%, 60 cycle and 6 kc mixed 4:1 1100 uv, 30% modulation. Antenna: 300 ohms unbalanced. Output Impedance: 600 ohms (cathode follower). Output Voltage: nominal .5 volt (with 30% modulation, 20 uv signal). Power Requirements: 105-125 volts 50/60 cycle AC at 25 watts. Overall Dimensions: 4¼" H. x 13¼" W. x 5¼" D.

NEW HIGH FIDELITY FM TUNER KIT (FM-4)

This superbly designed unit incorporates advancements in circuit design with features asked for by hi-fi fans everywhere. Better than 2.5 microvolt sensitivity, automatic frequency control (AFC) with defeat switch, flywheel tuning and prewired, pre-aligned and pretested tuning unit . . . bring you the finest in FM listening entertainment. The exceptionally clean chassis layout, pre-aligned IF transformers and the prewired, pre-aligned tuning unit insure ease of construction with no further need of alignment after the unit is completed. The five tube circuit features a generous power supply utilizing a silicon diode rectifier for cool running operation and low power consumption. The attractive styling of the FM-4 features a vinyl-clad steel cover with leather-like texture, soft black front panel, set off with brushed-gold trim and new soft evenly-lit dial scale. A multiplex adapter output is provided. Feature for feature the FM-4 offers the most outstanding dollar value in FM entertainment available today. Shpg. Wt. 8 lbs.

MODEL PT-1

$89.95

MONOPHONIC-STEREO AM-FM TUNER KIT (PT-1)

Outstanding features in both styling and circuitry are combined in this 16-tube deluxe stereo AM-FM combination tuner to bring you the very finest of program sources for your listening enjoyment. Features include three printed circuit boards for easy construction and high stability—wired, pre-aligned 3-tube FM tuning unit—built-in AM rod antenna—tuning meter—automatic frequency control (AFC) with on-off switch—and flywheel tuning. Other features include variable AM bandwidth, 10 kc whistle filter, tuned-cascode FM front end, FM AGC and amplified AVC for AM. AM and FM circuits are separate and individually tuned so they can be used simultaneously for stereo applications. Cathode follower outputs with individual level controls are provided for both AM and FM, with a multiplex adapter output provided. A tuning meter and flywheel tuning combined with two edge-lit slide rule scales provide effortless tuning. Styling features vinyl-clad steel cover in black with inlaid gold design and soft black, rigid die-cast panel set off by brushed gold trim, black knobs with gold inserts. Shpg. Wt. 24 lbs.

MODEL BC-1A

$26.95

HIGH FIDELITY AM TUNER KIT (BC-1A)

Delivers AM broadcast reception comparable to FM quality. Features a special detector using crystal diodes and broad-band IF circuits for low signal distortion. Prealigned RF and IF coils eliminate the need for special alignment equipment. Sensitivity better than 3 microvolts for one volt output. Two output levels provided. Built-in power supply. Special antenna supplied, also provision for outside antenna. Shpg. Wt. 9 lbs.

MODEL FM-3A

$26.95

HIGH FIDELITY FM TUNER KIT (FM-3A)

Featuring broad-banded circuits for full fidelity and better than 10 microvolt sensitivity for 20 db of quieting, the FM-3A pulls in stations with clarity and full volume. Incorporates stabilized temperature compensated oscillator, built-in power supply, pre-aligned IF transformers and ratio detector. The pre-assembled tuning unit is pre-aligned. Two output levels provided. Shpg. Wt. 8 lbs.

AUTOMATIC HI-FI RECORD CHANGER KIT (RP-3)

Combining automatic convenience with turntable quality through unique and simple design the Heathkit RP-3 handles your records with the finest of care for full fidelity reproduction. The unique "turntable pause" feature during change cycle and smooth friction clutch start prevents record damage. Proper weight distribution and low pivot point friction of the tone arm minimize arm resonance, tracking error, and record wear. All record changer kits come equipped with changer base, stylus pressure gauge, 45 RPM spindle, and necessary wire.

STEREO MODEL RP-3S: Equipped with Shure diamond stylus magnetic cartridge providing frequency response of ±4 db from 30 to 14,000 CPS. Shpg. Wt. 19 lbs. **$74.95**

MONAURAL MODEL RP-3-LP: (monaural microgroove recordings only): Equipped with Fairchild Magnetic diamond stylus cartridge. Shpg. Wt. 19 lbs. **$74.95**

MONAURAL MODEL RP-3: Features a GE VRII magnetic cartridge with diamond LP and sapphire 78 stylus. Shpg. Wt. 19 lbs. **$64.95**

SPECIFICATIONS—Operates from: 105-130 volts 60 cycles. Wow and Flutter: Less than 0.18% peak at 33-1/3 RPM. Turntable Speed: Accurate within ±2%. Change Cycle: Completed in 9 seconds. Dimensions: 13½" wide x 12" deep. 5" above and 3" below mounting board. Motor Type: 4 Pole hum shielded. Type of Drive: Friction. Record Speeds: 4 speeds. Automatic and manual 33-1/3, 45, 78 RPM. Manual only—16 RPM. Variations in Tracking Force: Less than 0.9 gram from first record to tenth record. Controls: "ON-OFF" switch. Manual Reject. "Speedminder" (automatic speed selection and indexing). Manual speed selector (4 speed). Finish: Midnight Gray. Base: Maple (unfinished). Mounting Board: Birch (unfinished).

NEW from the HEATHKIT AUDIO LABS

a complete line of monophonic and stereo

HEATHKIT®

Hi-Fi Amplifiers

MODEL SA-3

NEW

$29.95

NEW LOW COST STEREO AMPLIFIER KIT (SA-3)

The answer to budget cost stereo is now found in the all-new Heathkit SA-3 Stereo Amplifier. All the convenience of complete dual channel control can now be yours at a fraction of the cost of comparable equipment. The high level preamplifier section of the SA-3 provides complete control for both channels. Ganged tone controls provide convenient "boost" and "cut" action for base and treble while dual concentric volume controls make possible precise channel balancing. A channel reversing switch and a speaker phasing switch allows optimum performance. Two separate inputs are provided for each channel to accommodate ceramic cartridge phonographs, AM-FM tuners, or tape recorder. Program source may be reproduced in either monophonic or stereo form. A really big package of stereo performance for the small investment!

SPECIFICATIONS—Power Output: 3 watts per channel. Power Response: ±1 db 50 cps—20 kc at 3 watts output. Total Harmonic Distortion: less than 3% 60 cps—20 kc. Intermodulation Distortion: less than 2% at 3 watts output using 60 cycle and 6 kc signal mixed 4:1. Hum and Noise: 65 db below full output. Controls: dual clutched volume, ganged treble, ganged bass, 7 position selector, speaker phasing switch, on-off switch. Inputs: (each channel) tuner, crystal or ceramic phono. Outputs: (each channel) 4, 8 and 16 ohms. Finish: black with gold trim; Dimensions: 12½" W. x 6¾" D. x 3¼" H.

MODEL EA-1

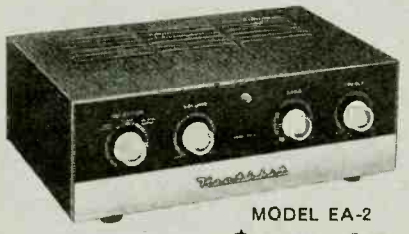
NEW

$15.95

NEW "ECONOMY" 3 WATT AMPLIFIER KIT (EA-1)

More than enough for room filling volume . . . ideal for getting started on a low cost individual component system. Designed for use with ceramic cartridge record players, tuners, tape recorders, etc. Built-in preamplifier provides you with all the necessary tone and volume controls for adjusting the sound reproduction to your personal taste. Smart appearance, quality components, assemble it in a few hours for years of trouble-free enjoyment. Shpg. Wt. 7 lbs.

SPECIFICATIONS—Power Output: 3 watts. Input Sensitivity: 100 mv for 3 watts output. Power Response: 60-20,000 cps with less than 3% total harmonic distortion at full output. Frequency Response: ±3 db, 20-40,000 cps at 0.5 watt output. Hum and Noise: 70 db below full output. Power Supply: transformer operated full wave rectifier. Inputs (2): crystal or ceramic phono cartridge, tuner. Output Impedance: 4, 8 and 16 ohms. Dimensions: 3¾" H. x 9½" W. x 6" D.



MODEL EA-2

$28.95

"BOOKSHELF" HI-FI 12 WATT AMPLIFIER KIT (EA-2)

Enjoy superior quality and performance at modest cost. Used with a Heathkit tuner, record player, or tape deck in conjunction with the SS-2 Basic Speaker System, the EA-2 rounds out a splendid, budget, high fidelity system. RIAA record equalization is featured on the mag phono input and neon pilot lamp tells you when amplifier is on. Attractively styled for installation anywhere in the home. Shpg. Wt. 15 lbs.

SPECIFICATIONS—Power Output: 12 watts. Overall Frequency Response: at 12 watts ±1 db 20-20,000 cps. Harmonic Distortion: at 12 watts 2% or less. 20-20,000 cps. IM Distortion: at 12 watts 2% (4:1 ratio 60 and 6,000 cps). Hum and Noise: 47 db below 12 watts mag phono, 63 db below 12 watts auxiliary inputs. Power Supply: transformer operated. Power Requirements: 117 V. 60 cycle AC, 100 watts. Dimensions: 12½" W. x 8¾" D. x 4⅝" H.

PREAMPLIFIERS

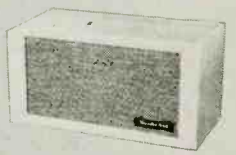
Model WA-P2 "Master Control" hi-fi preamplifier kit. 7 lbs. **$19.75**
Model SP-2 Mono-Stereo (2 channel mixer) Preamplifier kit. 15 lbs. **$56.95**
Model SP-1 Single Channel version of SP-2. 13 lbs. **$37.95**
Model C-SP-1 Converts SP-1 to SP-2. 5 lbs. **$21.95**

HEATHKIT®

POWER AMPLIFIERS

Model UA-1 "Universal" hi-fi 12-watt amplifier kit. 13 lbs. **$21.95**
Model W-4AM Single Chassis 20-watt hi-fi amplifier kit. 28 lbs. **$39.75**
Model W-3AM Dual Chassis hi-fi 20-watt amplifier kit. 29 lbs. **$49.75**
Model W-7M "Extra Performance" hi-fi 55-watt amplifier kit. 28 lbs. **$54.95**
Model W-5M high fidelity 25-watt amplifier kit. 31 lbs. **$59.75**
Model W-6M high fidelity 70-watt amplifier kit. 52 lbs. **$109.95**

SPEAKER SYSTEMS



Model SS-3 "Basic" fir hi-fi speaker system kit. 26 lbs. **$34.95**
Model SS-2 "Basic Range" hi-fi speaker system kit. 26 lbs. **$39.95**
Model SS-1B "Range Extending" hi-fi speaker system kit. 80 lbs. **$99.95**

Model HH-1 "Legato" hi-fi speaker system kit. 195 lbs. **$299.95**

HEATH COMPANY, Benton Harbor, Michigan

a subsidiary of Daystrom, Inc.

NEW: Heath Now Puts 2-Way Radiotelephone Communications in Reach of Everyone

Citizen's Band Transceiver Kit

NEW: No Radio Operators License Necessary!

NEW from the HEATHKIT COMMUNICATIONS LABORATORIES

- Designed to meet all FCC requirements for new 11-meter "Citizens Band" class D operation.
- Any U.S. citizen 18 or older eligible for license.
- No theory to study—no tests to take.
- Hundreds of uses in business or pleasure.
- Top quality components—proven performance—easy to build.

NEW

MODEL CB-1

Includes transceiver, microphone, and special power cords.

$42.95

First and only kit of its kind . . . designed to meet all FCC requirements for two-way radio telephone communication on new class D 11-meter "citizens band" . . . any U.S. citizen eighteen or older eligible for license . . . no code test, no radio theory exams, no knowledge of specialized operating procedures required . . . just fill out simple form included with kit and mail to FCC for registration. The Heathkit CB-1 Transceiver is light, compact, simple to assemble, easy to use. Buy two or more units, have your own communications system . . . talk with family, friends, associates from your car, home, boat or office . . . cover distances from one to ten miles depending on location and type of installation (extensively field tested). A flick of a switch selects "transmit" or "receive" while single receiver tuning control selects any of 23 assigned channels . . . third knob controls volume and turns set on and off. With separate vibrator power supply available from Heath, along with two special power cords included with kit, you can convert transceiver from fixed location at home or office to mobile operation in cars, boats, etc., in minutes, after initial installation, with no tools or adjustments. There's a Heathkit accessory antenna for any application, mobile or fixed. Kit comes complete with microphone, station identification card which fits in plastic window at end of cabinet, all pertinent FCC regulations and application forms, a sheet of adhesive-back letters and numbers to affix call letters in space provided on front panel, and crystal for one channel. Specify your frequency choice or we will supply crystal of appropriate frequency. The famous Heathkit quality coupled with the market-shattering low price of this kit make it truly a value of a lifetime.

SPECIFICATIONS—Receiver Type: Superregenerative detector w/rf stage. Power Input: 5 watts to plate of final RF amplifier (FCC maximum). Transmitter Frequency Control: Third overtone type quartz crystal operating within 0.005% of marked channel frequency between 32 F and 140 F. Modulation: AM plate modulation automatically limited to less than 100% (FCC requirements). Power Supply: 117 V 50/60 cycle, AC. 6 V battery using Model VP-1-6 Vibrator Power Supply or 12 V battery using Heathkit VP-1-12. Power Requirements: 117 volts 50/60 cycle AC 35 watts; 6 V battery w/VP-1-6, 6.5 amps., 12 V battery w/VP-1-12, 4.0 amps. Total B + requirements, 260 volts at 60 ma; total heater requirements, 6.3 volts at 1.8 amps. or 12.6 volts at 0.9 amps. Power Rectifier: 2 silicon diodes in full wave voltage doubler circuit. Microphone: Combination hand-held and desk type, ceramic element, plastic case, with cord and connector. RF Output Impedance: 50 ohms. Speaker Size: 4 inch (round). Undistorted Audio Power Output: Approximately 1 watt. Line Cords: Two supplied, one for AC operation, one for battery operation. Power circuits automatically switched when appropriate line cord is plugged in. Cabinet Dimensions: 8" H. x 6" D. x 9¾" W.

ANTENNAS

MODEL CBU-1 "UTILITY" ANTENNA

Low cost, portable antenna for CB-1 Transceiver for temporary installations, mobile or fixed, where maximum coverage is not required. Rugged clip for mounting on eaves-trough of house or rain gutters of cars, trucks, etc. Bracket supplied for mounting on transceiver or any flat surface. 45½" base-loaded, antenna with 12' connecting cable comes complete, ready to use.

$9.95

MODEL CBM-1 "MOBILE" ANTENNA

For CB-1 Transceiver permanent mobile installations where greatest coverage is desired. Easy to install double chain-type bumper mount spring base—no cutting or drilling. Easily adapted to boats, etc. ¼ wave whip antenna approximately 9' from mounting surface to tip—supplied with clip for securing in semi-horizontal position to clear obstructions. Kit is complete with 102" whip in 2 sections, 15' connecting cable and all necessary hardware.

$19.95

MODEL CBF-1 "FIXED LOCATION" ANTENNA

A ¼ wave "ground plane" type antenna for CB-1 Transceiver using 4 radial elements as the "ground plane" and 1 vertical element as the radiator. Excellent coverage, essentially non-directional, making it ideal for communications between fixed and mobile units. Antenna measures 9' 4" from bottom of mounting bracket to top of vertical radiator. Radial length 9'. Kit is complete with 50' connecting cable and easy to install mounting clamp.

$19.95

POWER SUPPLIES FOR MOBILE USE OF CB-1:

MODEL VP-1-6 Vibrator Power Supply kit for 6 volt batteries. Shpg. Wt. 4 lbs.

$7.95

Model VP-1-12 Vibrator Power Supply kit for 12 volt batteries. Shpg. Wt. 4 lbs.

$7.95

NEW

MODEL CO-1

$7.95

(batteries included)

NEW TRANSISTOR CODE PRACTICE OSCILLATOR KIT (CO-1)

Your best buy in a high quality code oscillator, the CO-1 is ideal for Boy Scouts or beginning radio hams. Practice code by authentic CW tone or blinker light. Switch selects built-in speaker or light. Contactor provided for practice keying or any standard key can be connected. Completely transistorized for long battery life. Powered by two standard flashlight batteries. Batteries included. Shpg. Wt. 3 lbs.

TRANSISTOR PORTABLES

. . . and other Do-It-Yourself Hobby Kits

Model XR-1P Transistor Portable Radio kit...6 lbs. **$29.95**
Model CR-1 Crystal Radio kit...3 lbs. **$7.95**
Model BT-1 Battery Tester kit...2 lbs. **$8.50**
Model ET-1 Enlarger Timer kit...3 lbs. **$11.50**
Model BR-2 Broadcast-Band Receiver kit..10 lbs...(less cab.).. **$18.95**
Model RC-1 Professional Radiation Counter kit...8 lbs. **$79.95**

MODEL XR-1P

MARINE KITS . . .

For Fun and Safety Afloat

Model DF-2 Two Band Transistor Radio Direction Finder kit 9 lbs. **$69.95**
Model FD-1-6 Fuel Vapor Detector kit (6 v.)...4 lbs. **$35.95**
Model FD-1-12 Fuel Vapor Detector kit (12 v.)...4 lbs. **$35.95**
Model MC-1 Marine Battery Charge kit...16 lbs. **$39.95**
Model PC-1 Power Converter kit...8 lbs. **$24.95**

MODEL DF-2

New—Electronic Ignition Analyzer Kit—IA-1A

NEW from Heath Test Equipment Labs

MODEL IA-1A
$59.95

- A Fraction of the Cost of Comparable Instruments
- Shows "Picture" of Entire Ignition System Performance on Cathode Ray Screen
- Shows Primary or Secondary Circuit Patterns
- "Trouble-Shoot" Complicated Ignition Faults in Minutes

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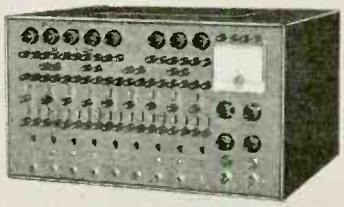

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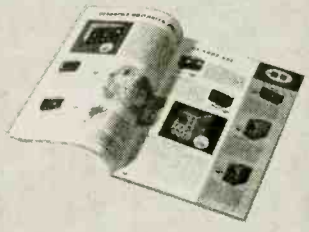

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AUDIO—HIGH FIDELITY

(*Continued from page 59*)

TCHAIKOVSKY: *Violin Concerto in D Major*
Alfredo Campoli, violin
Ataulfo Argenta conducting London Symphony Orchestra
London Stereo Record CS-6011

Those to whom this violin concerto is an old story will discover new footnotes in this exceptionally rich-sounding stereo recording. The projection of the soloist is noteworthy even by London's standards. This is the version to get if you want the full flavor of one of the juiciest violin concertos ever written.

Music for Dreaming
Paul Weston Orchestra
Capitol Stereo Record ST-1154

Mood music on records completes a full cycle with this stereo release. Paul Weston's original *Music for Dreaming* album, his first for Capitol, established a style in this field that has remained popular to this day. The same arrangements are used in this stereo album. The sound is exceptional—the sweetest stereo Capitol has produced to date in its pop releases.

Most Happy Hammond
Jackie Davis
Capitol Stereo Record ST-1046

Explore the nether regions of the swinging Hammond organ played by Jackie Davis in this collection of Broadway show tunes. Guitar, vibes and drums add life to an already exhilarating display of pyrotechnics.

MILHAUD: *La Creation du Monde*
STRAVINSKY: *L'Histoire du Soldat*
John Carewe conducting London Symphony Orchestra Chamber Group
Everest Stereo Record SDBR-3017

This is a biting stereo treatment of Stravinsky's *Soldier's Tale* which explores the extreme ranges of six instruments of the string, woodwind and brass families. A one-man percussion band enlivens the proceedings. Stereo spacing and audio know-how bring out both the sassiness of the Stravinsky score and the jazz idioms of the Milhaud ballet work.

Michael Todd's *Around the World In 80 Days* In Words and Music
Chorus and Orchestra conducted by Franz Allers
Everest Stereo Record SDBR-1020

The numerous episodes of the film "Around the World in 80 Days" have been recreated for the home listener through Victor Young's familiar music and a profusion of lyrics written for this new recording by Harold Adamson. Sound is clean but the ultra-wide stereo spacing is aimed at the console market that thrives on exaggeration of this kind.

Destination Stereo
RCA Victor Stereo Sampler Record LSC-2307

$2.98 spent here will span nine highlights of the RCA stereo catalog. Compared with the original releases, samples of earlier items such as *Lt. Kije* and *Pictures at an Exhibition*, reveal the improvements that have taken place in recent months in cutting and pressing techniques.

Can Can in Stereo
Suzanne Auber and French Orchestra
Rondo Stereo Record ST-556

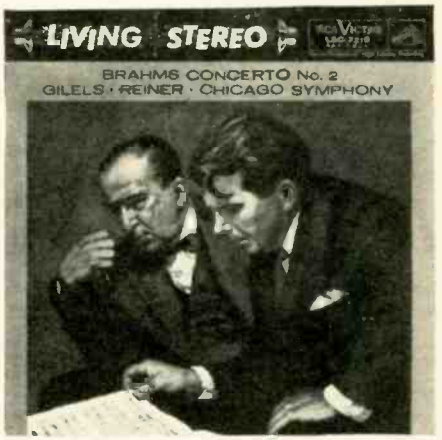
Rondo sells stereo discs in two price ranges, a Rondo-lette series at $2.49 and a top Rondo line at $4.98. Upon direct comparison, this $4.98 disc sounded no better than several Rondo lower-priced items. Pressings were noisy in each case. This potpourri of Offenbach melodies is marred by variable level in the right channel. Both channels began to lose presence after a half-dozen playings. If these are representative samples of Rondo's stereo efforts, both series are overpriced.

The Sound of New York
ABC-Paramount Stereo Record ABCS-2269

I can hear out-of-town listeners saying New York is a fine town to hear on records but—. Kenyon Hopkins, a film and TV composer, wrote and arranged this music–sound portrait of Manhattan. Actual sounds of traffic, the waterfront, subways, cocktail parties, etc. are used throughout the production to enhance the mood of these musical impressions of New York City. Optimum stereo is found in the parade sequence.

HINDEMITH: *Kleine Kammermusik*
DANZI: *Quintet, Opus 67, No. 2*
New York Woodwind Quintet
Concert-Disc Stereo Record CS-205

What a refreshing change of pace this record offers! Flute, oboe, clarinet, bassoon and French horn unlock the separate streams of melody in contemporary music by Hindemith and in Danzi's quintet which dates back to the Mozartean age. Concert-Disc has staked out a large claim in the relatively wide-open field of chamber music with this and other fine stereo recordings. The Mozart *Clarinet Quintet* (CS-203) and *Horn Quintet* (CS-204), the *Spohr Nonette* (CS-201) and the *Complete Quartets* of Bartok—these denote a real faith in the stereo medium.



BRAHMS: *Piano Concerto No. 2*
Emil Gilels, piano
Fritz Reiner conducting Chicago Symphony Orchestra
RCA Victor Stereo Record LSC-2219

An intriguing choice confronts the listener trying to decide between the mono and stereo versions of this work. Each has its points of superiority. The piano of Soviet virtuoso Gilels has a three-dimensional quality in stereo but the mono disc, on the best equipment, conveys more of the frequency range and dynamics on the master tape. The orchestra, on the other hand, is more believable in stereo with effective interplay among the instrumental choirs. Those with medium-rated components may prefer the stereo version but the full tonal excitement of the pianist's performance resides in the monophonic disc (LM-2219).

ORFF: *Carmina Burana*
Leopold Stokowski conducting Houston Chorale and Houston Symphony Orchestra
Capitol Stereo Record SPAR-8470

Carmina Burana, a collection of medieval poems set to music by a German composer unknown in this country 5 years ago, attained enormous popularity. Leopold Stokowski first introduced this modern tonal painting of the Middle Ages to a New York concert audience in 1954. His subsequent association with the music and Capitol's sonorous recording assure this release a high place in the stereo catalog. Some of the immediately apparent attractions in the recording are the prominence of the bass instruments, the power of the percussion section and the imposing amplitude of the choral climaxes. The solo voices are only regional in stature but stereo helps Stokowski put on a show.

BACH: *Mass in B Minor*
Hans Grischkat conducting Swabian Chorale and Orchestra of 35th German Bach Festival
Stereovox Records (3) STPL 511.283

The appearance of a Bach *B Minor Mass* on stereo records is an event of musical importance. Vox bolsters its already considerable monophonic prestige in the category of choral music with a capable performance in the German tradition. Sound is excellent according to stereo standards of the day. Admittedly a luxury in some music on records, stereo now restores this work to the stature it once enjoyed only in live performance. Westminster has announced plans for a new recording of the Bach *B Minor Mass*. Other versions undoubtedly will follow but Vox has paved the way with distinction.

PUCCINI: *La Fanciula Del West*
(The Girl of the Golden West)
Franco Capuana conducting Chorus and Orchestra of Accademia di Santi Cecilia, Rome
London Stereo Records (3) OSA-1306

In the opinion of many music lovers, London's opera albums clinched the argument in favor of disc stereo. The latest release to reach me finds London invading territory unexplored by monophonic recordings. Although reasons may be

found for the neglect suffered by this Italian opera of mining days in our Wild West, the cast headed by Renata Tedaldi and Mario del Monaco receives from London's engineers the finest treatment yet accorded them.

NOTE: ***Records below are 12-inch mono LP and play back with RIAA curve unless otherwise indicated.***

Shakespeare's Ages of Man
Sir John Gielgud
Columbia OL-5390

During a recent highly successful American tour, the noted British actor Sir John Gielgud demonstrated in a one-man performance that the voice can be mightier than the pen. On a stage devoid of scenery, Sir John brought to life a multitude of Shakespeare's characters in their youth, manhood and old age. In recording the greater part of this production, Columbia has earned the gratitude of those who admire virtuosity in the spoken word.

The Birth of Big Band Jazz
Duke Ellington—Fletcher Henderson
Riverside RLP-12-129

This release, part of the Riverside Jazz Archive Series, contains some of the earliest Ellington recordings and a 5-year span of the mid-Twenties Henderson band. The Duke's side is a fascinating segment of the history of arranged jazz. Recorded in 1926, it foreshadows the reason for the band's first big break that was to come a year later at the Cotton Club in Harlem.

BEETHOVEN: ***Symphony No. 6 (Pastoral)***
Otto Klemperer conducting Philharmonia Orchestra
Angel 35711

A serious discussion of the Beethoven and Brahms symphonies on records inevitably centers on the names of three interpreters—Toscanini, Walter and Klemperer. New chapters are still being added to the Walter and Klemperer stories as these men continue to rerecord the classics in today's sound. The recent Columbia version of the *Pastoral* by Bruno Walter (MS-6012) has the advantage of stereo and a realistic duplication of concert hall acoustics. Klemperer, on the other hand, makes excellent use of the opportunities for fine detail afforded by EMI's familiar studio setup of the orchestra. Some collectors of basic repertory may reserve their choice until the Angel stereo version comes along. They won't go wrong with either performance.

FRANCK: ***Symphony in D Minor***
Sir Thomas Beecham conducting Orchestre National de la Radiodiffusion Française
Capitol-EMI G-7157

Sir Thomas held title to one of the better recorded versions of this work in 78-rpm days. Now, with the aid of a leading French orchestra and up-to-date recording, he approaches the top of the LP list with a performance whose warmth and radiance cannot be challenged. Surface noise in low-level passages is the sole drawback.

Jazz Festival in Hi-Fi
Warner Bros. Record W-1281

This showcase of Warner Bros. jazz artists solves a problem frequently encountered by purchasers of sampler albums. These 10 selections were prepared especially for this release and are not duplicated in the regular albums.

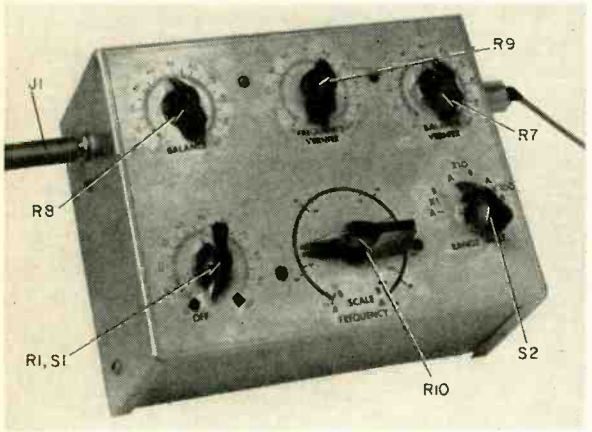
Standout tracks are those by the Trombones, Inc., the First Jazz Piano Quartet, Matty Matlock's Dixieland group, the Fred Katz Orchestra and the Morris Nanton Trio. The natural potency of the sound obtainable in today's better recording studios is maintained with a minimum of electronic embellishment.

STRAVINSKY: ***Agon Ballet***
BERG: ***Three Pieces for Orchestra***
WEBERN: ***Six Pieces for Orchestra***
Hans Rosbaud conducting Südwestdeutsches Orchester
Westminster XWN-18807

Have you noticed that modern music becomes more accessible when the recording is absolutely first-rate? The recent success at the Metropolitan Opera of Alban Berg's *Wozzeck* should spark interest in his *Three Pieces for Orchestra* recorded here. The transparency of Stravinsky's orchestral writing has been preserved to a remarkable degree by the German recording technicians involved in this mature project. END

Name and address of any manufacturer of records mentioned in this column may be obtained by writing Records, RADIO-ELECTRONICS, *154 West 14 St., New York 11, N.Y.*

Note two frequency scales on the front panel.



Measure HARMONIC DISTORTION

Distortion measurements in low-level circuits require special instruments. This one checks harmonic percentage

By GLENN E. JOHNSON

As the number of transistor devices increases, an instrument that can make distortion measurements at low levels is needed. Some transistor output circuits develop only 25 mw into 8- or 4-ohm loads. Any test of distortion at this level means that the output voltage is less than 0.5.

With the instrument described in this article, a 70-mv input is large enough to give the calibrating 1 volt out. The unit's sensitivity is not improved by sacrificing its ability to go into a deep null, and distortion measurements can be made down to 0.1% without noise becoming a problem.

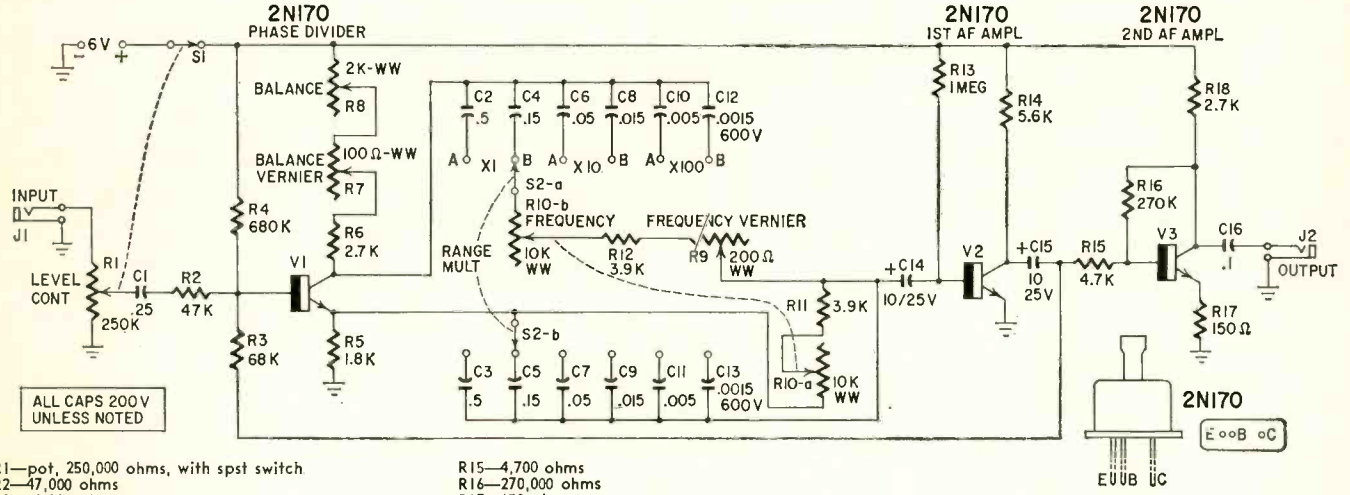
Three transistors are used in the analyzer, and they offer distinct advantages. Power supply problems are eliminated—batteries put an end to filtering and regulation. Low-impedance circuitry throughout, coupled with the absence of hum, makes a deep null possible, uncluttered with confusing noise and hum.

How it works

Performance and action of the transistor circuitry compare favorably with its vacuum-tube brother (see schematic). The input voltage is fed to a phase divider (V1) that develops twice the voltage at the collector as in the base. This meets the requirements for the Wien-bridge null network. The Wien bridge supresses the fundamental without materially affecting the harmonic content. The residual voltages that represent the distortion content are amplified and measured.

The other essential requirements are to maintain a low distortion level and make sure the second harmonic is not attenuated with the fundamental. Both are met with a generous amount of feedback. The output of the first audio amplifier, V2, is fed back to the analyzer's input through a 68,000-ohm resistor (R3). The negative feedback introduced in this way reduces the distortion created by the analyzer and sharpens the null. Use of a low signal level in the input circuit also tends to lower inherent distortion.

Using transistors rather than tubes has made some circuit changes necessary. Instead of variable capacitors as the variable element of the null network, the resistance is varied. This is done because low impedances are necessary. The FREQUENCY control (R10) is, therefore, a dual 10,000-ohm wirewound potentiometer, limited in range by series-connected 3,900-ohm fixed resistors (R11 and R12). The RANGE MULT

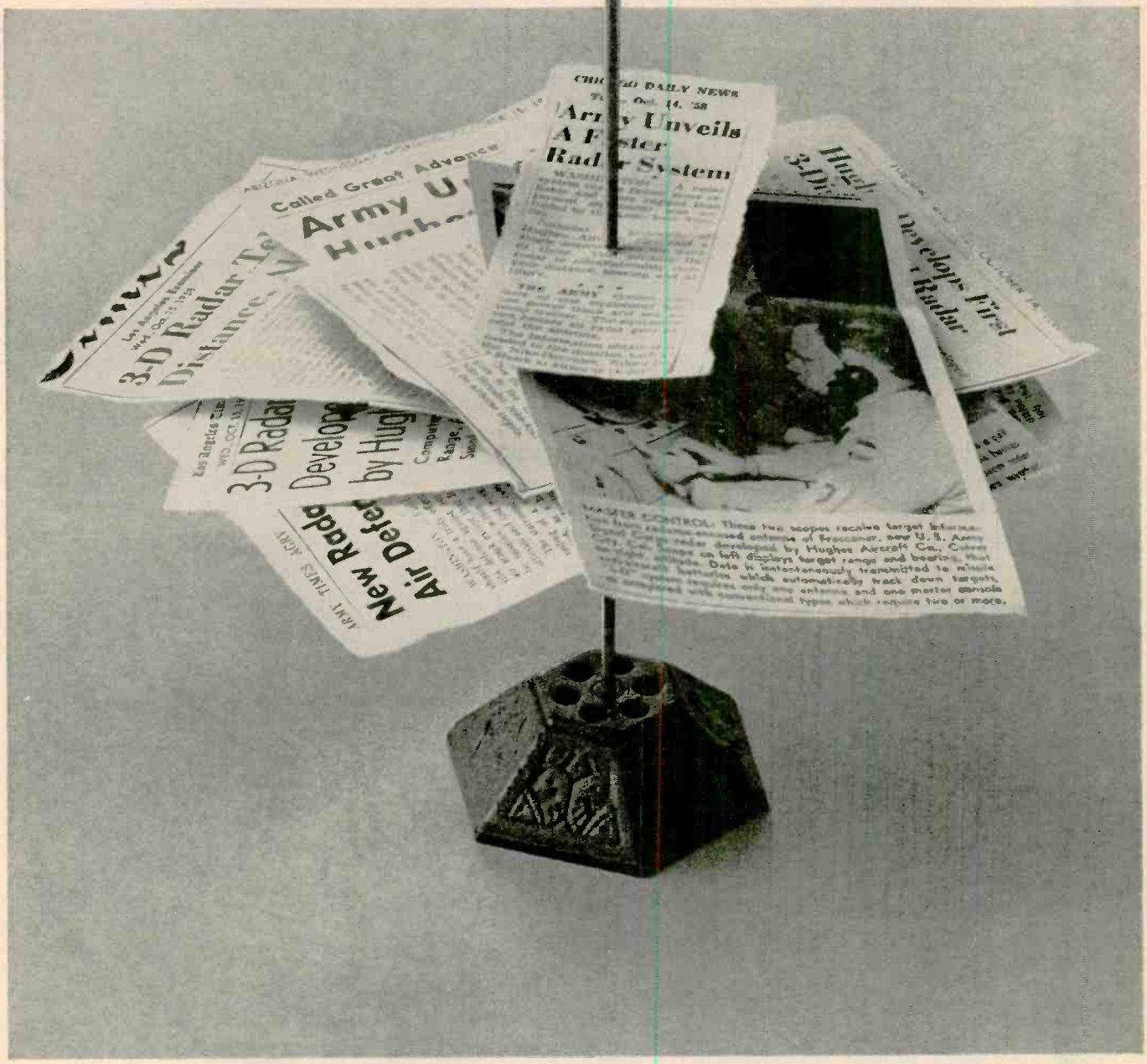


R1—pot, 250,000 ohms, with spst switch
R2—47,000 ohms
R3—68,000 ohms
R4—680,000 ohms
R5—1,800 ohms
R6—2,700 ohms
R7—pot, 100 ohms, wirewound
R8—pot, 2,000 ohms, wirewound
R9—pot, 200 ohms, wirewound
R10—pot, dual 10,000 ohms, wirewound
R11, 12—3,900 ohms
R13—1 megohm
R14—5,600 ohms
R15—4,700 ohms
R16—270,000 ohms
R17—150 ohms
R18—2,700 ohms
All fixed resistors ½ watt
C1—0.25 μf
C2, 3—0.5 μf
C4, 5—0.15 μf
C6, 7—.05 μf
C8, 9—.015 μf
C10, 11—.005 μf
C12, 13—.0015 μf, 600 volts
C14, 15—10 μf, 25 volts, electrolytic
C16—0.1 μf
All capacitors 200 volts unless noted
J1, 2—phone jacks
S1—spst on R1
S2—2-pole 6-position rotary
V1, 2, 3—2N170
Battery, 6 volts, (4 flashlight cells in series)
Chassis, 8 x 6 x 3½-inch aluminum box
Knobs
Miscellaneous hardware

Three inexpensive transistors give the circuit its 70-mv sensitivity.

WANTED:

Engineers who can top these stories



Hughes new frequency scanning radar has been called the most important new development in the art since radar itself was conceived. Mechanical antenna movement has been largely eliminated. The radar beam is positioned in space by varying the frequency of the electromagnetic energy applied to the antenna.

Already, this new principle has proved its mettle. The Army's new Frescanar radar handles a large number of targets with great accuracy and presents all information with three-dimensional realism.

Obviously this is but one step in the evolution of this new radar principle. Hughes Fullerton needs engineers who can exploit this breakthrough and go on to discover new commercial and military applications as yet undreamed of.

Hughes Fullerton is now rapidly expanding. While the main emphasis is on advanced Research and development work, there are positions open in a variety of engineering activities.

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HUGHES

GROUND SYSTEMS
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Hughes Aircraft Company
Fullerton 6, Orange County, California

The unit operates substantially as stated by the author. Nulls are sharp, clearly defined and easy to locate.

As the unit is calibrated by making resistance measurements, panel markings may not be exact. However, in making distortion measurements this causes no problems. The panel markings give you a starting point and the null will fall slightly to the right or left of this point.

If accurately calibrated—use a laboratory audio generator or audio signals of known frequency—the analyzer can be used to determine the frequency of an unknown tone.

CALIBRATION CHART

Range A		Range B	
Frequency (cycles)	Resistance (ohms)	Frequency (cycles)	Resistance (ohms)
23	13.9K	75	13.9K
25	12.7K	85	12.5K
30	10.6K	100	10.6K
40	7.95K	125	8.48K
50	6.35K	180	7.08K
60	5.3K	200	5.3K
70	4.55K	225	4.7K
80	3.9K	270	3.9K

switch (S2) has six positions covering 23 to 27,000 cycles. Every other switch position decades, so the control has two scales: 23–80 and 75–270. To have used only three ranges would have made it difficult to get a null on the low-resistance end of R10. The six ranges make it possible for the operator to get a fine null, even without using the FREQUENCY VERNIER control (R9).

Range capacitors may have to be selected. Even though the BALANCE control (R8) can be adjusted to compensate for misbalance between capacitors, extreme misbalance may exceed its range. If poor tolerance capacitors (20%) are used, frequency decading will not be accurate, but in this type of instrument this is not necessary.

The instrument's input impedance, at its maximum sensitivity of 70 mv, is 50,000 ohms. This increases rapidly as the LEVEL CONT (R1) is turned down for higher input levels. For example, at an input voltage of 0.3, the input impedance is above 200,000 ohms.

The harmonic content amplified by V2 is fed to V3 for further amplification, and on to an external indicator—audio vtvm or scope. A set level of 1 volt is used, and distortion percentage is arrived at by determining the percentage of the residual compared to the 1-volt set level—10 mv becomes 1% distortion. The 1-volt set level is set at a frequency beyond the second harmonic of the test frequency. For example, if 400 cycles is to be used to check harmonic distortion, the LEVEL CONT is adjusted for a 1-volt output at some frequency beyond 800 cycles.

Construction and calibration

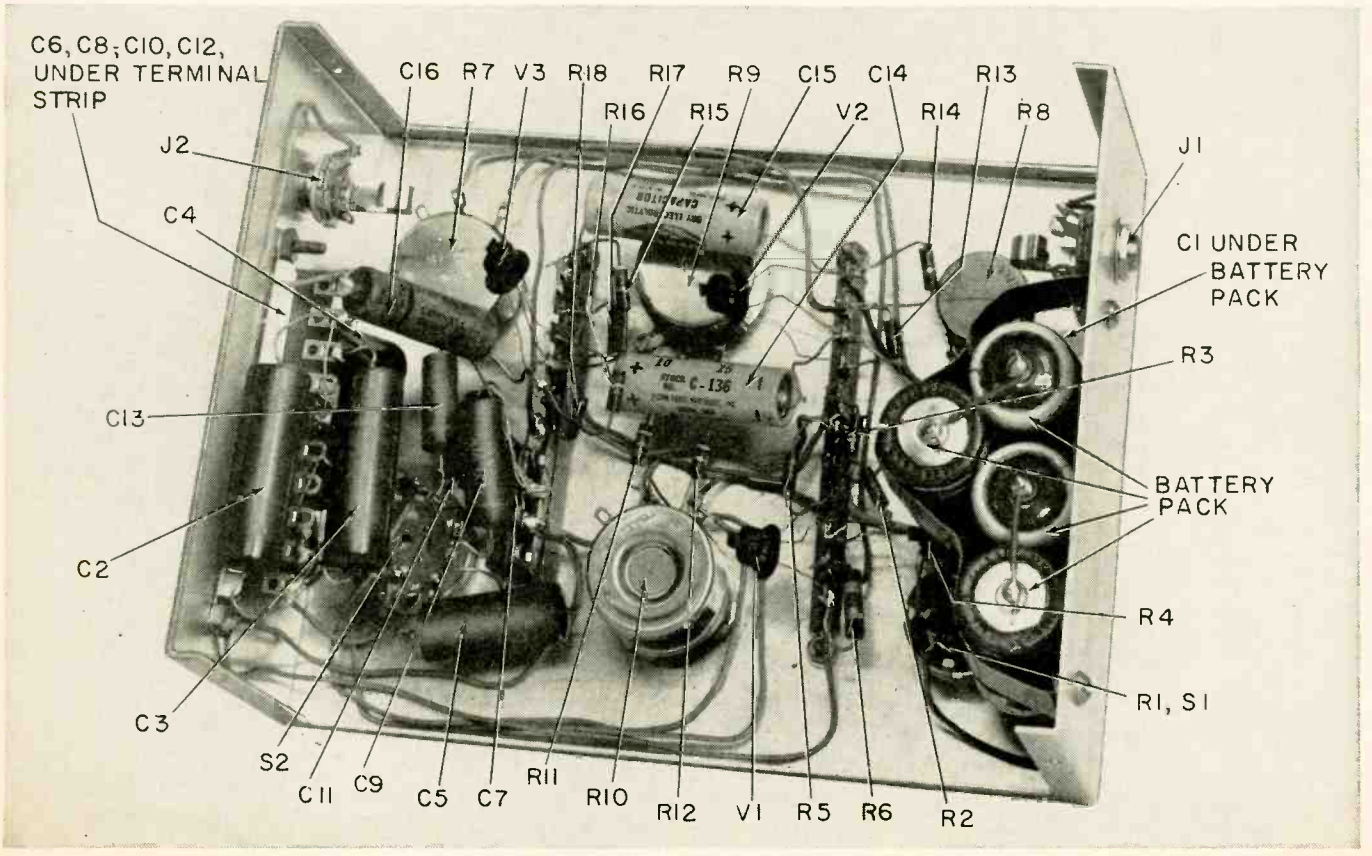
The unit is built into an 8 x 6 x 3½-inch aluminum box. Transistors and associated components are mounted on three terminal strips. The 2N170 transistors are easily available and prove satisfactory for the job.

It is best to calibrate the FREQUENCY control against an ohmmeter rather than against actual frequency. If you use 20% capacitors in the null network, the actual frequency will appear a little to the left or right of the calibrated point, representing the amount of capacitor inaccuracy. The calibration chart shows the frequency calibrating points related to resistance measured from the arm of potentiometer R10-b to the far end of resistor R12. In other words, 3,900 ohms plus the variable value of the pot.

The grouping of the controls is not critical and is governed by convenience. The central control is the frequency-setting dual pot R10. Other controls are arranged around it. The arrangement I used is shown in the photos. If you find some other setup more convenient, use it.

In operation, the unit's null is sharp. The wirewound controls cause no difficulty since fine controls are provided for both balance and frequency settings. A greatly misbalanced circuit—R8 at the extreme end of its range—may cause it to oscillate because of feedback through R3.

The analyzer's final sensitivity will depend to a large extent on the gain of the transistors used. Of several that were tested, many showed gains of over 70. This is a great deal more than the expected gain of 32. The gain variation may make it necessary to adjust the value of feedback resistor R3. It should be set for a minimum of variation in the set level when the range switch is rotated. Too low a value will make the analyzer susceptible to oscillation and reduce its sensitivity. END



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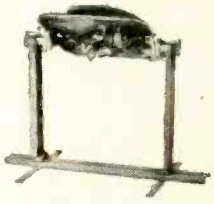

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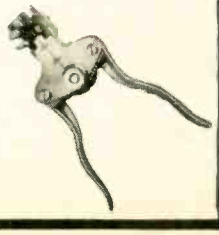

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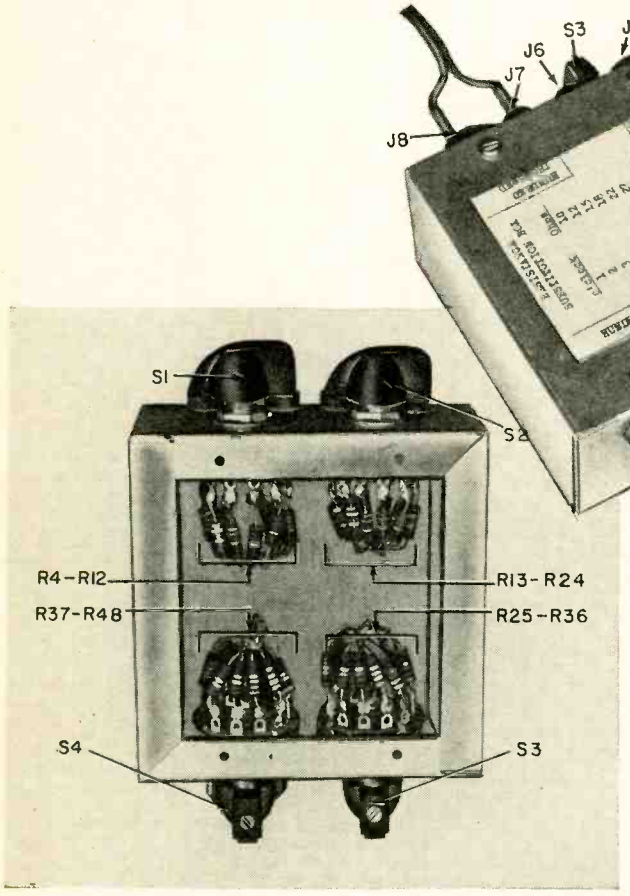
RESISTOR SUBSTITUTOR

All common resistance values from 100 to 820,000 ohms, in one compact box

By I. QUEEN
EDITORIAL ASSOCIATE



(Above) The completed substitutor. Chart on top shows switch position for desired value.

(Left) Plenty of room for all parts, even in this small case.

A RESISTOR substitutor is simple to build and always useful. It allows a desired resistance value to be conveniently selected. This resistance may be temporarily substituted for an unknown or defective unit or it may be used in an experimental circuit to note the effects of different values. For lab work, it is usual to work with a precision decade box that allows resistance selection to within 1 ohm or even 1/10 ohm. A simpler arrangement is desirable for servicing or experimental work.

Fig. 1 is a circuit that offers any preferred resistance value (± 10%) from 100–820,000 ohms. There are several advantages to this arrangement.

There are an even dozen resistance values in each decade, so a common 12-pole switch can be used. There are four decades with a separate switch for each. Calibration is easy, for only a single chart is needed (Table I). To select any desired resistance, note the first two significant digits, which correspond to a given switch position. Since there are 12 positions, we may mark them as numbers on a clock. Thus, 3 o'clock means that the switch is pointing right, and 6 o'clock is straight down. The first decade switch adds a single zero, the next two and so on. Or you can consider the first switch as hundreds, the next thousands, etc.

For example: to select 3,300 ohms, set the thousands or second decade switch to 7 o'clock.

R1—100 ohms	R17—2,200 ohms	R33—47,000 ohms
R2—120 ohms	R18—2,700 ohms	R34—56,000 ohms
R3—150 ohms	R19—3,300 ohms	R35—68,000 ohms
R4—180 ohms	R20—3,900 ohms	R36—82,000 ohms
R5—220 ohms	R21—4,700 ohms	R37—100,000 ohms
R6—270 ohms	R22—5,600 ohms	R38—120,000 ohms
R7—330 ohms	R23—6,800 ohms	R39—150,000 ohms
R8—390 ohms	R24—8,200 ohms	R40—180,000 ohms
R9—470 ohms	R25—10,000 ohms	R41—220,000 ohms
R10—560 ohms	R26—12,000 ohms	R42—270,000 ohms
R11—680 ohms	R27—15,000 ohms	R43—330,000 ohms
R12—820 ohms	R28—18,000 ohms	R44—390,000 ohms
R13—1,000 ohms	R29—22,000 ohms	R45—470,000 ohms
R14—1,200 ohms	R30—27,000 ohms	R46—560,000 ohms
R15—1,500 ohms	R31—33,000 ohms	R47—680,000 ohms
R16—1,800 ohms	R32—39,000 ohms	R48—820,000 ohms

All resistors ½ watt, 10 %
J1–8—insulated pin jacks
S1–4—single pole, 12 positions, rotary (shorting)
Case, 4 x 2 x 2 inches
Knobs, arrow (4)

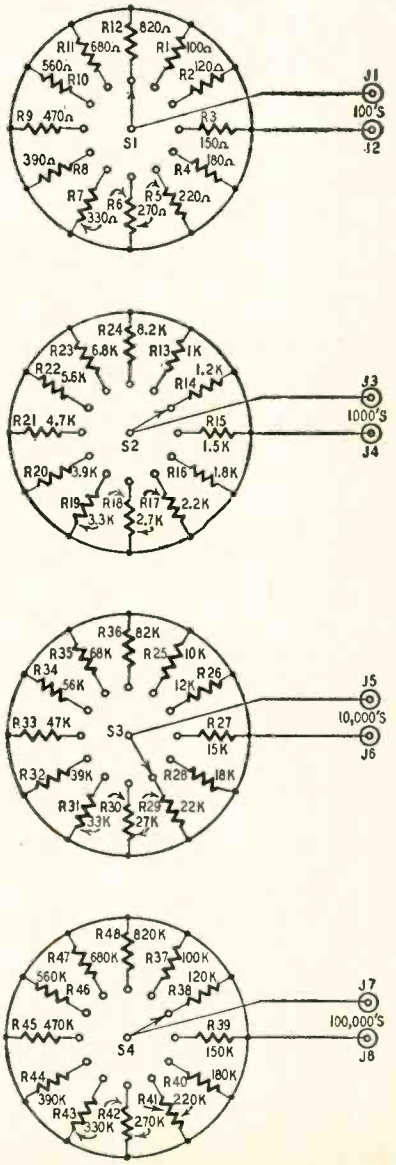
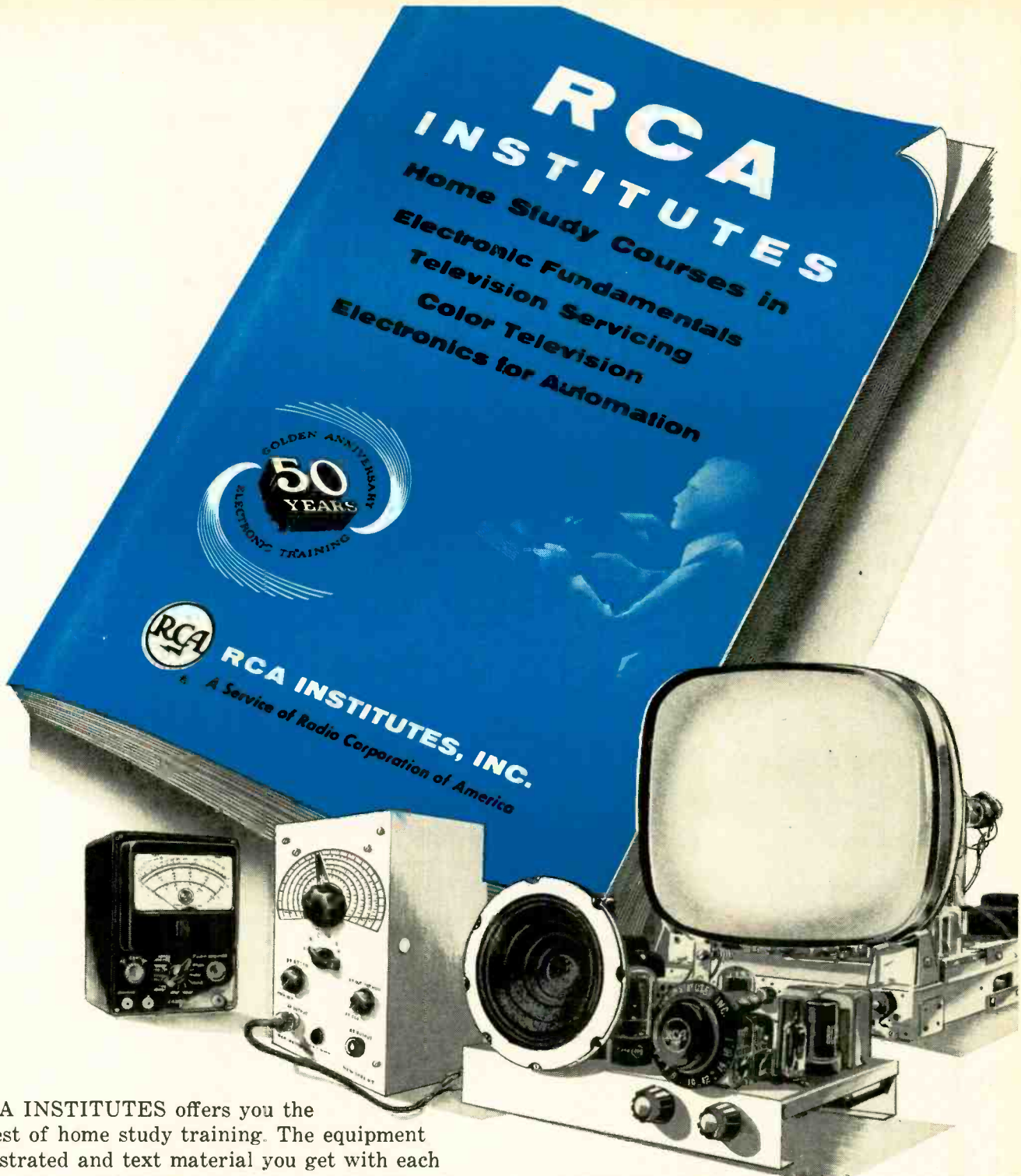


Fig. 1—Circuit of four-decade unit.



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TEST INSTRUMENTS

Note that each decade has its own output terminals. This makes it possible to use several substitution resistances at the same time. The only requirement is that they be in different decades.

The substitution circuit is built into a 4 x 2 x 2-inch aluminum box. Two decades are mounted on the front, the other

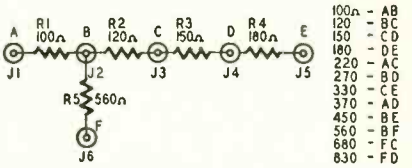


Fig. 2—Simpler resistor substitutor circuit.

two on the rear. Each pair of terminals is close to its own decade knob so there can be no error.

Those who wish a still simpler resistance box can use the circuit of Fig. 2. This is not nearly as convenient to use but it requires only five resistors and six pin jacks per decade. It compares with 12 resistors, a multiple-pole switch and two pin jacks per decade for Fig. 1. To set this box, phone tips may be plugged into appropriate jacks to select the desired resistance as shown in the table with Fig. 2. As before, additional decades may be connected. In this circuit note that three of the resistor values are not actually preferred values but are quite close. END

TABLE I

Resistance (first 2 digits)	O'clock
10	1
12	2
15	3
18	4
22	5
27	6
33	7
39	8
47	9
56	10
68	11
82	12

"I'm taking a correspondence course, lady, and I'm afraid I'll have to wait for my next week's lesson before I can finish."

TEST INSTRUMENTS

Damping Capacitors for Bilateral Instruments

By RONALD L. IVES

TO increase damping of direct-current instruments and protect their meter movements against surges and ripple, they are usually shunted with a large capacitor. Normally, these are electrolytics—because of size, weight and cost—so they must be polarized, as in Fig. 1.

This works well for unilateral instruments in which pointer movement is from zero to one side. But it is not satisfactory for zero-center or bilateral instruments because electrolytic capacitors are definitely polarized and, if used or connected with reversed polarity, they function as rather poor rectifiers. Long or repeated use in reversed polarity may destroy or alter the properties of the device.

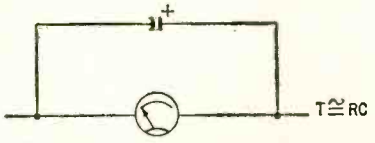


Fig. 1—Damping a dc meter with an electrolytic capacitor.

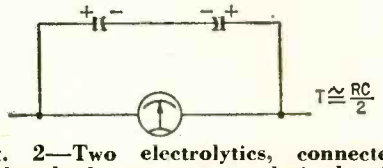


Fig. 2—Two electrolytics, connected back-to-back act as a nonpolarized unit, but for damping to equal Fig. 1 four times the capacitance is needed.

To prevent this difficulty, two equal capacitors are connected in series, with back-to-back polarization, across the bilateral instrument, as in Fig. 2. This works well but requires a lot of capacitance to get the needed damping as the time constant—due solely to resistance and capacitance—is only ½RC here, while in the simple connection (Fig. 1) it is RC.

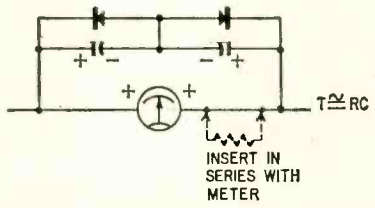


Fig. 3—Shunting the capacitors with reversed diodes effectively doubles the amount of damping you get from the Fig. 2 arrangement.

To produce Fig. 2 damping equal to Fig. 1 damping, four times as much capacitance, with comparable increases in cost and bulk is required. Where considerable damping is required, the capacitor bank is larger than the instrument and may cost almost as much.

The cost of this damping can be markedly reduced and the capacitor bank's bulk approximately halved by shunting each capacitor in Fig. 2 with a reversed diode, as in Fig. 3. With this connection, the instrument's time constant—capacitor assembly, neglecting electromechanical damping within the instrument—is RC. Whatever the signal polarity, only one capacitor is in use. The other is bypassed for dc by the diode.

If circumstances permit, a resistor should be inserted in one instrument lead (dashed in Fig. 3) to increase the damping. END

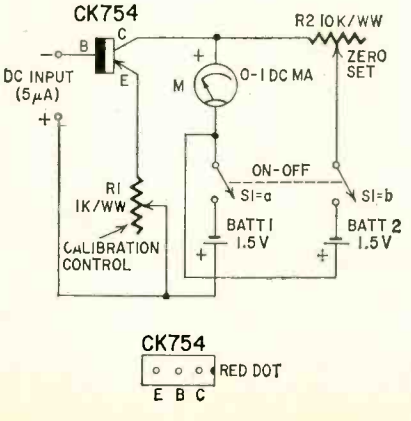
TRANSISTOR DC MICROAMMETER

By RUFUS P. TURNER

The diagram shows a single-stage transistor dc microammeter circuit in which a 5-μa input deflects a 0–1 ma dc meter to full scale. Formerly, this sensitivity could be obtained only by using two or more cascaded stages. The high gain is supplied by the CK754 transistor which has a short-circuit beta rating of 300. The current source should have high resistance.

Circuit sensitivity is improved by using a separate zero-set battery (BATT 2) and potentiometer (R2) instead of the usual resistance-bridge arrangement. Because of the low current drain, both batteries may be size-C flashlight cells.

The circuit is temperature-sensitive. This causes the zero to move upward as temperature rises. However, potentiometer R2 provides an adequate range for correcting the zero over a wide temperature range. This occasional resetting operation is no more troublesome than resetting an ohmmeter. END



Part II—Systems and circuits for SSB communications

THE SINGLE-SIDEBAND STORY

By EDWARD M. NOLL

SINGLE-SIDEBAND communication is gaining more and more proponents. Modern systems are compact, easy to adjust and operate, and offer a high degree of reliability and interference rejection. The electronic technician can readily understand methods and circuits because SSB is no longer the complex electronic science it once was.

A typical SSB system developed by the Crosby Laboratories is shown in Fig. 1. Such systems, with only 30–50 watts peak envelope power, provide reliable communications for ranges up to 500 miles. Under adverse reception conditions, they are said to perform better than 150- to 350-watt AM systems.

As shown in Fig. 1, a crystal oscillator supplies the initial carrier that is to be modulated by the audio information. The triple-triode modulator (Fig. 2) forms a double-sideband signal with the carrier removed. Note that the carrier is applied to the grid of the first triode, acting as a cathode follower. The carrier is cathode-coupled to the second and third triodes.

Audio is applied to the grid of the second triode, also connected as a cathode follower. The actual modulation occurs in the third triode. Proper bias for this modulator is supplied by the cathode bias arrangement of the third triode. The output of the third triode is double-sideband.

The carrier is removed by supplying the proper level of carrier alone to the grid of the third triode. This component is out of phase with the carrier on the cathode. Hence the two carrier components can be cancelled in the output by adjusting the balance control. A neutralization capacitor, C_N, overcomes any direct carrier feedthrough via tube capacitances.

The double-sideband signal is stepped up by a low-power linear amplifier and applied to a mechanical sideband filter that removes one of the sidebands. The SSB signal is amplified again and applied to a balanced converter. In this stage, the signal is stepped up in frequency by a heterodyning process. A second higher-frequency crystal oscillator supplies the beating carrier. A balanced converter keeps the carrier out of the output.

The converter's output is the SSB signal set to its transmitted frequency. A buffer and a push-pull linear power amplifier provide the final amplification prior to the transmission.

The front end of the SSB receiver starts with a two-stage rf amplifier and a mixer. The local-oscillator signal is supplied by a stable vfo or a crystal oscillator. An if amplifier and sideband

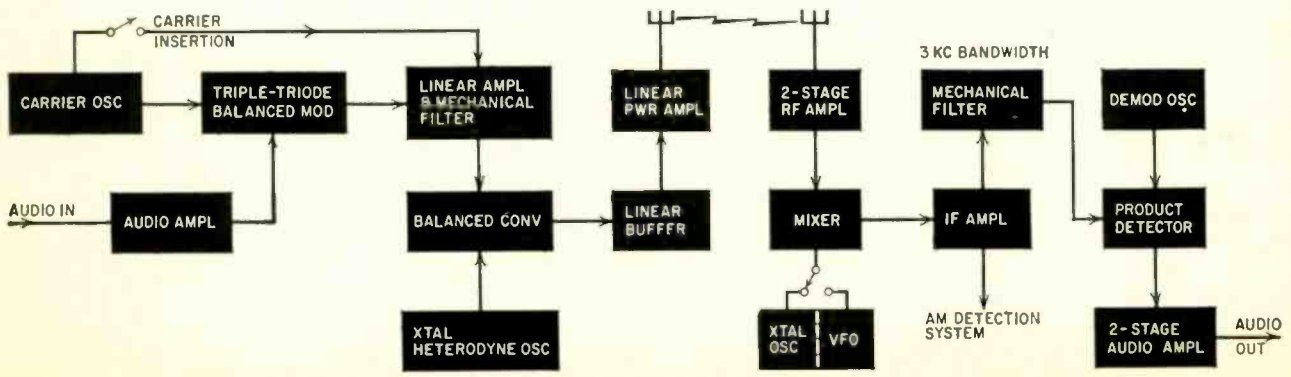


Fig. 1—Crosby Laboratory SSB system.

filter follow. The SSB signal is fed to the demodulator next. Crosby equipment uses a triple-triode product detector.

The demodulated signal is amplified by two audio stages. A low-pass filter arrangement at the output provides additional noise suppression, attenuating all noise and interference components above the 3,000-cycle high-frequency limit of the voice range. The bandwidth of the mechanical filters and the overall SSB system is some 3,000 cycles. Narrow bandwidth improves selectivity, and noise and interference rejection.

The triple-triode product detector (Fig. 3) consists of two cathode followers to which the sideband signal and the demodulating carrier from the crystal oscillator are applied. Combined carrier and SSB signal are applied to the cathode-driven output stage. This stage is cathode-biased for a strong linear output. The output circuit selects the difference frequency (original audio information) and filters out the demodulating carrier and the sideband frequencies.

Single-sideband converter

Crosby Laboratories also have an SSB converter. This type of unit is attached to conventional communications receivers to permit SSB reception without sacrificing some of the advantages of SSB transmission.

The receiver's if output is connected to an input converter (Fig. 4). The output of the beating oscillator drops the SSB signal frequency to the 250-kc range. A sideband filter and narrow-band if amplifier insure a 3-kc selectivity. A triple-triode product detector and demodulating carrier oscillator follow. The audio output is fed back into the audio system of the communications receiver.

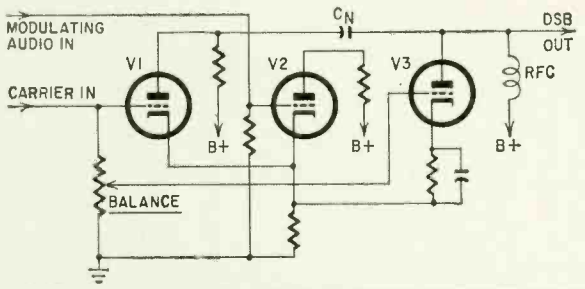


Fig. 2—Triple-triode modulator.

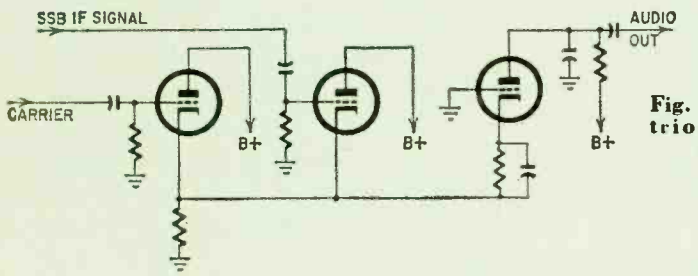


Fig. 3 — Triple-triode product detector.

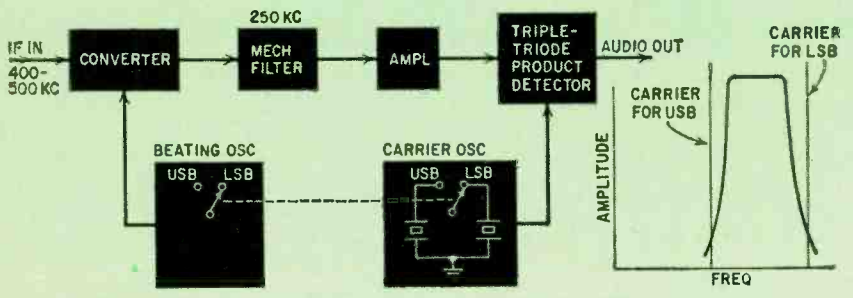


Fig. 4—Functional block diagram of Crosby SSB converter.

SSB transceivers

SSB is adaptable to communications receiver design. The various beating and carrier oscillators can supply signals for both the transmitter and receiver sections of the unit. A typical communications transceiver is the RCA SSB-1 shown in Fig. 5.

The transceiver can be used for voice or code communications using single sideband with suppressed (reduced) carrier or completely removed carrier. With the insertion of a carrier, a standard AM communications receiver can demodulate the signal. Code transmission facilities include a 1,000-cycle tone oscillator that is keyed and then used to modulate the transmitter.

The first beating oscillator operates at 250 kc. If we assume a 1,000-cycle modulating signal, the double-sideband output of the balanced modulator would locate sidebands at 249 and 251 kc. A mechanical filter follows to take out the low-frequency sideband. Notice that a switch is included for reinserting the carrier, when desired, at the output of the filter.

Two balanced-modulator converters follow the sideband filter. The second beating oscillator operates on 1,150 kc. When mixed with the 251-kc SSB signal in the converter, the sideband output will be 1,401 kc. The converter is of the

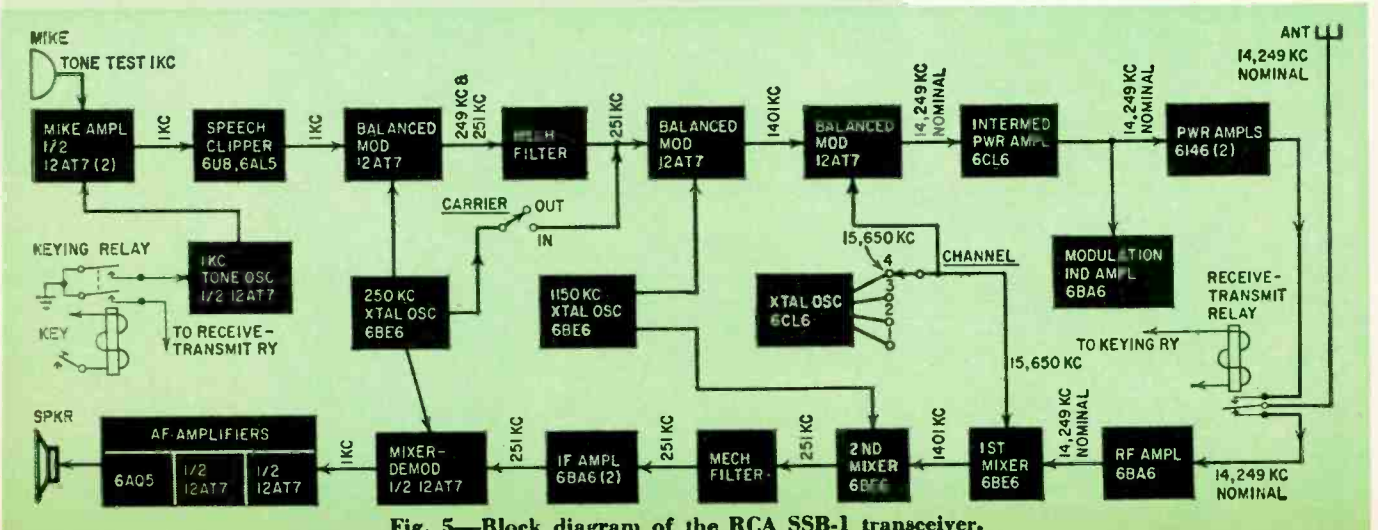


Fig. 5—Block diagram of the RCA SSB-1 transceiver.

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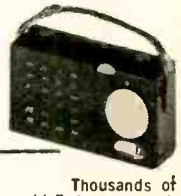

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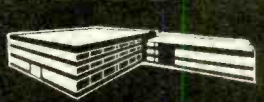

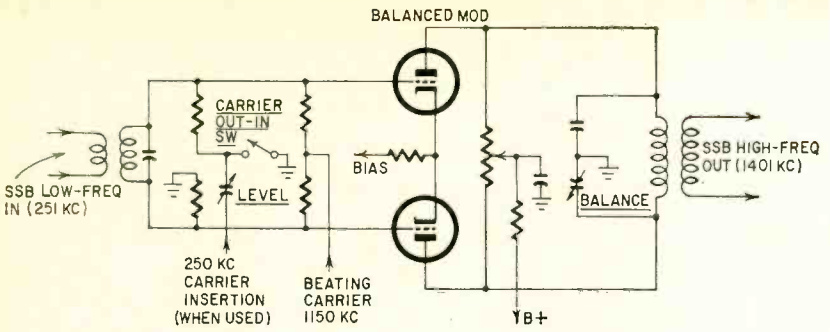

Fig. 6—Balanced modulator converter.

balanced type. Hence the 1150-kc beating carrier is not passed to the output.

A two-triode balanced modulator is used as in Fig. 6. The SSB signal drives the grids in push-pull; the beating carrier drives them in parallel. As the output is push-pull, the carrier cancels when the stage is balanced correctly. When a carrier is to be inserted, a 250-kc component is added at the modulator input. A carrier level control regulates the strength of the transmitted carrier.

The final beating oscillator in the RCA block diagram operates on 15,650 kc, producing a sideband frequency of 14,249 kc at the output of the final balanced modulator. Notice that a channel switch is shown with the final crystal oscillator. This permits a choice of crystal frequencies according to the transmission channel to be used. Equipment can be operated on any frequency between 3 and 15 mc.

Two power-amplifier stages follow. The final one excites the antenna through the relay contacts. This relay operates in conjunction with the transmit–receive switching, changing over the single antenna between transmitter output and receiver input.

Receive section

When any other station on the SSB network transmits (assuming channel 4 operation), it is picked up on the antenna. If 1,000-cycle modulation is present, the sideband frequency is again 14,249 kc. It first passes through an rf amplifier to the first mixer. Here it beats with a 15,650-cycle component from a crystal oscillator. Note that the beating signal from this crystal stage was also used in the transmit operation. All the crystal oscillators perform similar functions on transmit and receive.

The second mixer beats the SSB signal down to 251 kc. A following filter passes only the desired sideband spectrum. After additional amplification, the SSB signal is applied to the mixer demodulator.

The demodulator is a heterodyning product detector (see Fig. 7). It is a simple triode mixer with SSB signal (251 kc) and demodulating carrier (250 kc) applied to the control grid. Sum and difference frequencies appear in the output (501 kc and 1 kc). However, the 501-kc component is filtered out while the 1,000-cycle modulation is passed on to the audio amplifier system.

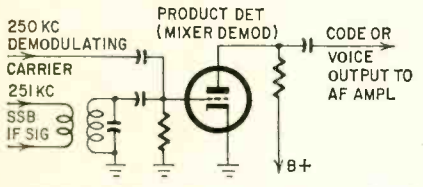

Fig. 7—Product detector for SSB receivers.

Phase-shift SSB system

One of the more recent SSB advancements has been the development of practical systems operating on a phase-shift principle. Such systems are employed in more elaborate and versatile SSB facilities. However, practical and economical phase-shift systems have been used by radio amateurs.

In the phase-shift method, as shown in Fig. 8, a so-called "doubly balanced modulator" is employed. It not only removes the carrier but takes out the undesired sideband as well. Thus, in this system, sideband filters are not needed. On occasion, they are used from the standpoint of noise rejection and selectivity.

In the phase-shift system, the actual modulation need not occur at a low frequency. Low frequencies are used (500 kc and lower) in the sideband filter method of generation because of the better filter responses obtainable at low frequencies. However, in the phase-shift method of SSB generation, the actual modulation can occur at the desired operating frequency or at a frequency not too much lower than the desired output frequency.

In the generation of the SSB signal, two phase-shift actions must occur. The doubly balanced modulators (Fig. 8) must be excited by two 90° related carrier voltages. Similarly, two 90° related audio signals must be applied to the modulators. Each balanced modulator performs the usual task of removing the carrier signal applied to its input.

The double-sideband outputs of the two balanced modulators are combined. Because of the phase relations, two of the sidebands are additive and two are subtractive.

For example, the upper sidebands could be additive and develop across the output. The lower sidebands would be subtractive and, with proper circuit balance, they cancel exactly, leaving no lower sideband in the output.

The SSB signal is now stepped up in power by succeeding linear amplifiers. The signal is transmitted and picked up by the SSB receivers in conventional fashion. Tuner and if systems of the SSB receiver are in accordance with AM communications receiver practice.

The SSB signal can be demodulated by either the sideband filter product-detector method or by a receiver using a phase-shift demodulation process. In the phase-shift demodulator, the SSB signal at the output of the if amplifier is applied to two detectors. The two detectors are excited by 90° related demodulating carriers. The two audio outputs from the detectors are now applied to an audio combining stage via two 90° related audio phase shifters. The original audio information is recovered at the output of the combining stage and is applied to an audio amplifier. END

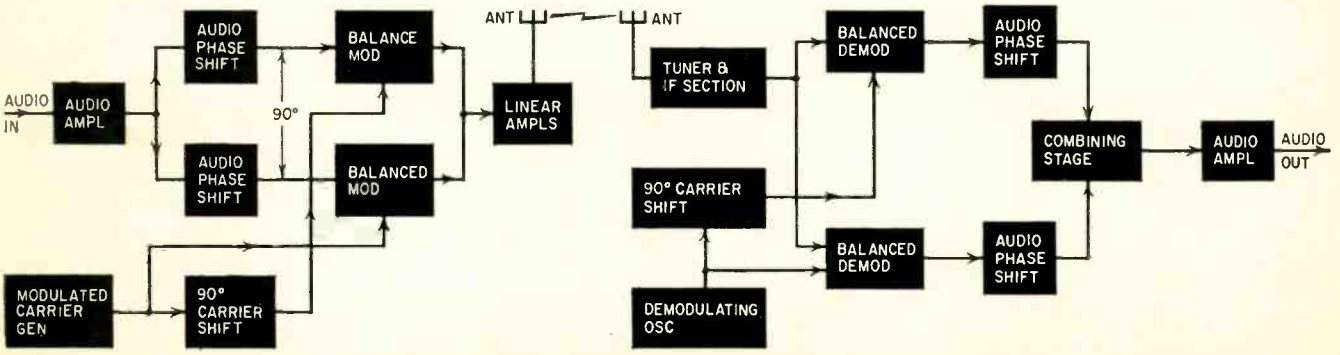

Fig. 8—Phase-shift method of SSB generation.

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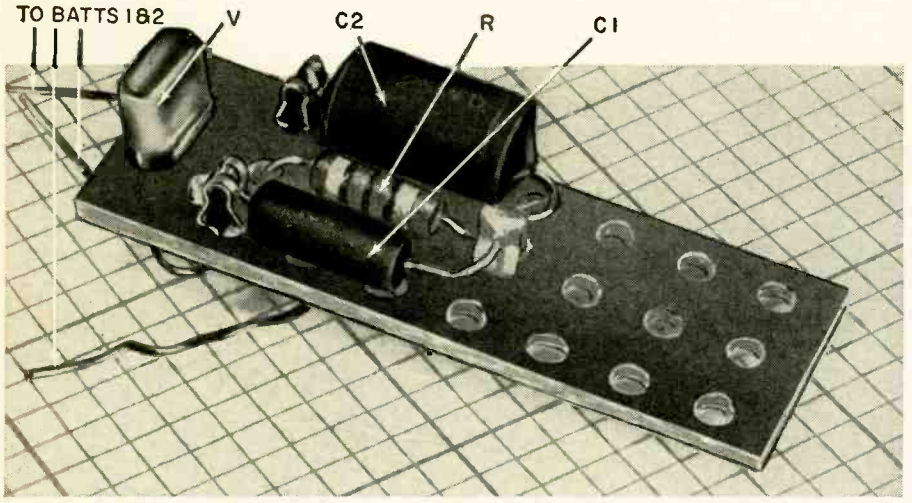
Simple Transistor Oscillator

By CHARLES DEWEY

An easy construction job for the beginner, this feedback oscillator uses headphones as the inductive component in its circuit



All parts can be mounted on a tiny bakelite strip.

THIS ultra-simple oscillator uses any of the low-cost p-n-p transistors. It is easily constructed and is just about perfect as a first transistor project.

The low-cost transistor, in certain low-power circuits, now completely eclipses the tube. For example, the oscillator described here was built for a *total cost of only $3.50*. It operates from two tiny mercury or penlight cells and draws less than 1 mw of power. Now look how simple the circuit is. It contains only one resistor and two capacitors. Compared to this, any vacuum-tube oscillator looks antique!

All low-priced transistors are units that have failed to meet the stringent requirements or production limits set for the higher-grade higher-priced transistors. I have tested low-cost p-n-p transistors from several manufacturers and found a unit-to-unit beta gain variation of more than 100%. Beta is the short-circuit current gain for a grounded-emitter circuit. Some occasional units had a very miserable gain of 6, while others gave a very respectable beta gain of 12 or more. I found one lone unit with a gain of 20.

An oscillator using a single junction transistor must usually have either a transformer or a tapped choke as an impedance-matching element. This transformer, however, adds inordinately to the circuit cost. Miniature transformers that are popular for transistor circuits sell for two or three times the price of the transistor. In this circuit, I eliminated this expensive component by letting the externally connected earphones become the inductive part of the tuned circuit.

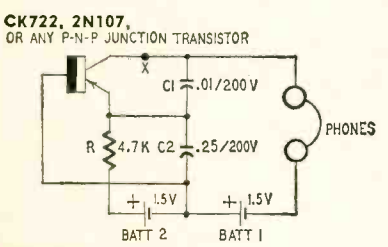
Oscillator circuit

The oscillator uses a grounded-base transistor circuit. In this configuration, the collector output impedance is extremely high, while the emitter impedance is very low. Simply explained, this is because the emitter-to-base junction is biased in a manner corresponding to a rectifier passing current in the forward or easy-flow direction. Conversely, the collector is biased in the reverse or high-resistance direction.

With vacuum tubes, a bias is necessary to *limit* plate current to a safe nondestructive value. The transistor must be provided with an emitter bias to cause *sufficient* collector-current flow for proper operation. Just as it is possible to vary the plate current of a vacuum tube with a grid-bias *voltage*, the transistor collector current is varied with the emitter-bias *current*. Without emitter bias, the only collector current is the result of temperature and leakage effects and is very small, about 5 μa.

BATT2 and resistor R provide the oscillator bias current. The value of this circuit bias can, for all practical purposes, be determined quite simply by dividing the bias voltage by the value of R. In this circuit, bias current is 300 μa.

Under these conditions, we have an amplifier capable of sustaining oscillations. This occurs because a given current change, at low voltage, in the emitter causes an almost equal current change across a very much higher collector impedance, producing a high-voltage output.



R—4,700 ohms, ½ watt
C1—.01 μf, 200 volts, molded
C2—0.25 μf, 200 volts, molded
BATT1, 2—1.5 volts (penlight or Mallory RM-625RT mercury cells)
V—Any low-cost p-n-p junction transistor (CK722, 2N107, etc.)
Bakelite mounting board cut to desired size
Headphones, 2,000 ohms

Fig. 1—Circuit of the oscillator.

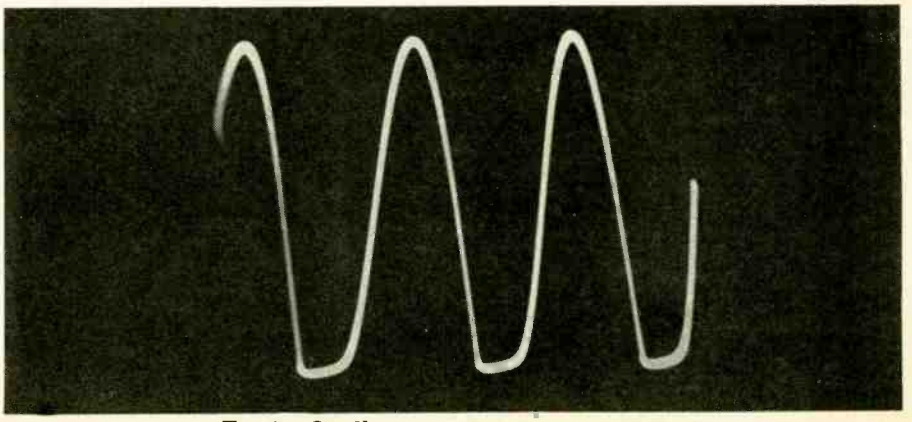


Fig. 2—Oscillator output as seen on a scope.

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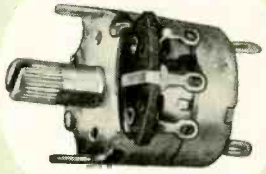

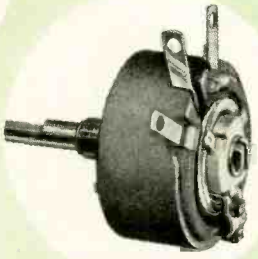

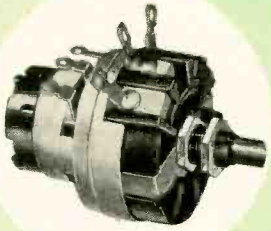

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However, we must match the high collector impedance to the low emitter impedance in the feedback circuit. The earphones obviously cannot be tapped like a transformer; so the tuning capacitor, made up of C1 and C2, is tapped instead. The values of these two capacitors can be varied, changing the oscillator frequency; their values are not critical. But, to maintain a reasonable impedance match, C2 should be 25–50 times larger than C1. For example, to lower the frequency of oscillation, C1 could be made .02 μf and C2, 0.5 μf.

Either a single 1,000-ohm earphone or a 2,000-ohm headset can be used. If it is desirable not to use the earphones, an iron-core choke or transformer winding can be substituted. The oscillator frequency, of course, will depend upon the transformer or choke inductance and some experimenting may be necessary to get the proper frequency.

The output waveform across the earphones, as shown in Fig. 2, is reasonably pure for a simple oscillator. The chopped-off positive peak is the result of driving the collector positive into its forward conduction region. This clipping can be reduced, if necessary, by inserting experimental values of resistance at the point marked X on the schematic—try 1,500 ohms first. If a high value of resistance that just maintains oscillation is selected, the sine wave produced will be beautifully clean and free from harmonics.

Construction

The oscillator's parts are small enough to fit into a medium-size thimble. Because of this small size, it is easy to find a small plastic box to accommodate the oscillator circuit and its two cells. The oscillator and two RM-625RT mercury cells fit easily, with room to spare, in a plastic hardware-assortment box.

With a telegraph key or pushbutton in series with either the collector or emitter battery, the oscillator becomes a very compact and inexpensive code-practice unit. Also, it makes a very handy test-signal source for trouble-shooting and servicing audio stages and equipment.

To turn off the oscillator, a spdt switch is needed to interrupt both the emitter and collector cells. Interrupting just the emitter cell leaves a few microamps of collector current still flowing.

If the transistor is soldered directly into the circuit, grasp the wire leads at a point between the transistor and solder joint with long-nose pliers. The pliers then carry away the excess heat before it reaches the transistor. Also be careful when soldering to the capacitors and batteries. They can take very little heat and quickly reach the melting point of the plastic sealing compounds.

This oscillator circuit is simple, inexpensive and just the thing for that first transistor project. END

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- ☐ 12 – RADIO OSCILLATOR COILS 456 kc $1
- ☐ 3 – ½ MEG VOLUME CONTROLS with switch .$1
- ☐ 5 – 50K VOLUME CONTROLS less switch.....$1
- ☐ 10 – SURE GRIP ALLIGATOR CLIPS.....$1
- ☐ 1 – GOLD GRILLE CLOTH 14" x 14" or 12" x 18" .$1
- ☐ 5 – SETS SPEAKER PLUGS wired.....$1
- ☐ 10 – SETS PHONO PLUGS and PIN JACKS..$1
- ☐ 2 – $2.50 SAPPHIRE NEEDLES 10,000 playings .$1
- ☐ 5 – DIODE CRYSTALS 2—IN21 2—IN22 1—IN64.$1
- ☐ 3 – DIODE CRYSTALS 1—IN60, 1—IN64, 1—IN69.$1
- ☐ 2 – SELENIUM RECTIFIERS 1—65ma & 1—150 ma$1
- ☐ 15 – ASST. TV COILS sync. peaking, width, etc. .$1
- ☐ 5 – TV CRT. SOCKETS with 18" leads $1
- ☐ 5 – HI-VOLT. ANODE LEADS with 18" leads ..$1
- ☐ 10 – TV CARTWHEEL CONDENSERS 10kv....$1

HANDY WAY TO ORDER—Simply tear out advertisement and pencil mark items wanted (X in square is sufficient); enclose with money order or check. You will receive a new copy of this ad for re-orders.

ON SMALL ORDERS—Include stamps for postage, excess will be refunded. Larger orders shipped express collect.

Free—CONDENSER and RESISTOR CODE CHARTS with each order

BROOKS RADIO & TV CORP., 84 Vesey St., Dept. A, New York 7, N.Y.

TELEPHONE COrtland 7-2359

ABC's of MOBILE RADIO

Part V—Sales and service are the two most important parts of mobile radio. Consider your fees, test equipment and personnel requirements

By LEO G. SANDS

LESS than a dozen manufacturers and several thousand independent service-shop operators are in the mobile radio business. Manufacturers have found it a rough, competitive business, yet not unprofitable to those at the top. Service shops, however, enjoy a steady year-round income from servicing and installing mobile radio equipment.

Selling new equipment is the job of salaried sales engineers employed directly by the manfacturers, through manufacturers' representatives and through independent dealers. Most of the industry's dollar volume is accounted for by salaried employees of Motorola, RCA, General Electric and Bendix Radio who work on straight salary plus some sort of incentive plan (depending upon company policy).

A rep sometimes receives a retainer from the manufacturer he represents, but most work on a straight commission basis. They seldom invest in merchandise, taking orders for delivery from the factory direct to the user, and waiting for their commissions after payment has been received by the manufacturer.

Independent service dealers who sell mobile radio equipment may act as salesmen working on a commission basis or, when they have sufficient finances, they buy merchandise, stock and resell it at a profit. The discount margin, however, is small, ranging from 10% to 25%.

The discount is small because of the competitive nature of the mobile radio business. The list price cannot be made high enough to allow an attractive profit to dealers without the manufacturer losing sales. However, some sales are big enough in dollars to yield a handsome profit to the aggressive dealer.

A dealer should stock at least a base-station setup and a mobile unit for demonstrations. Many prospective purchasers want a demonstration.

The equipment must be supplied with crystals and tuned to the frequency for which the purchaser is to be licensed. Most service shops do not maintain a stock of crystals for various frequencies although most do have facilities for tuning up and checking out the equipment.

Dealers who concentrate on selling "packaged" equipment for use on commonly used frequencies, such as for low-power industrial and taxicab service, can get by with a small stock of crystals and factory pretuned equipment.

Essential instruments for servicing 2-way radio. On the shelf at the far left is a relative field-strength meter. In the center is a frequency meter for measuring transmitter frequencies. It can also be used as an rf signal generator. At the right is an FM deviation meter for measuring transmitter modulation. The vom is obvious and the tube checker is a mutual-conductance type.

Installation fees

Here is a typical transaction. A manufacturer's sales engineer sells a mobile radio system direct to the user, the local service dealer getting a spiff, in some cases, for submitting a prospect. The sales engineer then turns the installation job over to a local service dealer who is paid from $15 to $35 per vehicle for installation. He is also referred to the customer as "the" man to handle service on a per-call or monthly contract basis.

When a service dealer makes the sale himself, he orders the equipment from the factory, bills his customer and pays the manufacturer the list price less his discount. He also bills his customer for installation and generally tries to sell him a service contract.

Equipment leases

Sometimes the customer leases equipment direct from the manufacturer or from a dealer. The monthly rental is usually based on amortization of the equipment (at list price) over a 5-year period plus interest on the investment. A monthly service charge is added to the monthly payment. Installation charges are usually billed when rendered. At the end of a 5-year lease period, the customer often has the option to renew, either at a lower rate or at the same rate, but with new equipment replacing the used equipment. Sometimes the lessee has the option to buy the equipment at the end of the lease period for $1 or some other nominal figure.

Service charges

Service rates vary widely. Some shops charge from $5 to $10 per hour. On a monthly contract basis, charges vary all over the lot, seldom based on good business practice, but generally on what the traffic will bear, which is usually too little. Some shops offer to service a mobile unit for $10 to $15 per month, including tubes and parts. Others charge $7.50 to $10 per month with tubes and parts extra.

Personnel requirements

To service mobile radio equipment properly, a big investment in test equipment is necessary. Even more important is experience and training. The shop owner is usually the most skilled man in the organization. As his business grows, he hires technicians who must also be skilled.

To service transmitters, one must have a first- or second-class radiotelephone license which can be obtained free by any US citizen who can pass a written examination on electronic theory and FCC rules and regulations. Several correspondence courses are

available, and numerous resident schools offer courses which provide the necessary training.

Besides a license, a potential mobile radio service technician should be familiar with transmitters and superheterodyne receivers. Mobile equipment needs skilled, tender loving care for optimum results. Training in servicing mobile equipment is not easily obtained since few schools offer special courses, beyond preparation for license examinations.

Getting a license

A base station may be operated by the holder of any class of FCC operator's license except amateur.

A restricted radiotelephone operator's permit is the minimum grade of license required by the base-station operator. However, on railroads where the railroad management decides who is to be authorized to operate radio stations, or when the base station is licensed in the Citizens radio service, no operator's license is required.

A third-class radiotelephone operator's license authorizes a person to operate 2–3-mc radiotelephone transmitters on board boats. No license is required for operating a vhf station on board ship, but the master of the vessel shall have authority over the use of the equipment. Anyone may talk over a mobile or ship radiotelephone.

Mobile radio transmitters and base-station transmitters may be serviced, tested or tuned only by a person holding a first- or second-class radiotelegraph or radiotelephone operator license. Any other person may also perform this work, but only in the presence of a licensed operator and with his authority.

The operator's license or verification card must be posted at the radio transmitter where and when performing service work, whenever the transmitter is in actual operation.

A log must be kept at the base station, in which the service technician enters all pertinent details of the service work performed by him or under his direction. He also enters his name and address as well as the class, serial number and expiration date of his license.

In the log, entries must also be made showing the names of all persons responsible for operation of a transmitter. Each such person signs his name (not initials) and notes the time when coming on and going off duty.

Entries must also be made in the station log whenever transmitter frequencies are measured. Except in the Citizens radio service, transmitter frequencies must be measured when the transmitter is initially installed and at intervals not to exceed 6 months. Frequency must also be measured when a change is made in a transmitter which affect carrier frequency or its stability.

A code transmitting and receiving test must be passed to obtain a radiotelegraph license.

RADIO LICENSE REQUIREMENTS

Class of License	License Examination Elements							
	I	II	III	IV	V	VI	VII	VIII
Radiotelephone, first class	x	x	x	x				2
Radiotelephone, second class	x	x	x					2
Radiotelephone, third class	x	x						
Restricted radiotelephone permit[1]								
Radiotelegraph, first class	x	x			x	x	3	2
Radiotelegraph, second class	x	x			x	x	3	2
Radiotelegraph, third class	x	x			x			

x This element required.
[1]No written or oral test.
[2]Required only when ship radar is to be serviced.
[3]Required only for aircraft radiotelegraph endorsement.

The chart lists the numbers of the written examination elements which must be passed for obtaining the various grades of operator licenses.

Element I includes questions about basic law applicable to radio communications and deals mainly with laws about operator license requirements and responsibilities.

Element II covers general basic operating practice, including procedures for handling distress and safety communications as well as proper general operating conduct.

Element III is a technical examination covering basic electrical and electronic theory, simple transmitter and receiver circuits, batteries, motors, generators, meters, tubes, antennas, wave propagation, modulators, multivibrators, frequency meters, transistors, magnetrons and klystrons.

To service mobile radio equipment only elements I, II and III must be passed. Those who want greater prestige or who might want to put in a hitch at a broadcasting station can take element IV to win a first-class radiotelephone ticket.

Element IV covers series and parallel circuits, transformers, pads, equalizers, audio amplifiers, more complex transmitters and receivers, FM, phase monitors, power supply circuits, coaxial cables, TV transmitters, microwave links and even color TV.

Element V covers radiotelegraph operating practice and element VI is a technical exam covering radiotelegraph circuits, radar, loran and direction finders. Element VII concerns aircraft radiotelegraphy and is highly technical. Element VIII is a technical exam covering ship radar techniques.

Several books are available for study before taking a license examination. These include:

License Manual for Radio Operators, by J. Richard Johnson (Rinehart & Co.) ($5)

How to Pass Radio License Examinations, by Charles E. Drew (Wiley) ($6.37)

Radio-Telephone License Manual (Editors & Engineers) ($3.75)

Radio Operator's License Q & A Manual, by Milton S. Kaufman (John F. Rider) ($6.47)

Commercial Operator's Q & A License Guide (Ameco) (Elements I & II, $0.75; Element III, $1.75; Element IV, $1.25)

Radio Operating Questions and Answers by Hornung & McKenzie (McGraw-Hill) ($5.88)

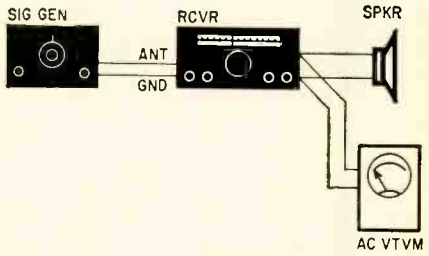
In addition, both correspondence and resident courses are offered by schools specializing in training of persons for FCC operator license examinations.

Test-equipment requirements

High-grade professional equipment is required for two-way radio servicing. Equipment adequate for servicing broadcast receivers and TV sets will seldom suffice. Standards are much more critical. Beside the usual vtvm, multimeter and hand tools, the well-equipped mobile radio shop requires precision-grade signal generators, frequency meters, modulation-deviation meters, special tune-up testers for various makes of equipment, and rf wattmeter and a truly critical tube tester.

Tube testing

The best test for tubes is substitution. When checking tubes in a receiver, after



Setup for testing tubes by substitution.

testing all tubes in a critical tester which checks dynamic mutual conductance, substituting a new tube in each socket may reveal defects missed by the tester. Feed a feeble signal from a signal generator to the receiver whose output is monitored by an ac voltmeter as in the diagram, or a vtvm connected to the second limiter on an FM receiver or the avc bus of an AM receiver.

However, a relatively cold tube may work fine and fail after minutes or hours of use. When time permits, new tubes should be preheated in an aging rack.

One tube fault missed by many general-purpose testers is grid emission. A tube with this defect may test OK, but can raise havoc in a mobile receiver. Recently, general-purpose tube testers have appeared on the market which check for grid emission. If your tube tester does not, a special grid circuit tester may be used. Just one tube with grid emission can cause receiver instability. It takes a very sensitive tester to detect the small amount of grid emission which can cause mobile radio troubles. When a tube which tests OK in a general-purpose tester works in one socket but not in another, suspect grid emission.

Signal generators

In the hands of an expert, an electric razor may suffice as a signal generator

RADIO

for aligning an AM broadcast receiver. An expert can often diagnose troubles using a wet finger as a voltmeter.

A vhf or uhf communications receiver, on the other hand, is expected to deliver useful and understandable speech when its input is tickled by an rf signal with an intensity of less than 1 μv. Improper adjustment of just one trimmer can reduce sensitivity enough to render the receiver essentially useless for its intended purpose.

Such a receiver can be aligned for optimum performance only by competent persons with adequate instruments. Wet-finger voltmeters and electric-razor signal generators won't do.

Neither will a cheap signal generator. It suffices for aligning home radio sets, but not in this field.

"Cheap" signal generators will not do because it's expensive to design and manufacture a signal generator with the required frequency stability, calibration accuracy and low leakage. There are several suitable signal generators on the market, but they are priced from $200 and up, not $20 and up.

While these figures may stagger some service-shop operators, facts must be faced. The if amplifier of a typical mobile system receiver is very selective, but is nevertheless flat-topped to prevent excessive distortion. When aligning the rf section, the input signal must be less an 1 μv. A signal far in excess of 1 μv reaches the receiver, because of just plain signal leakage, from an inadequately shielded signal generator.

Laboratory methods must be used to check the true performance characteristics of receivers used in this service. Receiver gain is measured by feeding a known signal to the input while measuring the output at the speaker terminals. For example, a typical receiver is expected to deliver so many milliwatts of audio output with a signal of so many microvolts or a fraction of a microvolt. It takes precision equipment to make such measurements correctly.

Receiver selectivity is measured by feeding a signal to the receiver so many kc off resonance to deliver audio at the specified reference level. For example, if a receiver's response is rated at no more than 6 db down at $\pm$15 kc, the signal input for reference output must be no more than 6 db (twice the voltage) higher than at the resonant frequency. The signal generator's calibration accuracy must obviously be of high order. Its output attenuator must also be accurate.

For overall alignment, a precision-grade uhf–vhf signal generator is required. For if alignment, a less precise signal generator will do. However, its characteristics must be known.

Receiver sensitivity can also be measured by metering the audio output with no signal applied, noting the noise level at the audio output. An unmodulated rf signal is fed to the input of the receiver, the intensity of the signal being advanced until background noise drops 20 db. This measurement indicates how many microvolts input are required to get 20 db of noise quieting. Obviously, accurately calibrated, precision equipment is required.

The signal generator's frequency stability is also important or one will spend considerable time retuning the generator as it drifts. It is also possible to align the receiver to the wrong side of the local oscillator, above or below the local oscillator frequency by the value of the intermediate frequency.

In addition to continuously tunable signal generators, some employ crystals which deliver an rf signal at the desired frequency. However, their use depends upon having an assortment of crystals.

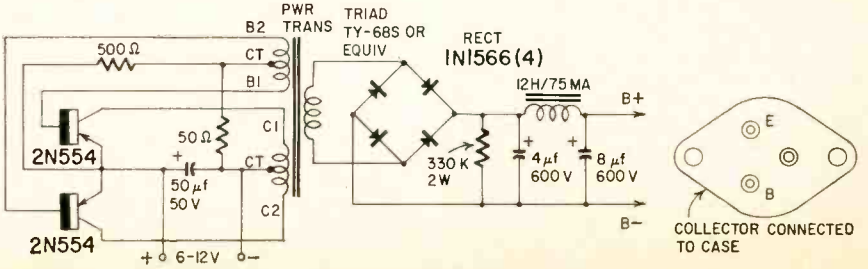
Next month we will continue with the technician's viewpoint, and discuss the methods required for making frequency and power measurements. Test equipment, tools and servicing problems will also be covered. TO BE CONTINUED

DC-TO-DC CONVERTER

This circuit provides a simple source of high-voltage dc for transmitters, receivers and other applications in automotive and marine equipment. The following specifications apply:

Input			Output		
Volts	Amps	Watts	Volts	Amps	Watts
6	1.5	9.0	125	.060	7.5
12	1.5	18.0	250	.060	15.0

A number of transformers (Triad TY-S series or equivalent) at different output voltages and current ratings is available for use in these circuits. The lowest-power-rated of these is efficiently driven by a pair of 2N554's in the circuit shown. (With other transformers, other component values may be required. Check with the transformer manufacturer.) Some of the available transformers may be improperly phased. If the circuit does not oscillate, reverse the transistor base leads. The output is rectified by a bridge made up of four 1N1566's. The power transistors must have a heat sink.—*Motorola*



TECHNICIANS' NEWS

DON'T SHOOT THE SERVICE MAN

So says *Confidential* Magazine in its April issue, with an article apparently written by a service technician with considerable practical experience. The story puts the blame squarely on the manufacturers who ". . . waste your time and energy . . . simply because [they] have designed your set so badly." The story makes several valid points, but goes off the deep end in places. Example: ". . . color television ought to be crated complete with a physics professor and his rations."

TECHNICIANS FORUM SET

The Television Service Association of Delaware Valley will sponsor an Electronic Technicians Forum in cooperation with parts distributors, manufacturers and their representatives. The 3-day exhibit, June 12–14 will be held at the Benjamin Franklin Hotel in Philadelphia, and will include technical presentations and demonstrations of new products. Dave Krantz, coordinator of the event, said that he expects 1,500 technicians to attend.

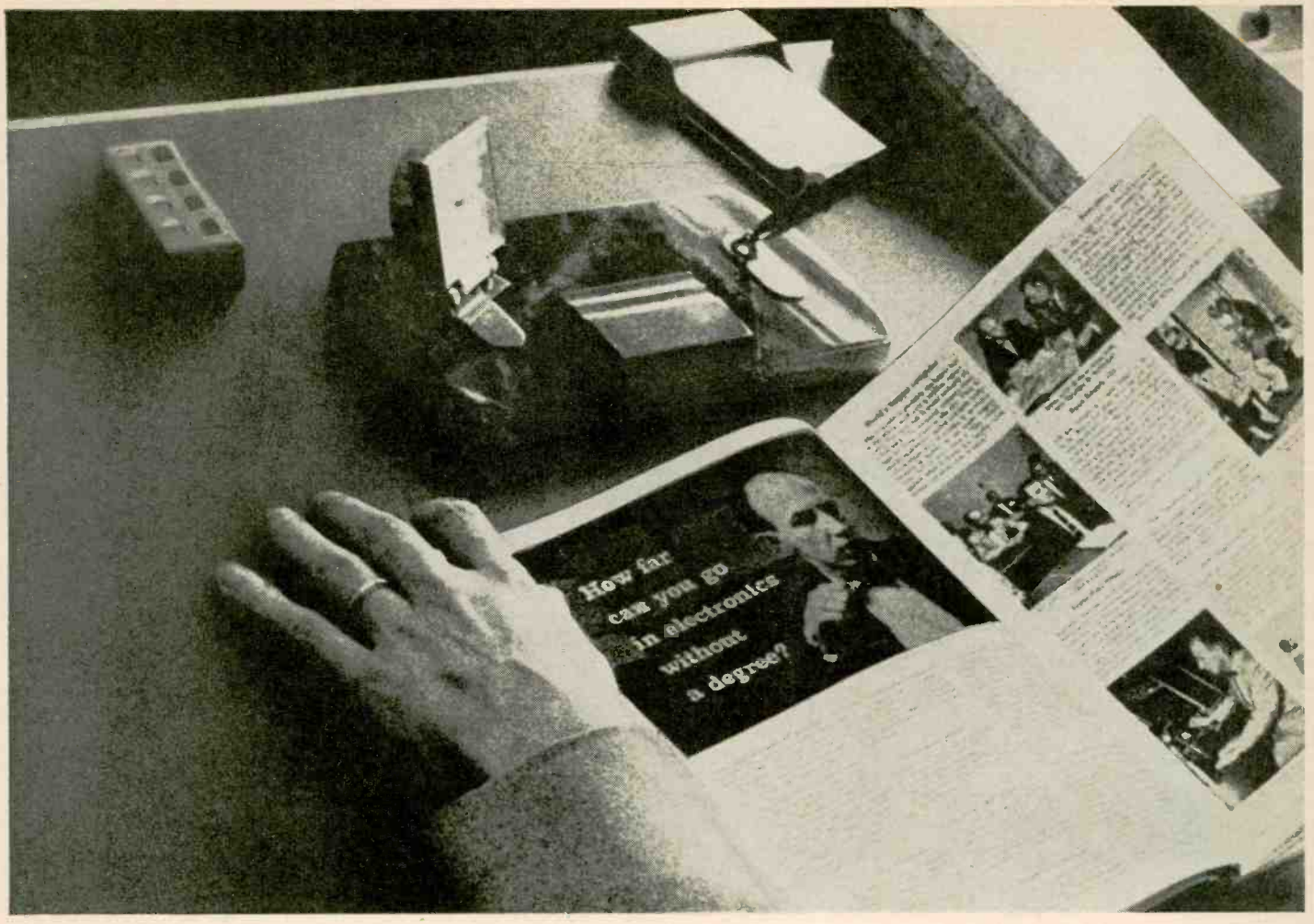
PRINTED-CIRCUITRY PROGRESS

From a letter from Frank Moch, executive director of NATESA, comes this encouraging news:

"I have just returned from the meeting of the Institute of Printed Circuits during the IRE meeting in New York City. Present were about 65 top men representing all phases of the printed-circuit art, including national service managers of Admiral, G-E, Magnavox, Motorola, RCA, Sylvania and Westinghouse. The program consisted of three speakers on each of three subjects, service, manufacturing, and raw materials.

"As a result of this meeting and of discussions that I have been participating in for the last several months with a number of set manufacturers, I can report that printed boards are here to stay, and that *all* set producers can be expected to use them. At the same time, many of the complaints we learned about in our printed-board survey [a summary of which is given on page 50 of this issue—*Editor*] will be cleared up. Among these advances will be boards with all components on one side only, actual circuit diagrams on the other side, exceptional accessibility to all parts, longer leads permitting parts to stand off boards for easier removal, better scorch resistance, definite reduction of conductors separating from

(*Continued on page* 94)



How far can you go in electronics . . .

Two years ago, Field Engineer William G. Miles was asked to outline *his* thinking on how far he could go in electronics at IBM . . . without a degree. Now, he reviews the progress he's since made. His present position: Group Manager, responsible for keeping one of America's largest electronic computers in top operating condition. Here's his story.

HURDLING THE DEGREE BARRIER. "A few years ago," recalls Bill Miles, "I felt that I'd gone about as far as a technician could without a degree. I just couldn't hurdle that education barrier. Now, thanks to IBM, I have a solid electronics education. I'm a Group Manager on Project SAGE, responsible for 20 field engineers. My future looks brighter than it ever did. I don't know of another company where a technician can go farther or receive more recognition, without a degree, than at IBM."

UTILIZING HIS NAVAL TRAINING. Bill Miles became interested in electronics in high school and spent three years as a Naval Aviation Radar Technician. After discharge from service, he worked as a TV serviceman, at the same time pursuing an engineering education at night. "I knew there were good career opportunities around somewhere, but I couldn't find them," Bill Miles says. "I investigated several big companies. They were impressed with my ability, but my lack of a degree kept me from the kind of a career I wanted. Then I answered an ad similar to this."

EXTENSIVE ELECTRONICS SCHOOLING. In May 1955, Bill Miles joined IBM and began an extended training course in electronic computers. "The teaching was adult and as technically advanced as I could ask for," he says. "Each day, I gained a deeper knowledge of electronics and added to my professional stature. IBM shows real interest in you as an individual: what your goals are, what plans you've made to reach your goals, how the company can help speed you toward them or even higher goals."

ASSIGNED TO SAGE SITE. After his training, Bill Miles was assigned to a SAGE site. SAGE is an important link in America's air defense, and the heart of SAGE is a real-time computer which is probably the world's largest and most reliable.

The SAGE computer analyzes radar data with uncanny accuracy, checks it against available air traffic information, and presents visual displays to assist the Air Force in identifying flying objects as friend or foe. By remote control, the computer can also guide interceptors or BOMARC missiles to the target.

UPGRADING TECHNICIANS. "The job of IBM field engineers is to keep SAGE computers running," explains Bill Miles. "This involves maintaining, testing, and checking computer units. It means anticipating trouble before it occurs. The work turned out to be exactly what I was looking for. I had a chance to do work ordinarily done by graduate engineers . . . work usually denied to men without a degree. Of all the companies I know, IBM appears to be one of the few which upgrades technicians to levels of engineering responsibility . . . levels dictated not by your formal education but by your native talents."

MANY EDUCATIONAL OPPORTUNITIES. "SAGE field engineers have many opportunities for education, above and beyond the 'basic' training, which lasts 20 weeks," says Bill Miles. "After a year or two in the field, they may be selected for further training to learn how the complete SAGE electronic computer system

Bill Miles reviews two-year-old article about his IBM career.

without a degree?

works. To keep up with the most advanced electronic developments, they may also attend classes during working hours."

RAPID ADVANCE TO GROUP MANAGER. In his four years with IBM, Bill Miles has received several promotions. He is now Group Manager at a SAGE site. "My advancement is an example of IBM's policy of promoting from within," he says. "The company is quick to recognize a man's contributions and quick to reward him. To some degree, the growth of the SAGE system was a factor in my advancement, and SAGE is due for additional growth in the next few years. This means lots of opportunities for new men and rapid progress along a clearly defined advancement route. There are no limits set on your future. Everything IBM has ever promised about advancement in field engineering, I've seen happen—either to me or to someone I know."

* * *

If you have a minimum of 3 years' technical schooling after high school—or equivalent experience—you may be eligible for 20 weeks' training as a Computer Units Field Engineer. While training, you receive full pay plus living allowance.

IBM is the leader in a field that offers you unlimited horizons. And, as you may already know, at IBM you receive company-paid benefits that set standards for industry today.

WRITE TODAY TO:

Mr. N. H. Heyer
Dept. No. 649F
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IBM Corp., Kingston, N. Y.

You'll receive a prompt reply. Personal interviews arranged in all areas of the United States.

Discussing counseling methods with personnel management.

Demonstrating how SAGE operating console works.

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boards, circuit coding permitting easier identification of B-plus, age circuits, key voltage and test-point identification, wire jumpers connecting B-plus branches, better placement of boards.

"Every company indicated that it will incorporate many of these advances immediately. I believe that as a result printed-board servicing will be *greatly* simplified. I am happy to report that a very fine spirit of cooperation and willingness to listen to our story was evinced by all of the manufacturers."

OHIO LICENSE MEETING

TESA–Dayton got together more than a hundred service technicians in late February at a general meeting to enlist aid and collect money to get the Ohio license bill through. Ohio TESA president Russ Harmon attended, along with a number of other prominent outside representatives of service. The technicians heard talks from several authorities on what they thought could be done to help pass the bill. Several hundred dollars in pledges to carry on the fight were signed.

RTA–SANTA CLARA OFFICERS

The third annual installation dinner dance of the Radio TV Association of Santa Clara Valley, California, was attended by over 300 people who witnessed the ceremony inaugurating the term of Jack Morriscoe as new president. Outgoing president Richard Kelso also installed the new vice president, Russell Hamm, and secretary-treasurer John C. Murphy. New directors are George Akers, Harley Boltz and Roy Fakler.

NATESA GROWING

The *NATESA Scope* informs us that the group is now just 10 years old, and points with justifiable pride to the fact that it has grown in that time from 8 affiliates to over 122.

TV LEGISLATION SLOW

Legislation aimed at licensing TV service technicians failed to become law in three states recently. In New York, Washington state and Kansas, bills failed to reach the floor, being stopped in committee. The Kansas situation was reported here last month (page 108).

The New York State bill, which would have made voluntary "certification" of TV service technicians possible, was still in committee when the NY legislature adjourned for the year. The licensing bill had been introduced by State Attorney General Lefkowitz in January, 1959, and was supported by many segments of the industry in the state, who felt that this bill, or almost any bill, was better as a starter than none at all.

Spokesman for the Attorney General said he will introduce another bill next year. He believed that this year's proposed law failed to get action because the legislators hadn't been able to take enough time to evaluate it.

The license bill in Washington came close, and for a time seemed certain of passage, having support not only from labor, the State Association of Electrical Workers representatives, service technician associations all over the state, and from individual shop owners, but from the state Department of Licenses.

After a public hearing, the 9-man House Committee on Licenses approved the bill and it was placed on the calendar for second reading. Then the fun began, *TSA Service News* (Kings County, Wash.) says:

". . . Promoters of self-service tube testers wanted grocery stores exempted. . . . A spokesman for newspapers was greatly alarmed about . . . prohibiting false or misleading advertising. . . . One legislator feared the bill would cost the taxpayers money. . . . Another was fearful customers would have to pay more for service. . . . The majority of legislators . . . said they hadn't read the bill and weren't too sure what they were talking about! (We thought this was why they were sent to the Capitol.)

"A Seattle distributor salesman said in his territory the bill would hurt the *experimenters* 'who have been the backbone of the industry'. . . . Two part-time tube jerkers with full-time union jobs in aircraft wrote that it would put them out of 'business' because they do not have a shop or fixed place of business. . . . A senator was concerned that 'it is getting so a *poor man* can't make a living because of all the licensed trades'. . . . Another legislator wanted cabinet shops exempted . . . and one opposed the bill because his druggist fixes sets as a sideline. He thought the druggist couldn't pass the examination. . . . One lawmaker thought of the 'capable but poor cripple who ekes out a living fixing his neighbors' sets.'

"Many seemed to have a mental image of the television technician . . . as the boy wonder who has played around with radio since knee pants but who probably couldn't get a license. We gathered that this lad was esteemed in the same category as the village idiot.

"House Bill No. 179 died in the House Rules Committee, which refused to bring it out for a third reading for consideration by the full House of Representatives. When a group of service dealers from all parts of the state asked the chairman in his Olympia office to bring it out for consideration so that at least the public would read that it had passed or failed, they received only a laugh and no results.

"Logical conclusion: If these legislators are in fact representative of the people we must believe that the public doesn't care about or want good service." . . .

TUBE CHECKERS CHECKED

Do-it-yourself tube checkers in the state of Michigan alone are selling approximately $2,250,000 worth of tubes a year, according to an estimate by the Michigan chapter of the National Electronic Distributors Associa-

tion (NEDA). The chapter reported a spot check of 17 do-it-yourself testers showed considerable variations in tests of the same new tubes which checked "good" on a master mutual-conductance type checker. At six "test-ur-own" locations, at least one of the three tubes reportedly tested as "weak" or "bad."

PRAISES CODE OF ETHICS

In St. Louis, Mo., an advertising code of ethics for television service has been in effect since 1954. The president of the St. Louis Better Business Bureau, Mr. Riehl, stated in a letter to our organization that, since the adoption of the code, the situation in St. Louis has been very satisfactory. With a percentage of .001% of complaints against a million and a half service calls, I would think Mr. Riehl's statement is a little conservative.

We cannot fully express our gratitude and appreciation to the people who have, by formulating the code, given us a guide to the future and a record of exemplary service in the past, particularly "Doc" Pritchard of the Post Dispatch. His insistence on strict adherence to the code is a tribute.

We are proud of the code. We know it works. We offer our assistance to anyone interested in raising the prestige of this industry by the adoption of such a code.—*From TEAM News, St. Louis, Mo.*

CUT-RATE ADVERTISING

Set owners are bombarded every day by cut-rate service ads, said Frank J. Moch in a letter to NATEA chapters. So many appear that the public accepts them at face value. Because of the attitude of many newspaper publishers, it is useless for legitimate people to advertise.

"You and I know that if you run a legitimate business with its inherent costs, you cannot render a service call cut-rate during regular business hours. And at night costs skyrocket due to time lost trying to locate house numbers and parking space and to interference due to the whole family being in on the repairs.

"What happens when the customer 'takes the bait'? Perhaps the man who calls is an incompetent though basically honest part-timer. In this case, sets are pulled needlessly with added, unnecessary cost. Or the operator may be working on a commission arrangement, so he loads the job with a lot of tubes, or he takes the set into the shop with exhorbitant extra, unearned charges added when the set is returned. Thousands of set owners thus receive poor service or are overcharged. Since there is no way for the set owner to identify a reliable good operator, all service technicians are considered alike.

"The ethical, qualified service organization suffers. How long can you survive this phoney competition? Only through association activity can you solve this problem." END

SUPERIOR'S NEW MODEL 77

VACUUM TUBE VOLTMETER

WITH NEW 6" FULL-VIEW METER

Compare it to any peak-to-peak V. T. V. M. made by any other manufacturer at any price!

• Uses new improved SICO printed circuitry. • Employs a 12AU7 as D.C. amplifier and two 9006's as peak-to-peak voltage rectifiers to assure maximum stability • Meter is isolated from the measuring circuit by a balanced push-pull amplifier. • Uses selected 1% zero temperature coefficient resistors as multipliers.

AS A DC VOLTMETER: The Model 77 is indispensable in Hi-Fi Amplifier servicing and a must for Black and White and color TV Receiver servicing where circuit loading cannot be tolerated.

AS AN ELECTRONIC OHMMETER: Because of its wide range of measurement leaky capacitors show up glaringly. Because of its sensitivity and low loading, intermittents are easily found, isolated and repaired.

SPECIFICATIONS

• **DC VOLTS** — 0 to 3/15/75/150/300/750/1,500 volts at 11 megohms input resistance. • **AC VOLTS** (RMS) — 0 to 3/15/75/150/300/750/1,500 volts. • **AC VOLTS** (Peak to Peak) — 0 to 8/40/200/400/800/2,000 volts. • **ELECTRONIC OHMMETER** — 0 to 1,000 ohms/10,000 ohms/100,000 ohms/1 megohm/10 megohms/100 megohms/1,000 megohms. • **DECIBELS** —10 db to + 18 db, + 10 db to + 38 db, + 30 db to + 58 db. All based on 0 db = .006 watts (6 mw) into a 500 ohm line (1.73v). • **ZERO CENTER METER** — For discriminator alignment with full scale range of 0 to 1.5/7.5/37.5/75/150/375/750 volts at 11 megohms input resistance.

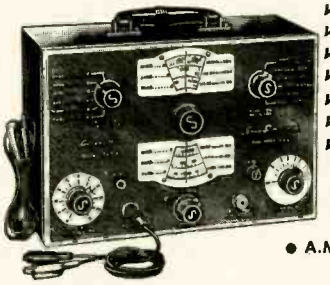
AS AN AC VOLTMETER: Measures RMS value if sine wave, and peak-to-peak value if complex wave. Pedestal voltages that determine the "black" level in TV receivers are easily read.

Comes complete with operating instructions, probe, leads, and streamlined carrying case. Operates on 110-120 volt 60 cycle. Only.. **$42.50**

SUPERIOR'S NEW MODEL TV-50A

GENOMETER

7 Signal Generators in One!



- R.F. Signal Generator for A.M.
- R.F. Signal Generator for F.M.
- Audio Frequency Generator
- Marker Generator
- Bar Generator
- Color Dot Pattern Generator
- Cross Hatch Generator

This Versatile All-Inclusive GENERATOR Provides ALL the Outputs for Servicing:

• A.M. RADIO • F.M. RADIO • AMPLIFIERS • BLACK AND WHITE TV • COLOR TV

R. F. SIGNAL GENERATOR: 100 Kilocycles to 60 Megacycles on fundamentals and from 60 Megacycles to 180 Megacycles on powerful harmonics.

VARIABLE AUDIO FREQUENCY GENERATOR: Provides a variable 300 cycle to 20,000 cycle peaked wave audio signal.

MARKER GENERATOR: The following markers are provided: 189 Kc.; 262.5 Kc., 456 Kc., 600 Kc., 1000 Kc., 1400 Kc., 1600 Kc., 2000 Kc., 2500 Kc., 3579 Kc., 4.5 Mc., 5 Mc., 10.7 Mc., (3579 Kc. is the color burst frequency.)

BAR GENERATOR: Pattern consists of 4 to 16 horizontal bars or 7 to 20 vertical bars.

DOT PATTERN GENERATOR (FOR COLOR TV): The Dot Pattern projected on any color TV Receiver tube by the Model TV-50A will enable you to adjust for proper color convergence.

CROSS HATCH GENERATOR: The pattern consists of non-shifting horizontal and vertical lines interlaced to provide a stable cross-hatch effect.

The Model TV-50A comes complete with shielded leads and operating instructions. Only **$47.50**

SUPERIOR'S NEW MODEL 80

20,000 OHMS PER VOLT ALLMETER

THE *ONLY* 20,000 OHMS PER VOLT V.O.M. SELLING FOR LESS THAN $50 WHICH PROVIDES *ALL* THE FOLLOWING FEATURES:

- **6 INCH FULL-VIEW METER** provides large easy-to-read calibrations. No squinting or guessing when you use Model 80.
- **MIRRORED SCALE** permits fine accurate measurements where fractional readings are important.
- **CAPACITY RANGES** permit you to accurately measure all condensers from .00025 MFD to 30 MFD in addition to the standard volt, current, resistance and decibel ranges.
- **HANDSOME SADDLE-STITCHED CARRYING CASE** included with Model 80 Allmeter at no extra charge enables you to use this fine instrument on outside calls as well as on the bench in your shop.

SPECIFICATIONS:

7 D.C. VOLTAGE RANGES
(At a sensitivity of 20,000 Ohms per Volt)
0 to 15/75/150/300/750/1500/7500 Volts.

6 A.C. VOLTAGE RANGES:
(At a sensitivity of 5,000 Ohms per Volt)
0 to 15/75/150/300/750/1500 Volts.

3 RESISTANCE RANGES:
0 to 2,000/200,000 Ohms. 0-20 Megohms.

2 CAPACITY RANGES:
.00025 Mfd. to .3 Mfd., .05 Mfd. to 30 Mfd.

5 D.C. CURRENT RANGES
0-75 Microamperes, 0 to 7.5/75/750 Milliamperes, 0 to 15 Amperes.

3 DECIBEL RANGES:
— 6 db to + 18 db, + 14 db to + 38 db + 34 db to + 58 db

NOTE: The line cord is used only for capacity measurements. Resistance ranges operate on self-contained batteries.

FEATURES:

• A built-in Isolation Transformer automatically isolates the Model 80 from the power line when capacity service is in use.

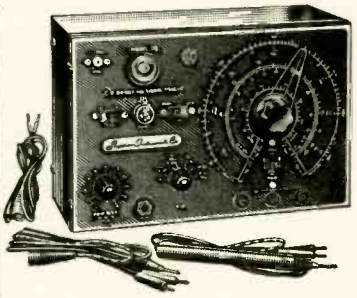
• Selected, 1% zero temperature coefficient metalized resistors are used as multipliers to assure unchanging accurate readings on all ranges.

Model 80 Allmeter comes complete with operating instructions, test leads and portable carrying case. Only **$42.50**

SUPERIOR'S NEW MODEL 76

ALL PURPOSE BRIDGE

For the first time ever: ONE TESTER PROVIDES ALL THESE SERVICES!



IT'S A CONDENSER BRIDGE with a range of .00001 Microfarad to 1000 Microfarads (Measures power factor and leakage too.)

IT'S A RESISTANCE BRIDGE with a range of 100 ohms to 5 megohms

IT'S A SIGNAL TRACER which will enable you to trace the signal from antenna to speaker of all receivers and to finally pinpoint the exact cause of trouble whether it be a part or circuit defect.

IT'S A TV ANTENNA TESTER The TV Antenna Tester section is used first to determine if a "break" exists in the TV antenna and if a break does exist the specific point (in feet from set) where it is.

SPECIFICATIONS:

CAPACITY BRIDGE SECTION
4 Ranges: .00001 Microfarad to 1000 Microfarads. Will also locate shorts, and leakages up to 20 megohms. Measures the power factor of all condensers from .1 to 1000 Microfarads. (Power factor is the ability of a condenser to retain a charge and thereby filter efficiently.)

RESISTANCE BRIDGE SECTION
2 Ranges: 100 ohms to 5 megohms. Resistance can be measured without disconnecting capacitor connected across it. (Except, of course, when the R C combination is part of an R C bank.)

SIGNAL TRACER SECTION
With the use of the R.F. and A.F. Probes included with the Model 76, you can make stage gain measurements, locate signal loss in R.F. and Audio stages, localize faulty stages, locate distortion and hum, etc. Provision has been made for use of phones and meter if desired.

TV ANTENNA TESTER SECTION
Loss of sync., snow and instability are only a few of the faults which may be due to a break in the antenna, so why not check the TV antenna first? 2 Ranges: 2' to 200' for 72 ohm coax and 2' to 250' for 300 ohm ribbon.

Model 76 comes complete with all accessories including R.F. and A.F. Probes: Test Leads and operating instructions. Nothing else to buy. Only **$26.95**

SUPERIOR'S NEW MODEL 79

SUPER-METER

WITH NEW 6" FULL-VIEW METER

A Combination
VOLT-OHM MILLIAMMETER
Plus
CAPACITY, REACTANCE, INDUCTANCE, AND DECIBEL MEASUREMENTS
Also Tests
SELENIUM AND SILICON RECTIFIERS, SILICON AND GERMANIUM DIODES.

The model 79 represents 20 years of continuous experience in the design and production of SUPER-METERS, an exclusive SICO development. It includes not only every circuit improvement perfected in 20 years of specialization but, in addition includes those services which are "musts" for properly servicing the ever-increasing number of new components used in all phases of today's electronic production. For example with the Model 79 SUPER-METER you can measure the quality of selenium and silicon rectifiers and all types of diodes—components which have come into common use only within the past five years, and because this latest SUPER-METER necessarily required extra meter scale. SICO used its new full-view 6-inch meter.

SPECIFICATIONS:

• **D.C. VOLTS:** 0 to 7.5/15/75/150/750/1,500. • **A.C. VOLTS:** 0 to 15/30/150/300/1,500/3,000 • **D.C. CURRENT:** 0 to 1.5/15/150 Ma. 0 to 1.5/15 Amperes • **RESISTANCE:** 0 to 1,000/100,000 Ohms, 0 to 10 Megohms. • **CAPACITY:** .001 to 1 Mfd., 1 to 50 Mfd. • **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.

The following components are all tested for QUALITY at appropriate test potentials. Two separate BAD-GOOD scales on the meter are used for direct readings. **All Electrolytic Condensers from 1 MFD to 1000 MFD. All Germanium Diodes. All Selenium Rectifiers. All Silicon Diodes. All Silicon Rectifiers.**

Model 79 comes complete with operating instructions, test leads, and streamlined carrying case. Use it on the bench—use it on calls. Only **$38.50**

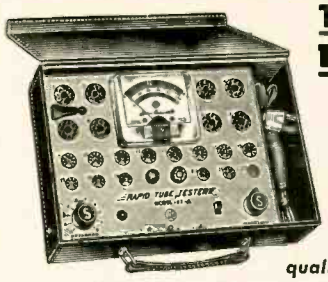
EXAMINE BEFORE YOU BUY!

USE APPROVAL FORM ON NEXT PAGE

SUPERIOR'S NEW MODEL 82A

Multi-Socket Type

TUBE TESTER



TEST ANY TUBE IN 10 SECONDS FLAT!

1. Turn the filament selector switch to position specified.
2. Insert tube into a numbered socket as designated on our chart (over 600 types included).
3. Press down the quality button—

THAT'S ALL! *Read emission quality direct on bad-good meter scale.*

SPECIFICATIONS

- Tests over 600 tube types
- Tests OZ4 and other gas-filled tubes
- Employs new 4" meter with sealed air-damping chamber resulting in accurate vibrationless readings
- Use of 22 sockets permits testing all popular tube types and prevents possible obsolescence
- Dual Scale meter permits testing of low current tubes
- 7 and 9 pin straighteners mounted on panel
- All sections of multi-element tubes tested simultaneously

Ultra-sensitive leakage test circuit will indicate leakage up to 5 megohms

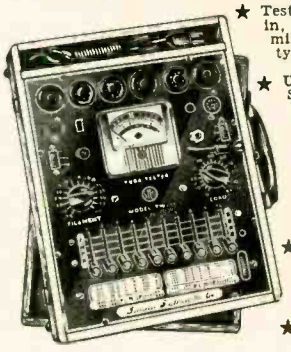
Production of this Model was delayed a full year pending careful study by Superior's engineering staff of this new method of testing tubes. Don't let the low price mislead you! We claim Model 82A will outperform similar looking units which sell for much more — and as proof, we offer to ship it on our examine before you buy policy.

To test any tube, you simply insert it into a numbered socket as designated, turn the filament switch and press down the quality switch — THAT'S ALL! Read quality on meter. Inter-element leakage if any indicates automatically.

Model 82A comes housed in handsome, portable Saddle-Stitched Texon case. Only **$36.50**

SUPERIOR'S NEW MODEL TW-11 **STANDARD PROFESSIONAL**

TUBE TESTER



★ Tests all tubes, including 4, 5, 6, 7, Octal, Lock-in, Hearing Aid, Thyratron, Miniatures, Sub-miniatures, Novals, Sub-minars, Proximity fuse types, etc.

★ Uses the new self-cleaning Lever Action Switches for individual element testing. Because all elements are numbered according 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 TW-11 as any of the pins may be placed in the neutral position when necessary.

★ The Model TW-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 the wrong socket.

★ Free-moving built-in roll chart provides complete data for all tubes. All tube listings printed in large easy-to-read type.

NOISE TEST: Phono-jack on front panel for plugging in either phones or external amplifier will detect microphonic tubes or noise due to faulty elements and loose internal connections.

EXTRAORDINARY FEATURE

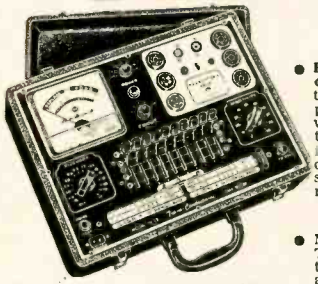
SEPARATE SCALE FOR LOW-CURRENT TUBES: Previously, on emission-type tube testers, it has been standard practice to use one scale for all tubes. As a result, the calibration for low-current types has been restricted to a small portion of the scale. The extra scale used here greatly simplifies testing of low-current types.

The Model TW-11 operates on 105-130 Volt 60 Cycles A.C. Comes housed in a beautiful hand-rubbed oak cabinet complete with portable cover. **$47.50**

SUPERIOR'S NEW MODEL TV-12

TRANS-CONDUCTANCE

TUBE TESTER



TESTING TUBES

- **Employs improved TRANS-CONDUCTANCE circuit.** An in-phase signal is impressed on the input section of a tube and the resultant plate current change is measured. This provides the most suitable method of simulating the manner in which tubes actually operate in Radio & TV receivers, amplifiers and other circuits. Amplification factor, plate resistance and cathode emission are all correlated in one meter reading.
- **NEW LINE VOLTAGE ADJUSTING SYSTEM.** A tapped transformer makes it possible to compensate for line voltage variations to a tolerance of better than 2%.

ALSO TESTS TRANSISTORS!

- **SAFETY BUTTON**—protects both the tube under test and the instrument meter against damage due to overload or other form of improper switching.
- **NEWLY DESIGNED FIVE POSITION LEVER SWITCH ASSEMBLY.** Permits application of separate voltages as required for both plate and grid of tube under test, resulting in improved Trans-Conductance circuit.

TESTING TRANSISTORS

A transistor can be safely and adequately tested only under dynamic conditions. The Model TV-12 will test all transistors in that approved manner, and quality is read directly on a special "transistor only" meter scale.

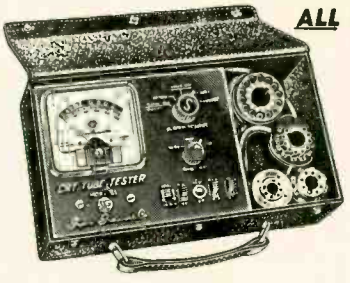
The Model TV-12 will accommodate all transistors including NPN's, PNP's, Photo and Tetrodes, whether made of Germanium or Silicon, either point contact or junction contact types.

Model TV-12 comes housed in handsome rugged portable cabinet and sells for only... **$72.50**

SUPERIOR'S NEW MODEL 83

C.R.T. TESTER

Tests and Rejuvenates ALL PICTURE TUBES



ALL BLACK AND WHITE TUBES

From 50 degree to 110 degree types —from 8" to 30" types.

ALL COLOR TUBES

Test ALL picture tubes—in the carton—out of the carton—in the set!

- Model 83 is not simply a rehashed black and white C.R.T. Tester with a color adapter added. Model 83 employs a new improved circuit designed specifically to test the older type black and white tubes, the newer type black and white tubes and all color picture tubes.
- Model 83 provides separate filament operating voltages for the older 6.3 types and the newer 8.4 types.
- Model 83 employs a 4" air-damped meter with quality and calibrated scales.
- Model 83 properly tests the red, green and blue sections of color tubes individually—for each section of a color tube contains its own filament, plate, grid and cathode.
- Model 83 will detect tubes which are apparently good but require rejuvenation. Such tubes will provide a picture seemingly good but lacking in proper definition, contrast and focus. To test for such malfunction, you simply press the rej. switch of Model 83. If the tube is weakening, the meter reading will indicate the condition.
- Rejuvenation of picture tubes is not simply a matter of applying a high voltage to the filament. Such voltages improperly applied can strip the cathode of the oxide coating essential for proper emission. The Model 83 applies a selective low voltage uniformly to assure increased life with no danger of cathode damage.

Model 83 comes housed in handsome portable Saddle Stitched Texon case—complete with sockets for all black and white tubes and all color tubes. Only **$38.50**

SHIPPED ON APPROVAL

NO MONEY WITH ORDER — NO C.O.D.

Try any of the instruments on this or the facing page for 10 days before you buy. If completely satisfied then send down payment and pay balance as indicated on coupon. No Interest or Finance Charges Added! If not completely satisfied return unit to us, no explanation necessary.

MOSS ELECTRONIC, INC.
Dept. D-607, 3849 Tenth Ave., New York 3, N. Y.

Please send me the units checked on approval. If completely satisfied I will pay on the terms specified with no interest or finance charges added. Otherwise, I will return after a 10 day trial positively cancelling all further obligations.

Name .....

Address .....

City .....Zone....State.....

All prices net, F.O.B., N. Y. C.

- ☐ **Model 77** Total Price $42.50 — $12.50 within 10 days. Balance $6.00 monthly for 5 months.
- ☐ **Model 76** Total Price $26.95 — $6.95 within 10 days. Balance $5.00 monthly for 4 months.
- ☐ **Model TW-11** ..... Total Price $47.50 — $11.50 within 10 days. Balance $6.00 monthly for 6 months.
- ☐ **Model TV-50A** .. Total Price $47.50 — $11.50 within 10 days. Balance $6.00 monthly for 6 months.
- ☐ **Model 79** ... Total Price $38.50 — $8.50 within 10 days. Balance $6.00 monthly for 5 months.
- ☐ **Model TV-12** .. Total Price $72.50 — $22.50 within 10 days. Balance $10.00 monthly for 5 months.
- ☐ **Model 80** ... Total Price $42.50 — $12.50 within 10 days. Balance $6.00 monthly for 5 months.
- ☐ **Model 82A** .. Total Price $36.50 — $6.50 within 10 days. Balance $6.00 monthly for 5 months.
- ☐ **Model 83** .. Total Price $38.50 — $8.50 within 10 days. Balance $6.00 monthly for 5 months.

SEEBURG RECORD CHANGER

Trouble on the model M automatic and similar units using selector blades or knives is often caused by burrs on the knives. Examine with a small magnifying glass.

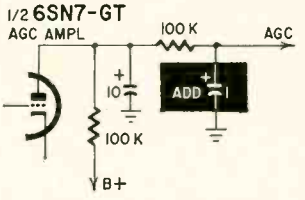
Remove any burrs on the knife edges with an ignition-point file. Smooth file cuts with sandpaper.

File only enough to remove the burr, being careful not to change the shape of the knives. Use the magnifying glass to check your job.—*James A. McRoberts*

INTERMITTENT PIX

A 16-inch Starrett was pulled to the shop for intermittent loss of picture which was repaired with not too much trouble. However, after a lengthy air check to make sure the set was operating normally, we noticed that every now and again the picture would go into a vertical slide and lose vertical sync entirely. Touching the hold control would settle the picture back for an instant or two but then she'd slide off again.

It had all the earmarks of a bad integrator capacitor, but they all checked out good. To make the job more difficult, this condition would not present itself at all times but only occasionally. A check with the customer revealed that



the set had been behaving that way for some time now and, in fact, for as long as she could remember. Indeed, she was so used to it that she told us not to bother with it.

Coming from a customer, this is surprising but our appetites were whetted by the challenge so we decided to stick with it. And stuck we were. After days of checking the only thing we could come up with was that the vertical sync pulse was being clipped in the composite video signal—but where?

A check of every component in the if and agc networks was made and nothing turned up. Consulting our hand-drawn schematic (the commercial schematic of this set differed from the actual wiring in many ways) we decided that perhaps what we needed was something that wasn't there. An additional agc filter was wired in as shown in the diagram and it turned the trick. The picture hasn't rolled once since.—*Frank A. Salerno*

END

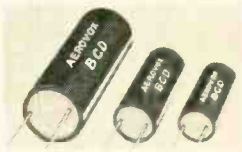
On the Market

TUNER CLEANER. Wax-free lubricant comes in can with detachable needle for concentrating spray into almost-inaccessible spots. Needle packed in plastic tube for tool-kit storage. —**Injectorall Co.**, 2081 Shore Parkway, Brooklyn 14, N. Y.

TV ROOF MOUNT, universal design, fits all wall surfaces and roofs, mounts with speed nails (supplied) and hammer. *Tri-Roof Mount* will support most antennas available. Kit includes nails, lead wire, standoffs and lightning arrester.—**Telco Electronics Mfg. Co.**, 400 S. Wyman St., Rockford, Ill.

ANALOG COMPUTER *model EC-1* for educational use. Low-cost kit includes 9 dc operational amplifiers, 3 initial-condition power supplies, 5 coefficient pots, 4 sets of relay contacts, regulated power supply and repetitive oscillator, patch cords for setting up problems. All parts mounted on plugs for rapid insertion into problem-board sockets. Results read directly from meter or externally from separate scope. Stands alone or mounts in relay rack.—**Heath Co.**, Benton Harbor, Mich.

ELECTROLYTIC CAPACITORS mount upright for use on printed-wiring boards. *Type BCD* has bakelite case and epoxy resin end-fill to bar moisture, leakage, drying out. 1-inch leads for easy insertion in boards. Lead polarities marked.—**Aerovox Corp.**, New Bedford, Mass.



MINIATURE POTENTIOMETERS. Precision units rated at 1.5 watts at 40°C. ½ inch diameter by ½ inch long. *Series 57* stock values in standard and locked-shaft types from 50 to 50,000 ohms.—**Clarostat Mfg. Co.**, Dover, N. H.

MINIATURE ELECTROLYTICS, *type SMTUCP*, with common anode for dual sections. Isolated cathode construction suited to much transistor circuitry.—**Illinois Condenser Co.**, 1616 N. Throop St., Chicago 22.

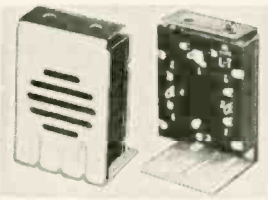
COLOR SET RECTIFIER. *Model TV-502* compact exact replacement in RCA, Sylvania, Raytheon color sets using doubler power supplies. Silicon rectifier stack replaces 2 selenium stacks in black-and-white sets using twin selenium rectifiers in doubler circuits. — **International Rectifier Corp.**, 1521 E. Grand Ave., El Segundo, Calif.

FLYBACKS. Stancor exact replacements for Admiral, Crosley and Bendix TV receivers. *Model HO-305* replaces 2 Crosley units used in 34 sets; *HO-306* replaces 3 Bendix units used in 30 models. 3 others handle 301 Admiral receivers. — **Chicago Standard Transformer Corp.**, 3501 W. Addison St., Chicago 18, Ill.

SENSITIVE RELAYS are meter type, in 2½- and 3½-inch sizes. *Models 195 and 95* used wherever under-voltage or over-voltage indicators, overload or limit alarms, low-level switching or position or gauging devices are required. Available in dc ranges from microamps to 10 amperes; 50 mv to 500 volts; ac

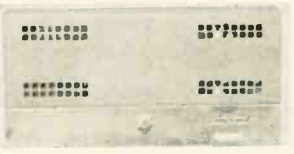
500 mv to 500 volts; 100 μa to 20 ma. Higher ranges with external shunts.—**Simpson Electric Co.**, 5200 W. Kinzie St., Chicago.

TV TUBE SAVER attaches to back of TV set. Thermal time delay keeps B-plus off plates until



tubes warm up. *Save-A-Tube* also puts thermistor in ac power line, which reduces initial power surge, extending filament life. 3 models handle most black-and-white TV and color sets.—**G-C Electronics**, Rockford, Ill.

TV DISTRIBUTION AMPLIFIERS, *series SPA*, deliver 20 volts on any vhf channel into 75 ohms over long distances. Require 1 volt input, produce 26 db gain. Grounded-grid amplifier



drives push-pull twin transmitting type tube which is shielded to eliminate stray radiation. Bandwidth 6 mc and over.—**SEG Electronics, Inc.**, 1778 Flatbush Ave., Brooklyn, N. Y.

MULTITESTER SEMI-KIT. Pocket-size unit with 20,000-ohms-per-volt sensitivity on dc

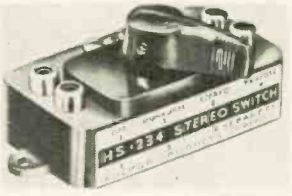
range, 10,000 on ac. 5 dc and ac voltage scales from 10 to 1,000 full scale; three dc current ranges 500 μa to 250 ma; capacitance 250 μμf to .02 μf; inductance 5,000 henries. *Model TK10* has 2 db scales and zero adjust. Meter is 3-inch scale with 40-μv movement.—**Lafayette Radio**, 165-08 Liberty Ave., Jamaica 33, N. Y.

MULTITESTER *model TS-55-A* with 1,000 ohms-per-volt sensitivity has 5 ac and dc ranges selected by plugging into pin jacks on front panel. Voltage ranges from 10 to 1,000 full scale; current 1 ma and 500 ma dc; resistance 100,000 ohms full scale. 3¼ x 1⅜ x 5 inches.—**ALCO Electronics Mfg. Co.**, 3 Wolcott Ave., Lawrence, Mass.

VTVM–CAPACITANCE meter *model 107A* has 6 ranges each for ac and dc voltage, capaci-

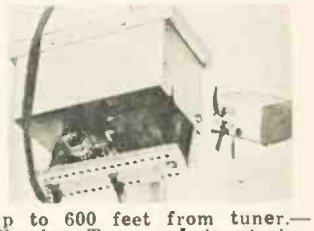
tance. 4 ranges for inductance. 6-inch meter reads voltages peak-to-peak ac from 0.2 to 2,800, rms ac 0.1 to 1,000, dc 0.1 to 1,000. Capacitance measurements from 50 μμf to 5000 μf. Resistance from 0.2 ohms to 1,000 megohms. Inductances from 1.4 to 140,000 henries can be measured using internally supplied ac. Also available as kit.—**Electronic Measurements Corp.**, 625 Broadway, New York.

STEREO SWITCH *model HS 234*. 4 positions: normal stereo, mono combining both channels, stereo reverse and silent. Small plastic unit with lever knob



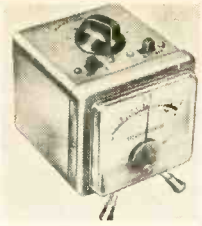
mounts anywhere with 2 screws. Phono jacks used for insertion between stereo cartridge or tape head and preamps, between preamps and power amplifiers, or for controlling loudspeakers.—**Anchor Products Co.**, 2712 W. Montrose Ave., Chicago 18, Ill.

FM ANTENNA BOOSTER, *model AB-FM*, wide-band antenna-mounted amplifier for FM using new 6ER5 frame-grid rf tube. Power for unit is sent up 300-ohm line to amplifier from remote control unit located near FM tuner, while amplified rf comes down line from booster remote unit and then to tuner. Connections use "no-strip" terminals. Gain 16 db across FM band. Draws 5 watts ac; works



up to 600 feet from tuner.—**Blonder-Tongue Laboratories, Inc.**, 9 Alling St., Newark 2, N. J.

STEREO BALANCE METER has two meter coils in a magnetic field, one tending to drive the indicating needle in each direction. When signal levels in both channels are equal, needle stays in scale center. Imbalance of *model TM-66* is shown by deflection of needle to one side or



other. Slide switch puts meter in either channel as VU meter; 7-step range switch allows use with 600-ohm lines or across customary voice-coil circuits. Sensitivity 1.2 volts full scale.—**Lafayette Radio,** 165-08 Liberty Ave., Jamaica 33, N. Y.

FM–AM TUNER *model 320.* Medium-priced unit with wide-band FM and wide-range AM circuits, audio output level control, multiplex switch, AM bandwidth switch on front panel.

Drift-free FM requires no afc, has 2-mc bandwidth and high capture ratio. Both FM and AM use rf stage. Electronic eye for tuning on both bands. FM sensitivity 3 μv for 20-db quieting. Separate outputs for tape recorder and multiplex. Wood case optional.—**H. H. Scott, Inc.,** 111 Powdermill Rd., Maynard, Mass.

MICROPHONE MIXERS, passive units for high-impedance microphones. *Model 306* 4-chan-

nel unit for mono, or 2-channel stereo mixer. 4 input jacks on rear, volume controls and stereo–mono switch on front. Output jacks connect to 2 amplifier or recorder inputs. *Model 301* similar, for mono only.—**Switchcraft, Inc.,** 5555 N. Elston Ave., Chicago 30, Ill.

4-WAY SPEAKERS, *Tetraxiom series* with 4 driver units mounted concentrically. Woofer 15-inch cone with free-floating rim; mid-range unit horn driver; two horn tweeters extend range well beyond 20,000 cycles. Tweeters angled for

wide dispersion. Massive castings used for *model 575,* rated at 50 watts, and *model 355,* rated at 40 watts.—**Rockbar Corp.,** 650 Halstead Ave., Mamaroneck, N. Y.

PICKUP ARM with newly designed bearings and pivots using knife-edge for low friction. *Models PK-270* (12-inch arm) and *PK-280* (16-inch arm). Wired for stereo; plug-in heads for all standard cartridges. Bubble level incorporated in support column along with three

adjustments for leveling.—**Lafayette Radio,** 165-08 Liberty Ave., Jamaica 33, N. Y.

REPLACEMENT STYLI, *New Compatible Standard,* ground with hardest planes toward record surface. Increased sensitivity at 10,000 cycles, lowered distortion at 5,000. Designed for stereo–mono discs, provide longer life.—**Fidelitone, Inc.,** 6415 Ravenswood Ave., Chicago 26, Ill.

MOISTURE GAUGE *model 101,* operates with electrodes buried in soil, reads percentage

of moisture instantaneously. Transistor circuitry uses battery, lasts for many months. 100-μa meter, accuracy ±2% at 70°F.—**Henry Francis Parks Laboratory,** PO Box 1665, Lake City Station, Seattle 55, Wash.

CRT TESTER ADAPTER, *model CR48,* adapts B & K model 400 and 350 CRT Rejuvenator-

Testers, normally for 6.3-volt C-R tubes, to the new CRT's with 2.34-, 2.68- and 8.4-volt filaments.—**B & K Mfg. Co.,** 3726 N. Southport Ave., Chicago 13, Ill.

SMALL SOLDERING IRON— 30-watt unit for work with

miniature components, and print-circuit boards.—**L. I. Electrolabs, Inc.,** 1186 Broadway, Hewlett, N. Y. END

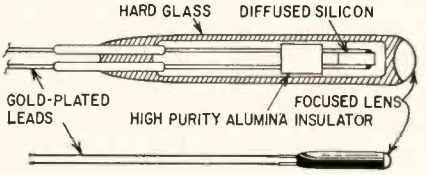
All specifications on these pages are from manufacturers' data.

NEW TUBES and SEMICONDUCTORS

SEMICONDUCTOR devices hold the fort this month with some silicon Mesa transistors, a photo-duo-diode, and high-current switching devices.

1N2175

A subminiature light-sensing photo-duo-diode. Diffused n-p-n unit lets current flow whenever either junction is exposed to light, but effectively shuts current off in darkness. The device is suited for reading data from punched



1N2175

tape and card systems. The single-ended glass case measures only 0.5 inch by 0.085 inch. A minute glass lens is located at the end opposite the leads.

Maximum ratings of the Texas Instruments 1N2175 are:

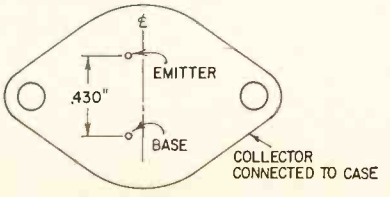
V_{bias} (at 25°C)	±50
P_{total} (at 25°C) (mw)	250

Typical specifications are:

Dark current (at 25°C, ± 50 V) (μa)	0.01
(at 100°C, ± 50 V) (μa)	20
Light current (at 25°C, ± 10 V) (μa)	200
Photocurrent rise time (μsec)	2
decay time (μsec)	20
Sensitivity (radiation system at 10V) (μa/mw/cm²)	22.3
(illumination system at 10V) (μa/ft candle)	0.6

2N637, -A, -B

A series of high-gain p-n-p transistors especially designed as high current switching devices for dc-to-dc converter and dc-to-ac inverter circuits. The series has three breakdown voltages ratings for use in both 12 and 28-volt supplies without danger of burnout.



2N637,-A,-B

Current gain is held to close tolerance to eliminate the need for matching. The transistors are capable of switching 250 watts and have applications as relay replacements, drivers for relays, magnetic clutches, solenoids and other loads requiring high current.

Maximum ratings of these Bendix units are:

V_{CE}	40	70*	80†
I_C (amps)	5		
P_C (average watts)	25		
I_B (ma)	500		

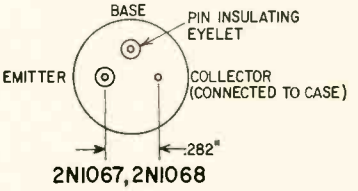
Typical electrical characteristics are:

h_{FE} (current gain) (min) (V_{CE} = 5, I_C = 3 amps)	30
Switching time	
t_r (μsec) (I_C = 3 amps)	15
t_f (μsec) (I_B = 300 ma)	35

*2N637-A
†2N637-B

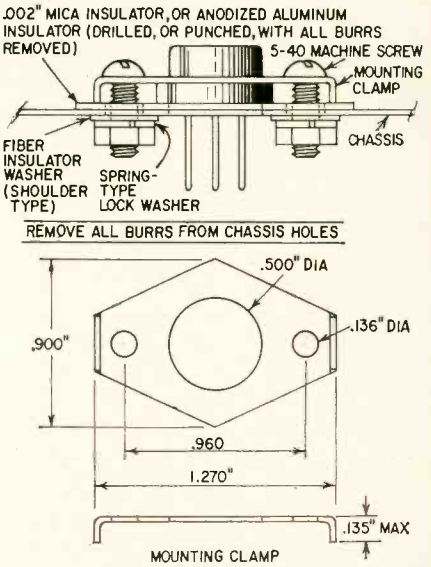
2N1067, 2N1068

Single-diffused junction silicon n-p-n intermediate-power Mesa transistors, intended for military and industrial applications. They are particularly useful



2N1067, 2N1068

in power switching circuits such as dc-to-dc converters, dc-to-ac inverters, multivibrators, and relay and solenoid-actuating devices. The transistors may also be used in oscillators, dc amplifiers, class A and class B push-pull amplifiers.



2N1067, 2N1068

Maximum ratings in industrial service for these RCA transistors are:

	2N1067	2N1068
V_{CE} (peak) (base connected to emitter)	60	60
(peak) (base open)	30	30
V_{EB} (peak)	12	12
I_C (peak) (amps)	0.5	1.5
I_E (peak) (amps)	0.5	1.5
I_B (peak) (ma)	200	500
P_{total} (at 25°C) (watts)	5	10
(at 100°C) (watts)	2.5	5

These transistors do not have a

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Premium-Performance or Budget-Priced NATIONAL BRAND PICTURE TUBES

PREMIUM-PERFORMANCE

CBS

Silver Vision

- Brighter silver-activated AG-905 screen
- Sharper pin-point focus electron gun
- Nationally advertised brand
- Meets performance specifications of all leading TV set manufacturers

BUDGET-PRICED

CBS

PALOMAR

- All-new electron gun
- All-new phosphor screen
- Full 12 months warranty
- Backed by CBS Electronics, a Division of Columbia Broadcasting System, Inc.

For over a year, the combined sales appeal of CBS Silver Vision and CBS Palomar picture tubes has been field-tested on the West Coast. Now this proven sales approach originated by an independent tube manufacturer is available to all independent service-dealers.

Does your customer demand the finest in performance, or is he budget-minded? You can make the sale with CBS Silver Vision . . . or with CBS Palomar. Either is easy to sell because of top brand prestige. Either stays sold because of top performance in its field.

And their dependable CBS national brand assures you of profit without callbacks. Play safe. Sell premium-performance CBS Silver Vision or budget-priced CBS Palomar with confidence.

THE CBS FAMILY • CBS ELECTRONICS • CBS INTERNATIONAL • CBS TELEVISION NETWORK • CBS LABORATORIES • CBS NEWS • CBS RADIO • CBS TELEVISION STATIONS • COLUMBIA RECORDS • LEADERS IN ELECTRONIC COMMUNICATIONS

ELECTRON TUBES
CBS
SEMICONDUCTORS

CBS ELECTRONICS formerly CBS-HYTRON
Danvers, Massachusetts
A Division of Columbia Broadcasting System, Inc.

mounting flange, so a special type of heat sink is required. Details of such a heat sink are shown in the diagram.

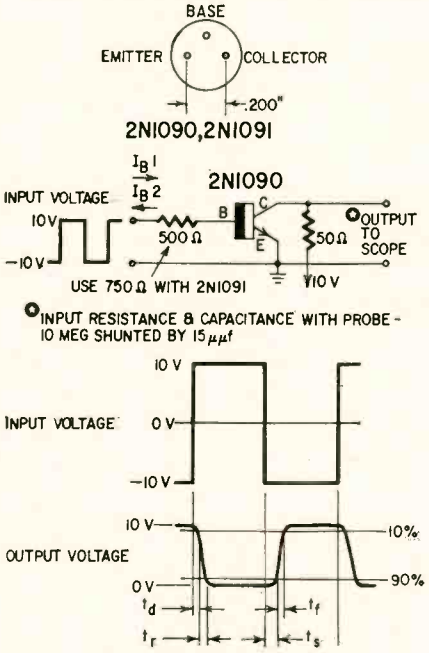
Multiunit semiconductor

A diode-triode in one transistor envelope acts as a detector–driver in transistor radios. An experimental set using this unit has a sensitivity of 200 μv per meter and a power output of 50 mw.

The multi-unit transistor made by RCA consists of an alloyed p-n junction (diode unit) for use as a detector, and an alloyed p-n-p junction (triode unit) for use as an audio amplifier. Both units are constructed on one germanium pellet, so the n-type base region is common to both units. This construction provides direct connection between the diode unit and the triode unit, reducing the number of circuit components to a minimum.

2N1090, 2N1091

These n-p-n germanium alloy-junction transistors are designed for high-current medium-speed switching circuits of military and industrial computers.



Typical operating characteristics of the accompanying inverter circuit using these RCA units are:

	2N1090	2N1091
V_c supply	10	10
I_c transistor on (ma)	200	200
I_B (turn on) (I_{B1}) (ma)	20	13.3
(turn off) (I_{B2}) (ma)	−20	−13.3
Switching time		
t_d (delay time) (μsec)	0.05	0.05
t_r (rise time) (μsec)	0.25	0.20
t_s (storage time) (μsec)	0.20	0.17
t_f (fall time) (μsec)	0.15	0.13

Semiconductor brief

International Rectifier Corp. has announced a new series of subminiature silicon bridge rectifiers which extend their present line. The new units measure only 0.875 x 0.719 x 0.750 inch and weight ¼ ounce. END

SIMPLE SERVICE CALLS

How many TV service calls have you made where the only trouble was the set's line cord pulled from its wall outlet? After making several such calls, I decided something must be done. Now I carry some spring type clothespins in my toolkit and, whenever I make such a call, I ask the customer for permission to nail a clothespin to the wall near the outlet to hold the cord in place. It only takes a minute so there is no charge for the service.

This promotes good customer–technician relations and at the same time lets me plug my service—plainly stamped on each pin is my name, address and phone number.—*John A. Comstock*

HANDY BENCH GADGET

Here's a mighty handy gadget that we find many uses for on the bench in our service shop. It consists of a large paper-clamp screw and wing nut fastened to a metal base taken from a

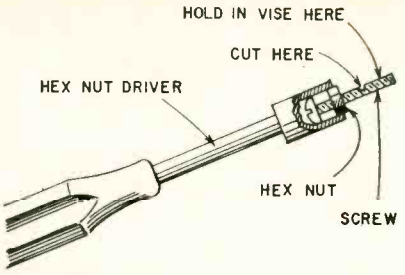
discarded desk fan. In addition to being a handy service-light holder as shown in the photograph, it is just as handy as a soldering-iron holder and a vise for holding parts while they are being soldered or tested. By loosening the wing nut, it can be angled to several different working positions. It is a very flexible "tool" and should make a welcome addition to any service bench.—*J. C. Alexander*

SCREW-CUTTING JIG

Many electronic construction projects require screws cut to odd lengths, and sometimes, when stock is low, standard lengths can be made from long ones. In either case, a nut can be put on the screw and run up beyond the cutoff point. The cut is then made with a hacksaw and the nut is backed off to clear the burrs off the thread.

The hard part of the job is holding the screw while the cut is made. A

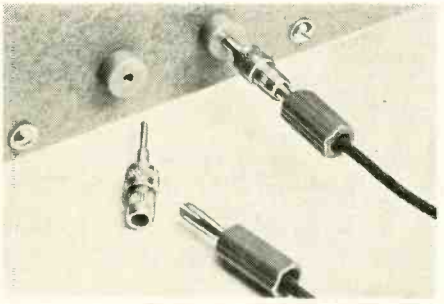
TRY THIS ONE *(Continued)*



simple and easy way to do this is to run the nut up close to the screw head and insert the screw, head first, into a hex-nut driver. Now hold the projecting end of the screw in a vise and cut to the desired length.—*James E. Pugh, Jr.*

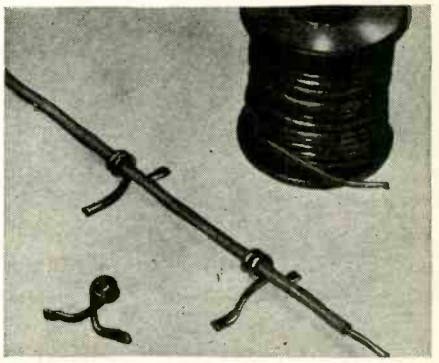
BANANA PLUG TO TIP JACK

In electronic service and experimental work, it is sometimes desired to fit banana plugs to tip jacks. To do this, some kind of an adapter is needed. One solution to the problem is shown in the photo. Simply buy a couple of ICA type 358 solderless tip plugs and use them as adapters. You will find the openings on the back ends of the ICA solderless plugs just the right size to receive banana plugs.—*Art Trauffer*



SOLDER LOOP ANCHORS WIRE

When I need a tiny wire clamp to hold a long insulated wire positioned correctly in electronics gear, I make



standoff clamps by twisting short lengths of wire solder around the conductor a couple times, and tack-solder the ends to the chassis. The wire lead stays put with this arrangement, and it is particularly useful in critical circuits of mobile electronics gear subject to mechanical shocks and vibration.—*J. A. Coombs* END

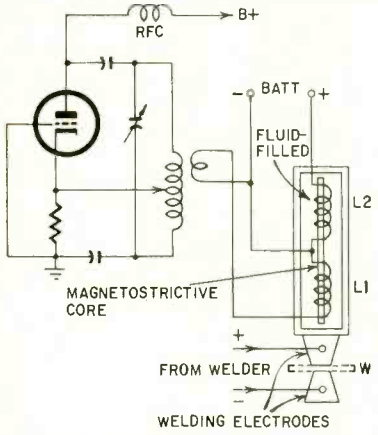
PATENTS

ULTRASONIC WELDER

Patent No. 2,846,563

Eugene J. Cronin, Menlo Park, Calif.

Ultrasonic vibrations help make stronger welds. The weld is vibrated during its cooling period to keep the metal from forming large crystals. Thus the particles remain small until the melt "freezes."



The triode generates an ultrasonic voltage which is fed to L1, wound around a magnetostrictive rod. This rod is immersed in a water-cooled compartment. Vibrations of the rod are transmitted to the upper welding electrode as shown. It is these vibrations that prevents the formation of large crystals.

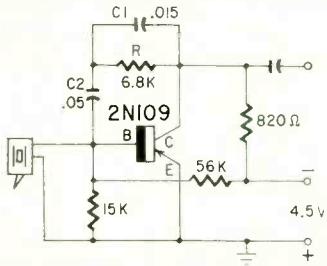
Polarizing coil L2 is fed with dc to bias the rod (magnetically) for maximum sensitivity. The weld is made at W between electrodes fed with dc.

CRYSTAL PREAMPLIFIER

Patent No. 2,857,462

Hung Chang Lin, Levittown, Pa. (Assigned to RCA)

A crystal microphone or pickup is capacitive, hence its output increases with frequency. The response may be flattened by terminating it with a high resistance. This is often done when the preamplifier is a tube. With a transistor it is more difficult because of the low input resistance. This circuit uses feedback to overcome the frequency distortion. Its output response is flat from 30 to 15,000 cycles with 0.1% distortion.



R, C1, C2 comprise the feedback network. At 50 cycles, the reactance of C2 equals transistor beta multiplied by load resistance. At higher frequencies, the gain drops by 6 db per octave as the amount of feedback through the capacitor increases.

From 500 to 2,000 cycles, attenuation is controlled largely by R, so output level remains constant. At 2,000 cycles, the reactance of C1 equals R, and the response falls 6 db per octave above that frequency. The overall equalization compensates for the RIAA recording characteristics.

(*Continued on page* 110)

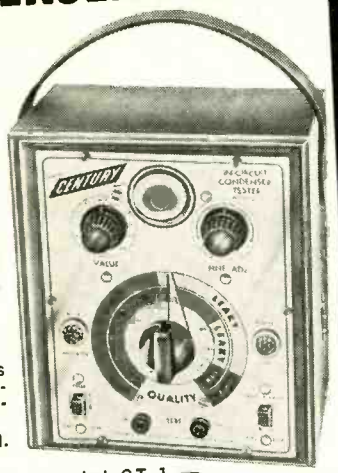
SHIPPED ON APPROVAL

IN-CIRCUIT CONDENSER TESTER

Model CT-1

AN ABSOLUTE 'MUST' FOR EVERY SERVICEMAN!

Here is an in-circuit condenser tester that does the whole job. The CT-1 actually steps in and takes over where all other in-circuit condenser testers fail. The ingenious application of a dual bridge principle gives the CT-1 a tremendous range of operation. . . .



in-circuit checks:

- Quality of over 80% of all condensers even with circuit shunt resistance present . . . (leakage, shorts, opens, intermittents)
- Value of all condensers from 200 mmfd. to .5 mfd.
- Quality of all electrolytic condensers (the ability to hold a charge)
- Transformer, socket and wiring leakage capacity

out-of-circuit checks:

- Quality of 100% of all condensers . . . (leakage, shorts, opens and intermittents)
- Value of all condensers from 50 mmfd. to .5 mfd.
- Value of all electrolytic condensers (the ability to hold a charge)
- Quality of all electrolytic condensers
- High resistance leakage up to 300 megohms
- New or unknown condensers . . . transformer, socket, component and wiring leakage capacity

Model CT-1 — housed in sturdy hammertone finish steel case complete with test leads **$34.50** Net

SIZE: W–6" H–7" D–3¼"

SPECIFICATIONS

• Ultra-sensitive 2 tube drift-free circuitry • Multi-color direct scale precision readings for both quality and value . . . (in-circuit or out of circuit) • Simultaneous readings of circuit capacity and circuit resistance • Built-in hi-leakage indicator sensitive to over 300 megohms • Cannot damage circuit components • Electronic eye balance indicator for even greater accuracy • Isolated power line

MINI-CHECK TUBE TESTER

Model MC-1

A Real *ECONOMY* MULTIPLE SOCKET TUBE TESTER without sacrifice in *ACCURACY, SPEED* or *VERSATILITY*

Here is a multiple socket tube tester designed to meet limited budgets. Although low in price it boasts a unique circuitry that enables you to check over 600 tube types — and has a range of operation that far exceeds others in its price class.

Model MC-1 — housed in sturdy wrinkle finish steel case **$39.50** Net

SIZE: W–9" H–8½" D–2¾"

SPECIFICATIONS

• Checks emission, inter-element shorts and leakage of over 600 tube types. This covers OZ4s, series-string TV tubes, gas regulators, auto 12 plate volt, hi-fi and foreign tubes • 3 settings enable a test of any tube in less than 10 seconds • Employs dynamic cathode emission test principles • 3½" D'Arsonval type meter — most accurate type available . . . its greater sensitivity means more accuracy . . . its jewel bearing means longer life • 17 long lasting phosphor bronze tube sockets • Combination gas and short jewel indicator • 9 filament positions • Handy tube chart contained in special back compartment • New tube listings furnished periodically at no cost • Detachable line cord

plus these BONUS FEATURES . . . found in no other low price tube tester

✓ Checks for cathode to heater shorts ✓ Checks for gas content ✓ Checks all sections of multiple purpose tubes . . . will pickup tubes with one "Bad" section ✓ Line isolated — no shock hazard ✓ Variable load control enables you to get accurate results on all tubes ✓ Positively cannot become obsolete as new tubes are introduced.

IN-CIRCUIT RECTIFIER TESTER

Model SRT-1

Checks all power rectifiers in-circuit whether SELENIUM, GERMANIUM, SILICON, etc.

With the growing trend towards compactness, portability and low price, TV manufacturers are resorting more and more to producing series-string TV sets employing selenium, germanium or silicon power rectifiers. Now the need for an in-circuit rectifier tester is greater than ever.

THE SRT-1 CHECKS ALL POWER RECTIFIERS IN-CIRCUIT AND OUT-OF CIRCUIT WITH 100% EFFECTIVENESS FOR:

✓ Quality ✓ Fading ✓ Shorts ✓ Opens ✓ Arcing ✓ Life Expectancy

Model SRT-1—housed in sturdy hammertone finish steel case complete with test leads **$29.50** Net

SIZE: W–6" H–7" D–3¼"

SPECIFICATIONS

- Checks all types of power rectifiers rated from 10 ma. to 500 ma. (selenium, germanium, silicon, etc.) both in-circuit or out-of-circuit.
- Will not blow fuses even when connected to a dead short.
- Large 3" highly accurate multi-color meter . . . sensitive yet rugged.
- Separate meter scales for in-circuit and out-of-circuit tests.
- Cannot damage or over heat rectifier being tested.

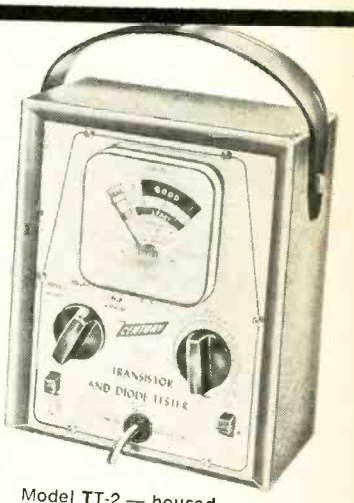
SIMPLE TO OPERATE Just clip SRT-1 test leads across rectifier under test right in the circuit without disconnecting rectifier from circuit. Press test switch and get an instant indication on the easy-to-read three-color meter scales. . . .

TRANSISTOR TESTER

Model TT-2

AN INEXPENSIVE QUALITY INSTRUMENT DESIGNED FOR ACCURATE AND DEPENDABLE TESTS OF ALL TRANSISTORS AND DIODES QUICKLY AND ACCURATELY

Every day more and more manufacturers are using transistors in home portable and car radios . . . in hearing aids, intercoms, amplifiers, industrial devices, etc. Since transistors can develop excessive leakage, poor gain, shorts or opens, the need for TRANSISTOR TESTER is great.



Model TT-2 — housed in sturdy hammertone finish steel case complete with test leads **$24.50** Net

SIZE: W–6" H–7" D–3¼"

SPECIFICATIONS

• Checks all transistors, including car radio, power output, triode, tetrode and unijunction types for current gain, leakage, opens, shorts, cut-off current • Checks all diodes for forward to reverse current gain • All tests can be made even if manufacturers' rated gain is not available • Less than half a minute required for tests of either transistors or diodes • Large 3" meter is extremely sensitive yet rugged . . . with multi-color scales designed for quick easy readings • Power is supplied by an easy to replace 6-volt battery — current drain so small, service life almost equal to shelf life. Battery cannot be drained due to accidental shorting of test leads • Cannot burn-out its own meter or damage transistor or diode under test • Long test leads and insulated test clips enable tests without entirely removing transistor from circuit • Test leads are identified by E.I.A. color code so that connection to the correct terminal is assured • Comes complete with replaceable transistor set-up chart that fits into a special rear compartment.

IMPORTANT FEATURE: The TT-2 cannot become obsolete as the circuitry is engineered to enable you to check all new type transistors as they are introduced. New listings will be furnished periodically at no cost.

EASY TO BUY IF SATISFIED

see order form on facing page

FOR 10 DAY *FREE* TRIAL

Convince yourself at no risk that CENTURY instruments are indispensable in your every day work. Send for instruments of your choice without obligation . . . try them for 10 days before your buy . . . only then, when satisfied, pay in easy-to-buy monthly installments — without any financing or carrying charges added.

NEW Battery Operated Peak-to-Peak VACUUM TUBE VOLT METER Model VT-1

WITH LARGE EASY-TO-READ 6" METER —

featuring the sensational new MULTI-PROBE * *Patent Pending*

No extra probes to buy! The versatile MULTI-PROBE does the work of 4 probes

❶ DC Probe ❷ AC-Ohms Probe ❸ Lo-Cap Probe ❹ RF Probe

The VT-1 is a tremendous achievement in test equipment. With its unique MULTI-PROBE it will do all the jobs a V.T.V.M. should do without the expense of buying additional probes. No longer do you have to cart around a maize of entangled cables, lose time alternating cables or hunting for a misplaced probe. With just a twist of the MULTI-PROBE tip you can set it to do any one of many time-saving jobs. A special holder on side of case keeps MULTI-PROBE firmly in place ready for use.

SIZE:
W-7⅜"
H-9"
D-4¼"

FUNCTIONS

DC VOLTMETER . . . Will measure D.C. down to 1.5 volts full scale with minimum circuit loading, and give accurate readings of scale divisions as low as .025 volts . . . Will measure low AGC and oscillator bias voltages from .1 volts or less up to 1500 volts with consistent laboratory accuracy on all ranges . . . Zero center provided for all balancing measurements such as discriminator, ratio detector alignment and hi-fi amplifier balancing.

AC VOLTMETER . . . True Peak-to-Peak measurements as low as 3 volts of any wave form including TV sync, deflection voltages, video pulses, distortion in hi-fi amplifiers, AGC and color TV gating pulses . . . Scale divisions are easily read down to .1 volts . . . Measures RMS at 1/20th the circuit loading of a V.O.M. . . . Unlike most other V.T.V.M.'s there is no loss in accuracy on the lowest AC range.

ELECTRONIC OHMETER . . . Measures from 0 to 1000 megohms . . . Scale divisions are easily read down to .2 ohms . . . Will measure resistance values from .2 ohms to one billion ohms . . . Will detect high resistance leakage in electrolytic and by-pass condensers.

RF and LO-CAP MEASUREMENTS . . . With these extra VT-1 functions you can measure voltages in extremely high-impedance circuits such as sync and AGC pulses, driving saw tooth voltages, color TV gating pulses, mixer output levels, I.F. stage-by-stage gain and detector inputs.

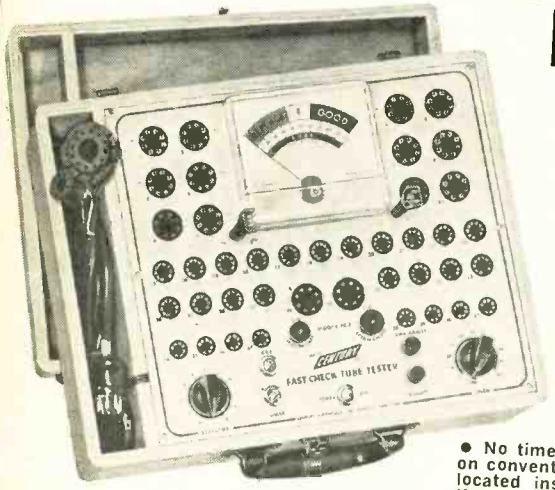
OUTSTANDING FEATURES

● Completely portable — self powered with long life batteries — permits use everywhere ● New advanced pentode amplifier circuit assures amazingly low battery drain ● Large 6" 100-microampere meter, many times more sensitive than meters used in most V.T.V.M.'s ● Laboratory accuracy performance — 2% of full scale on DC, 5% of full scale on AC ● Simplified multi-color easy-to-read 4-scale meter ● No heat operation assures rigid stability and accuracy ● Immune to power line fluctuations ● Amplifier rectifier circuit with frequency compensated attenator — a feature found only in costly laboratory instruments ● Meter completely isolated — practically burn-out proof ● Hand-crafted circuitry eliminates the service headaches of printed circuitry ● 1% resistors used for permanent accuracy ● Separate RF ground return for low-loss RF measurement ● Microphone type co-axial connector ● Matching cover protects instrument face — snaps on and off instantly.

SPECIFICATIONS

- DC Volts — 0 to 1.5/6/30/150/300/600/1500 volts
- AC Volts (RMS and Peak-to-Peak) — 0 to 3/12/60/300/1200 volts
- Ohms — 0 to a billion ohms, 10 ohms center scale — Rx1/10/100/1K/10K/100K/1M
- RF — Peak reading demodulator supplied for use on all DC ranges
- Zero Center — available on all DC volt ranges with zero at mid-scale
- Decibels — from —10 Db to +10/22/36/50/62 based on the Dbm unit: 0Db-1MW in 600 ohms
- Impedance — 11 megohms DC, 1 megohm AC, 10 megohms Lo-Cap
- Input Capacity — 130 mmfd. RMS, 250 mmfd. Peak-to-Peak, 25 mmfd. Lo-Cap

Model VT-1 — fully wired and calibrated, housed in handsome hammertone finish steel case, complete with MULTI-PROBE, and thorough instruction manual covering all the applications in detail. **$58.50** Net



SIZE: W—14⅝" H—11¼" D—4⅜"

Model FC-2 — housed in hand-rubbed oak carrying case complete with CRT adapter **$69.50** Net

FAST-CHECK TUBE TESTER Model FC-2

Simply set two controls . . . insert tube . . . and press quality button to test any of over 700 tube types completely, accurately . . . IN JUST SECONDS!

Over 20,000 servicemen are now using the FAST-CHECK in their every day work and are cutting servicing time way down, eliminating unprofitable call-backs and increasing their dollar earnings by selling more tubes with very little effort. See for yourself at no risk why so many servicemen chose the FAST-CHECK above all other tube testers.

PICTURE TUBE TEST ADAPTER INCLUDED WITH FAST-CHECK

Enables you to check all picture tubes (including the new short-neck 110 degree type) for cathode emission, shorts and life expectancy . . . also to rejuvenate weak picture tubes.

RANGE OF OPERATION

- ✓ Checks quality of over 700 tubes types, employing the time proven dynamic cathode emission test. This covers more than 99% of all tubes in use today, including the newest series-string TV tubes, auto 12 plate-volt tubes. OZ4s, magic eye tubes, gas regulators, special purpose hi-fi tubes and even foreign tubes.
- ✓ Checks for inter-element shorts and leakage.
- ✓ Checks for gas content.
- ✓ Checks for life-expectancy.

SPECIFICATIONS

● No time consuming multiple switching . . . only two settings are required instead of banks of switches on conventional testers ● No annoying roll chart checking . . . tube chart listing over 700 tube types is located inside cover. New listings are added without costly roll chart replacement ● Checks each section of multi-section tubes and if only one section is defective the tube will read "Bad" on the meter scale ● 41 phosphor bronze beryllium tube sockets never need replacement ● 7-pin and 9-pin straighteners mounted on panel ● Large 4½" D'Arsonval type meter is the most sensitive available, yet rugged — fully protected against accidental burn-out ● Special scale on meter for low current tubes ● Compensation for line voltage variation ● 12 filament positions ● Separate gas and short jewel indicators ● Line isolated — no shock hazards ● Long lasting etched aluminum panel.

NOTE: The Fast-Check positively cannot become obsolete . . . circuitry is engineered to accommodate all future tube types as they come out. New tube listings are furnished periodically at no cost.

CONVENIENT TIME PAYMENT PLAN — NO FINANCING CHARGES

ALL CENTURY INSTRUMENTS ARE GUARANTEED FOR ONE FULL YEAR

The extremely low prices are made possible because you are buying direct from the manufacturer.

CENTURY ELECTRONICS CO., INC.

CHECK INSTRUMENTS DESIRED

- ☐ Model CT-1 In-Circuit Condenser Tester $34.50
  $9.50 within 10 days. Balance $5 monthly for 5 months.
- ☐ Model MC-1 Mini-Check Tube Tester $39.50
  $9.50 within 10 days. Balance $6 monthly for 5 months.
- ☐ Model SRT-1 In-Circuit Rectifier Tester $29.50
  $4.50 within 10 days. Balance $5 monthly for 5 months.
- ☐ Model TT-2 Transistor Tester $24.50
  $4.50 within 10 days. Balance $5 monthly for 4 months.
- ☐ Model VT-1 Battery Vacuum Tube Volt Meter $58.50
  $14.50 within 10 days. Balance $11 monthly for 4 months.
- ☐ Model FC-2 Fast-Check Tube Tester $69.50
  $14.50 within 10 days. Balance $11 monthly for 5 months.

Prices Net F.O.B. Mineola, N. Y.

111 Roosevelt Avenue, Dept. 106, Mineola, New York

Please rush the instruments checked for a 10 day free trial. If satisfied I agree to pay the down payment within 10 days and the monthly installments as shown. If not completely satisfied I will return the instruments within 10 days and there is no further obligation. It is understood there will be NO INTEREST or FINANCING charges added.

Name .....

Please print clearly

Address .....

City ..... State .....

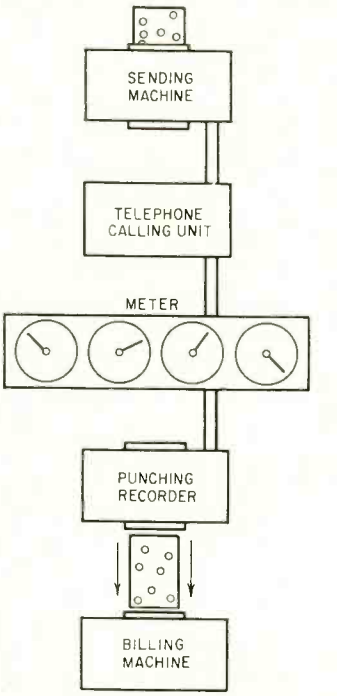
PATENTS *(Continued from page 107)*

AUTOMATIC METER-READER

Patent No. 2,870,258

Curtis M. Cooper, Binghamton, N. Y.

This inventor hopes to mechanize the job of reading utility meters. Electrical connection is



made by phone between the utility office and the consumer. Many relays, selectors and cogged wheels are shown in the patent and used in the device, but the basic idea is shown by a block diagram here.

A punched card is prepared by the utility company for each consumer who has a phone. This card automatically "dials" the number, but the telephone bell does not ring. Instead, a connection is made to the meter, which sends appropriate pulses back to the office to punch a card with the required data. This card is used to prepare the actual bill. The process is repeated once each month.

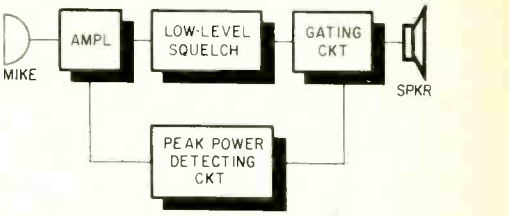
IMPROVING INTELLIGIBILITY

Patent No. 2,866,848

Lawrence J. Fogel, Jackson Heights, N. Y.
(May be used by the U.S. Government without royalty payments)

Many noise-reducing systems are of the low-pass type. In removing high-frequency noise they also remove much of the intelligibility of the consonants, in speech. This inventor shows that articulation resides mainly in these consonants although the energy is concentrated in the vowel sounds. By reducing the latter, he can accentuate the consonants and improve intelligibilty of the transmission.

See the diagram. In the presence of peak power



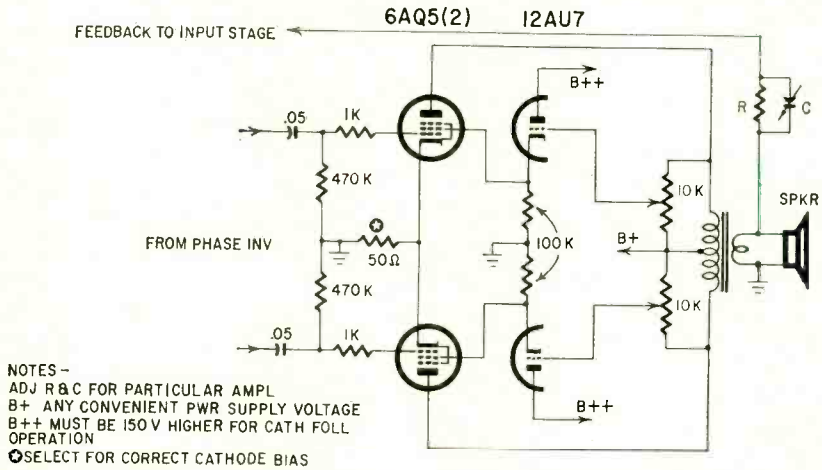
(mostly vowels), the gate is closed. The gating intervals must be extremely short. The consonants (articulation sounds) are only slightly attenuated. The squelch goes into action during the intervals when signals are weaker than the noise level.

The inventor also advises inserting a fixed frequency (about 200 cycles) during instants when the gate is closed to minimize the effects of the gaps in sound. END

NOTEWORTHY CIRCUITS

INEXPENSIVE ULTRA-LINEAR

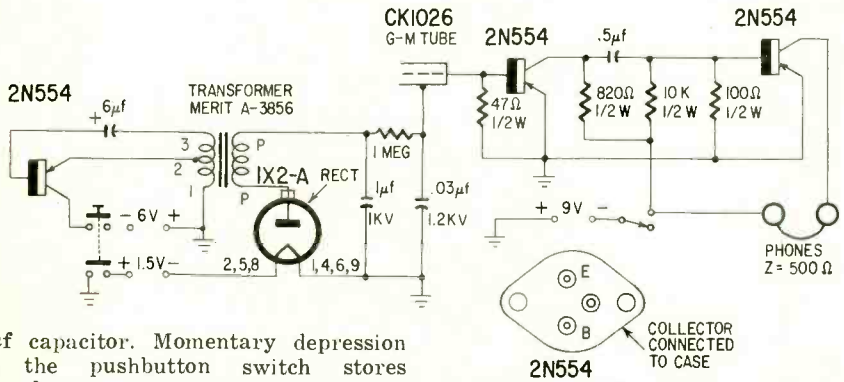
A fascinating circuit in the October, 1958, issue of *Electronic Industries* shows how to convert the push-pull pentode output stage of an audio amplifier to a form of Ultra-Linear operation. The only parts needed are a dual pot, two resistors and a twin triode. Once installed, three modes of amplifier operation are possible. With the potentiometer arms furthest from the pentode plates, ordinary pentode operation is obtained. At the other extreme full triode operation results. At some point between these settings Ultra-Linear operation is found. The feedback loop must be modified.



TRANSISTOR GEIGER COUNTER

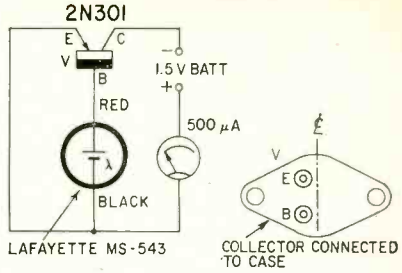
The transistor oscillator (charger) circuit on the left generates a high voltage (approximately 800 volts) in the transformer's secondary, which is rectified by the 1X2 and stored in the 1-μf capacitor. Momentary depression of the pushbutton switch stores enough energy to operate the G-M tube for several minutes. The charger circuit is used only occasionally to maintain this storage.

The two-stage amplifier on the right uses 2N554 transistors which have very high small-signal current and power gains and ordinarily give much higher gain per stage in this type of circuit than is obtainable with low-power audio units. Battery voltage as low as 6 volts for the amplifier gives good results.—*Motorola Semiconductors*



SENSITIVE LIGHT METER

This simple circuit does an excellent job of measuring weak illumination. As shown in the diagram, the photocell is connected so it reverse-biases the transistor. Thus, an increase in illumination drops the current output. A maximum of 400 μa flows when the photocell is in darkness. When exposed to 0.5 foot-candle, the indication falls to 90 μa. Roughly, this corresponds to the light from a 40-watt bulb at 8 feet. Most photographic exposure meters fail to



deflect at all (even with a booster) under such weak illumination. Because of the low drain, a penlight cell is used as the power supply.—*I. Queen* END

50 Years Ago

In Gernsback Publications

HUGO GERNSBACK, *Founder*

Modern Electrics	1908
Wireless Association of America	1908
Electrical Experimenter	1913
Radio News	1919
Science & Invention	1920
Television	1927
Radio-Craft	1929
Short-Wave Craft	1930
Television News	1931

Some larger libraries still have copies of Modern Electrics on file for interested readers.

In June, 1909, *Modern Electrics*

Antennae, by Dr. Greenleaf W. Pickard.
New Eiffel Tower Plant, by A. C. Marlowe.
First Aerophone Automobile.
Looped Aerial Connections, by E. L. McCaskey.
Recent Aerophone Work.
A Perikon Detector, by Lewis W. Klopfer.
Wireless Recorder, by Clarence W. Winchell.
Wireless "Tele-Mechanics," by the Paris Correspondent.
Amateur Defense of Interference, by John Crockford.

CORRECTION

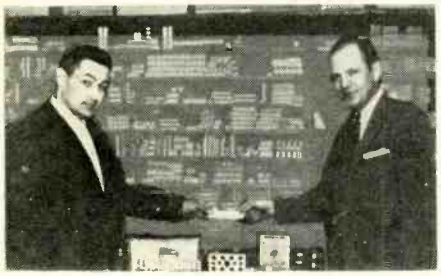
Mr. Phillip D. Blais, author of "Sensitive Wide-Band Ac Vtvm," (April, 1959), has informed us of an error in Fig. 3 on page 34. The attenuation formula should read:

$$\text{Attenuation} = \frac{R1 + R2}{R1} = \frac{C1 + C2}{C2}$$

"I keep getting a double image. Can either of you fix it?"

BUSINESS and PEOPLE

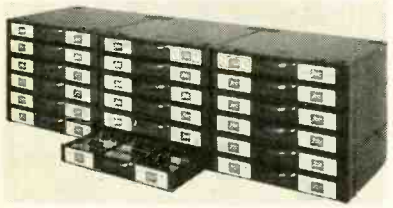
Service Instruments Corp., Addison, Ill., produced a sound film for distributor salesmen, coaching them on the best way to sell Sencore products. The company reports that its recent distributor sales contest was the most successful



ever held. In the photo, Jack Lehner, Sencore rep in Ohio, is presenting prize money to Carl E. Weed, outside salesman for Burroughs Radio, Inc., Mansfield, Ohio, who did a particularly outstanding job.

Daniel P. Knowland, Jr., was elected vice president of Heath Co., Benton Harbor, Mich. He has been associated with Daystrom, Inc., parent company of Heath, since 1954. In 1955 he became controller of Heath Co., and in 1958 he was promoted to assistant general manager.

Jensen Industries, Forest Park, Ill., applied the "tinker toy" construction idea to a series of stock cabinets for



phono cartridges. The metal cabinets interlock to form modular units of any size desired.

George H. Gage (left) joined CBS-Hytron, Danvers, Mass., as manager of product planning. He comes from General Electric, where he was commercial engineer, internal sales. **O. Lee Ballengee** (right) was promoted to equip-

ment sales manager, receiving tubes, from Midwest regional manager, equipment sales. **E. K. Wimpy**, director of general engineering, receiving tube operations, was upped to the position of manager of marketing research. He is succeeded by **Joe C. Harmony**, former general manager, receiving tube operations. **Ross Yeiter** is the new manager of marketing administration for semiconductor operations. He had been an administrative engineer.

Program to increase the stature of the TV service industry was launched by the EIA Service Committee at its Spring Conference. Member companies will supply service technicians with aids on customer relations, merchandising, management, expense control, etc.

EIA PRODUCTION AND SALES—
First two months

	1959	1958
TV set production	896,518	804,396
Radio production	2,250,122	1,739,177
TV retail sales	949,877	1,030,213
Radio sales	1,175,378*	839,942*
Receiving-tube factory sales	64,305,000	56,466,000
Picture-tube factory sales	1,523,242	1,178,056

*Excluding auto radios

Frank B. Powers, joined Aerovox Corp., New Bedford, Mass., as executive vice president and a director of the company. He takes over the responsibilities of **Bert Conway**, who is now chairman of the executive committee and continues as a director. Powers comes from P. R. Mallory & Co., where he was vice president of manufacturing.

Arthur L. B. Richardson (left) was elected a vice president of Sylvania Electric Products, Inc. He continues his duties as general counsel and secretary of the company. **David B. Tolins, Jr.**

(right) assumes the new post of advertising and sales promotion manager for the Semiconductor Div. in Woburn, Mass. He had been advertising supervisor of the Electronic Tube Division. **James W. Ritter**, former manager of sales management development of the Electronic Tube Div., becomes northeast district distributor sales manager at Ipswich, Mass. **Allen B. Pitts** was placed in charge of the bonded-shield picture-tube manufacturing program at Seneca Falls, N.Y., where he had been manufacturing superintendent.

National Technical Schools, Los Angeles, has enrolled 58 students from 19

foreign countries to take technical courses in the electronics, electrical and automotive fields. Some of the students are enrolled under the sponsorship of the State Department's International Cooperation Administration, while others are studying at the expense of their respective governments. National instructor Robert Dickerson, center, is shown explaining a printed-circuit TV chassis to a typical group of foreign students.

Robert E. Svoboda, general manager of the Amphenol Distributor Division of Amphenol - Borg, was elected president of the Association of Electronic Parts & Equipment Manufacturers, Inc., succeeding **Helen Staniland Quam**, of Quam-Nichols Co. **Irving Rossman**, Pentron, Inc., was elected first vice president; and **Warren Stuart**, Belden Mfg. Co., second vice president. **Kenneth Hathaway**, Ward Leonard, and **Kenneth C. Prince** were re-elected treasurer and executive secretary, respectively. New members of the board include **Jay Greengard**, Waldom Electronics; **Helen Staniland Quam**, and **Roy Laird**, Ohmite, Inc.

Daniel R. Ozsvath was appointed manager, merchandising, market planning – receiving tubes, RCA Electron Tube Div., Harrison, N.J. He had been manager, marketing administration, Entertainment Tube Products Dept.

James M. Price (left) joined Electro-Voice, Inc., Buchanan, Mich., as general manager of the Radio Manufacturing Engineers Div., from Texas Electronic Supply, where he was president. **Henry**

Mandler (right) joined the sales staff, specializing in high-fidelity products. He was previously general manager of Custom Audio. **A. F. Vandergriff**, sales engineer of A. O. Smith Co., joined Electro-Voice as Chicago sales engineer for the Industrial Sales Div. END

LITERATURE

Any or all of these catalogs, bulletins, or periodicals are available to you on request direct to the manufacturers, whose addresses are listed at the end of each item. Use your letterhead—do not use postcards. To facilitate identification, mention the issue and page of RADIO-ELECTRONICS on which the item appears. UNLESS OTHERWISE STATED, ALL ITEMS ARE GRATIS. ALL LITERATURE OFFERS ARE VOID AFTER SIX MONTHS.

QUESTIONS AND ANSWERS *on Stereo* for the layman are contained in a brochure answering frequently-encountered problems. Three simple diagrams showing how the company's components may be combined, complete this booklet.—**Pilot Radio Corp.**, 37-06 36th St., Long Island City 1, N. Y.

TRANSFORMERS AND REACTORS are listed along with an informative section on toroidal inductors in *Catalog 591*. The company's entire line of over 1,000 units is detailed.—**Freed Transformer Co.**, 1718 Weirfield St., Brooklyn 27, N. Y.

FIFTEEN MINUTES TO STEREO is a 24-page booklet. The function of each component is explained and its relationship shown in simple diagrams. Included are tips on what to look for in buying components.—**Available at General Electric dealers.**

RELAY CATALOG listing general-purpose relays in detail with dimensional drawings, contact arrangements, operating speeds, weights and other useful information. Covers the full range of basic relays from midget types through power relays.—**Guardian Electric Manufacturing Co.**, 1621 Walnut St., Chicago 12, Ill.

CAPACITOR CATALOG *AC-7* covers filters and capacitors for radio and TV replacement. Lists the full line made by this company.—**Astron Corp.**, 255 Grant Ave., E. Newark, N. J.

RECEIVER CATALOG *RC-1000* describes the company's entire line of amateur and shortwave receivers and accessories. This 8-page catalog includes complete specifications and prices.—**National Co.**, 61 Sherman St., Malden 48, Mass.

TRANSISTOR SIMILARITY *chart* shows Raytheon germanium transistors which are similar or equivalent to types of other manufacturers. Because of numerous minor type differences, this 4-page chart does not indicate exact interchangability.—**Raytheon Mfg. Co.**, 55 Chapel St., Newton 58, Mass.

OPPORTUNITY ADLETS

Rates—50c per word (including name, address and initials). Minimum ad 10 words. Cash must accompany all ads except those placed by accredited agencies. Discount, 10% for 12 consecutive issues. Misleading or objectionable ads not accepted. Copy for August issue must reach us before June 15, 1959

RADIO-ELECTRONICS, 154 West 14 St., New York 11, N. Y.

HIGH-FIDELITY SPEAKERS REPAIRED. AMPRITE Speaker Service, 70 Vesey St., New York 7, N.Y. BA 7-2580.

CASH PAID! Sell your surplus electronic tubes. Want unused, clean transmitting, special purpose, receiving, TV types, magnetrons, klystrons, broadcast, etc. Also want military & commercial lab test and communications gear. We swap too, for tubes or choice equipment. Send specific details in first letter. For a fair deal write, wire or telephone: BARRY, 512 Broadway, New York 12, N.Y. WAlker 5-7000.

HI-FI, Recorders, Tapes. FREE Wholesale Catalogue. CARSTON, 215-T East 88th St., New York 28, N. Y.

STEREO TAPE RENTALS. For the very best at lowest prices. Write CALIFORNIA TAPED MUSIC ASSN., 763 El Camino Real, Redwood City, Calif.

DISCOUNTS UP TO 50% on Hi-Fi amplifiers, tuners, speakers, tape recorders, individual quotations only, no catalogs. CLASSIFIED HI-FI EXCHANGE, 2375 East 65th Street, Brooklyn 34, N.Y.

IF YOU HAVE a background in electronics, but are having trouble passing FCC phone exams, my 12 years experience as chief instructor of electronics can help you over the hump. Not a course. Write me personally for free information. WALLACE COOK, 1614E Morson Road, Jackson 9, Miss.

5 Inch T.V. test CRT. Complete w/adapter $3.95 postpaid. CRT tester and reactivator guaranteed satisfaction in 30 days or money back. $29.95. CRYSTAL ELECTRONICS, 9507 - 101 Ave., Ozone Park, N. Y. HI. 1-0700.

LABORATORY QUALITY equipment and Military Surplus Electronics bought, sold. ENGINEERING ASSOCIATES, 434 Patterson Road, Dayton 9, Ohio.

ALL MAKES OF ELECTRICAL INSTRUMENTS AND TESTING equipment repaired. HAZELTON INSTRUMENT Co., 128 Liberty Street, New York, N.Y.

JOBS in foreign countries. Men-Women. Free job reports. DAVENPORT FOREIGN COMPANY, 1354-AA, GPO, New York 1, N. Y.

USED Test Equipment for T.V. Send for list. EILERS' T.V., Gladbrook, Iowa.

200' length RG11 new cable PL259's $16. GIZMOS & SUCH, Still River, Mass.

RELAYS 22F, Phasotron, 8000 ohms, DPDT, used, unsealed $2.25. VICTOR GREENE, 64 Mt. Prospect Ave., Belleville, New Jersey.

CAMERA Repairmen greatly needed! You can learn manufacturers' service methods at home, in your spare time! Free, big illustrated book tells how! Write today. NATIONAL CAMERA REPAIR SCHOOL, Dept. RE-6, Englewood, Colorado.

PROFESSIONAL Electronic Projects—Organs, Timers, Intercoms, Counters, etc. $1 each. List Free. PARKS, Box 1665, Lake City Station, Seattle 55, Wash.

TAKE MAGAZINE SUBSCRIPTIONS. Good Profits. Special Offers. CASSELL AGENCY, Boynton Beach 25, Fla.

DIAGRAMS FOR REPAIRING RADIOS $1. Television $1. Give make, Model. DALE CO. 319 West 14th St., N. Y.

CIVIL SERVICE JOBS—mechanical, clerical, professional. List $1. CIVIL SERVICE BULLETIN, 115D Haypath Road, Plainview, N.Y.

DIAGRAMS FOR REPAIRING RADIOS $1. Television $2. Give make, Model. DIAGRAM SERVICE, Box 672-RE, Hartford 1, Conn.

FREE WRITERS CATALOGUE giving manuscript markets. Write LITERARY AGENT MEAD, 915 Broadway, New York 10, N. Y.

CALCULUS. Easy Practical Lessons, First Four $1. Space-Age Mathco, 4256-4 Mimmor Dr., Cincinnati 17, Ohio.

NEW 1959 AUTOMOBILES—to 25% off retail prices. Delivered anywhere. MEDER, 550-RE Fifth Avenue, New York 36, N. Y.

SONGPOEMS and LYRICS WANTED! Mail to: TIN PAN ALLEY, INC. 1650 Broadway, New York 19, N. Y.

UNUSUAL VALUES. Hi Fi components, tapes and tape recorders. Send for package quotations. STEREO CENTER, 18 West 37th St., New York 1, N.Y.

LEARN the technique of winning—at races, cards, most any game. Write, TURF FANS BOOK SHOP, Box 2073-1, Inglewood, Calif.

RADIO & TV TUBES at Manufacturers Prices! 100% Guaranteed! Brand New! No re-brands or pulls! UNITED RADIO, Box 1000, Newark, N.J.

8—Test equipment circuits from old radios, $1. WHITENER, Box 4384, Austin 51, Texas.

LITERATURE *(Continued)*

ELECTRONIC INSTRUMENTS for measuring audio, subsonic and ultrasonic signals are described in detail in *Catalog 12A*. General and special-purpose precision oscillators and voltmeters are shown in addition to a transmission measuring set.—**Waveforms, Inc.,** 333 6th Ave., New York 14, N. Y.

VARIABLE TRANSFORMERS are described thoroughly and pictured along with complete specifications in 8-page *Bulletin No. 151*. Models are for 120- and 240-volt input, both 50 and 60 cycles. Prices are shown.—**Ohmite Mfg. Co.,** 3601 Howard St., Skokie, Ill.

SYMPOSIUM OF OPINION regarding current state of electronic technology with special emphasis on the funnybone aspect of computers is an 18-page booklet aimed at engineers. This reprint collection of cartoons from various publications is available to those with special interest in this field.—**Audio Devices, Inc.,** 444 Madison Ave., New York 22, N. Y.

1959 FACTBOOK ON INDUSTRY has data on 1958 sales and production of TV sets, radio, auto radios, transistors, tubes along with many other interesting statistics. Included are figures on set production for several years back. —**Electronic Industries Assn.,** 1721 De-Sales St., N. W., Washington 6, D. C. **75c.**

INSTRUMENT RECTIFIERS are specified and special symbols shown along with a brief general discussion of copper oxide and selenium cells in *Conant Instrument Rectifiers*. A color code for the company's rectifiers is shown together with a sheet on prices.—**Conant Laboratories,** 6500 O St.. Lincoln 5, Neb.

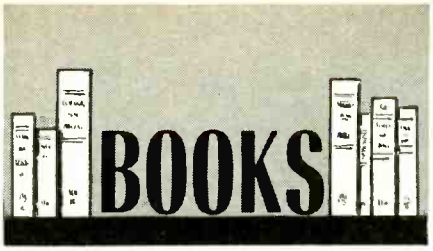
SILICON SEMICONDUCTORS are described and their characteristics listed for over 20 general-purpose types in *Sperry Silicon Diodes and Transistors*. Information on the advantages of silicon devices is included.—**Sperry Semiconductor Div., Sperry Rand Corp.,** South Norwalk, Conn.

PHOTOCELL CATALOG covering 25 selenium photovoltaic cells is *Bulletin PC-649A*. Cell structure, characteristics, operating conditions and typical applications for a line of self-generating photocells are covered in this 8-page booklet.—**International Rectifier Corp.,** El Segundo, Calif.

DC AMPLIFIER *Catalog B-C2HLA* describes a dc amplifier in 4 pages with photographs, block diagrams, outline drawings, specifications and 14 brief typical applications of the instrument. —**Minneapolis-Honeywell,** 40 Life St., Boston 35, Mass.

TRANSISTOR CATALOG *No. G-170* includes full information on bilateral transistors. Six specific transistors are detailed with curves on their collector characteristics. — **General Transistor Corp.,** 91-27 138th Place, Jamaica 35, N. Y.

END



DESIGNING AND BUILDING HI-FI FURNITURE. by Jeff Markell. Gernsback Library, Inc., 154 W. 14 St., N.Y. 11, N.Y. 5½ x 8½ in, 224 pp. $2.90.

This author tells how to make hi-fi systems pleasing to look at, not merely to listen to. Using his extensive professional experience, he explores the fundamentals of cabinet design and tells just how to determine the most appropriate style for one's own home. Included are sections on selecting the room, stereo speaker placement, principles of cabinet design, choice of materials, construction, finishing and retouching equipment cabinets and speaker enclosures. The book contains many helpful photographs.—*IQ*

MOST-OFTEN-NEEDED 1959 RADIO DIAGRAMS AND SERVICING INFORMATION. Compiled by M. N. Beitman. Supreme Publications, 1760 Balsam Road., Highland Park, Ill. 8½ x 10¾ in. 192 pp. $2.50.

A collection of selected schematics and essential servicing information for over 500 models and chassis of 26 brands and makes.—*RFS*

SYLVANIA SERVICE INFORMATION (Comprehensive Manual Vol. 3). Sylvania Home Electronics, Service Dept., Batavia, N.Y. 11 x 17 in. 49 pp. $2.

A compilation of this manufacturer's service information and production changes covering 1958 production of radio, TV and high-fidelity equipment.

CQ ANTHOLOGY, Edited by Wayne Green, W2NSD. Cowan Publishing Corp., 300 W. 43 St., New York 36, N.Y. 6 x 9 in. 160 pp. $2.

A compilation of reprints of some of the most popular articles on surplus conversion, antennas, transmitters, receivers and accessories and amateur test instruments and accessories in *CQ* magazine from 1945 through 1955. A handy addition to the amateur's reference shelf.—*RFS*

ELECTRONIC COMPONENTS HANDBOOK. VOL. 2. Edited by Keith Henney and Craig Walsh. McGraw-Hill Book Co., 330 W. 42 St., N. Y. 36, N. Y. 8½ x 11 in. 357 pp. $12.50.

Innumerable books have tried to show engineers how to design equipment. But there have been no books telling him what pieces he must use. This book, along with Vol. 1 which appeared in 1957 and Vol. 3, to appear later this year, does that exhaustively and well.

There are sections on power sources and converters, fuses and circuit breakers, electrical indicating instruments, printed-wiring boards, solder and fluxes, choppers, blowers, rf transmission lines and waveguides. Each section describes various available types of components and the uses of each. It lists the effect on each of unfavorable environmental

conditions, and has a digest of the applicable military specifications.

THE RADIO AMATEUR'S HANDBOOK (36th Edition—1959). American Radio Relay League, Inc., West Hartford, Conn. 6½ x 9½ in. 746 pp. including catalog section and index. $3.50 in U.S., $4 in U.S. Possessions and Canada. $4.50 elsewhere.

Old-timers need no introduction to *The Handbook* so we will add only that it has been completely revised and restyled in keeping with the many advances in the state of the art. It is the standard radio construction manual, reference book, tube and transistor manual and text for home study. A must for every ham, experimenter and engineer.—*RFS*

RCA RECEIVING TUBE MANUAL, Tech. Series RC-19. Electron Tube Div., Radio Corp. of America, Harrison, N. J. 5¼ x 8¼ in. 385 pp. 75¢.

This is the latest edition of the familiar and indispensable tube handbook. The first 70 pages contain general information on tubes and their use in typical circuits, including frequency converters, power supplies, tone controls and video amplifiers.

The main section of the book lists all RCA receiving tubes with their characteristics and maximum ratings as well as typical operating conditions. The space devoted to tubes issued before 1950 is minimized to allow fuller treatment of more recent types. Much useful information on picture tubes is also included.

The final section has charts for designing resistance-coupled amplifiers, typical schematics and suggested reading lists. This handbook is an everyday working tool for everyone concerned with tubes, repair technician and equipment designer alike.—*IQ*

SWITCHING CIRCUITS AND LOGICAL DESIGN, by Samuel H. Caldwell. John Wiley & Sons, Inc., 440 Fourth Ave., N. Y. 16, N. Y. 6 x 9 in. 686 pp. $14.

When switching circuit design becomes as intricate as it has in modern computers and telephone systems, recourse to switching algebra is essential. This comprehensive text contains material helpful both to student and specialist.

It begins with the elementary concepts of switching algebra and goes on to series-parallel networks, minimization, codes, sequential circuits, etc. Many examples are worked out in the text. It is based on a two-semester course presented at MIT.—*IQ*

PRACTICAL DICTIONARY OF ELECTRICITY AND ELECTRONICS. by R. L. Oldfield. American Technical Society, 848 E. 58 St., Chicago 37, Ill. 5½ x 8½ in, 216 pp. $5.95.

Practicing technicians and engineers concerned with operation, maintenance or manufacture of a wide variety of equipment in these two overlapping fields will find this dictionary an excellent practical reference work. The terms most often used are briefly but accurately defined, and usually cross-referenced. In addition numerous new terms, phrases and abbreviations not yet common but beginning to appear, for example *carcinotron* and *megatron*, are covered. (Maser and varactor do not appear.)

Trade words with special meanings like *dish* (microwave reflector) are included. Over 5,000 headings are defined.

Much information is also to be found in the handbook section which has frequently employed tables, formulas and symbols. Those dealing with any but a narrow range of equipment will find this dictionary very valuable.—*CG*

THE RADIO HANDBOOK (15th Edition), Edited by William I. Orr, W6SAI. Editors and Engineers, Summerland, Calif. 6¾ x 9½ in. 799 pp. $7.50.

Although it retains the familiar format of the earlier edition published 3 years ago, this edition is a thorough revision. Three new chapters have been added and many others have been updated with new test instruments, transmitters and circuits. The book even includes a chapter on high-fidelity equipment.

As a text, reference manual and construction work-book for old-timer and neophyte alike, it deserves the most convenient spot on your electronics bookshelf.—*RFS*

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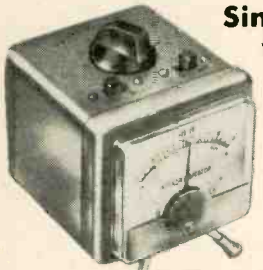

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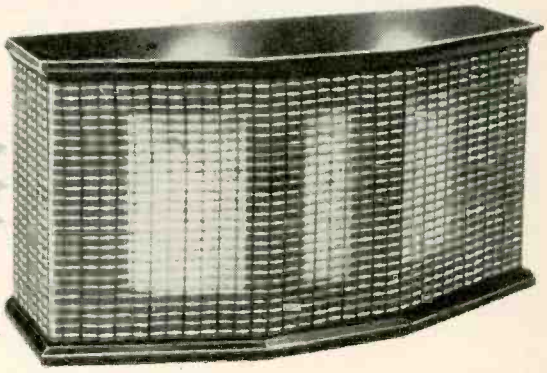

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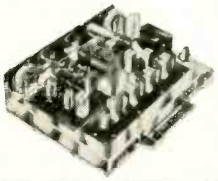

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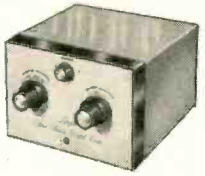

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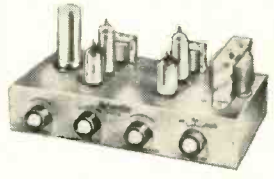

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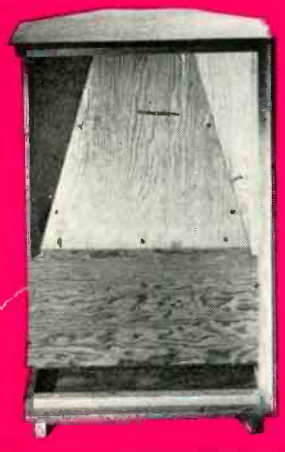

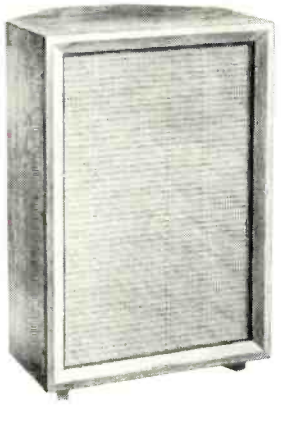

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Both tub[illegible] card. Ch[illegible] virtually

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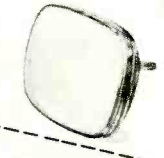

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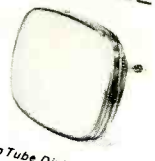

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