THE STRANGE WORLD OF COLOR VISION

JANUARY 1958

Radio-Electronics

HUGO GERNSBACK, Editor

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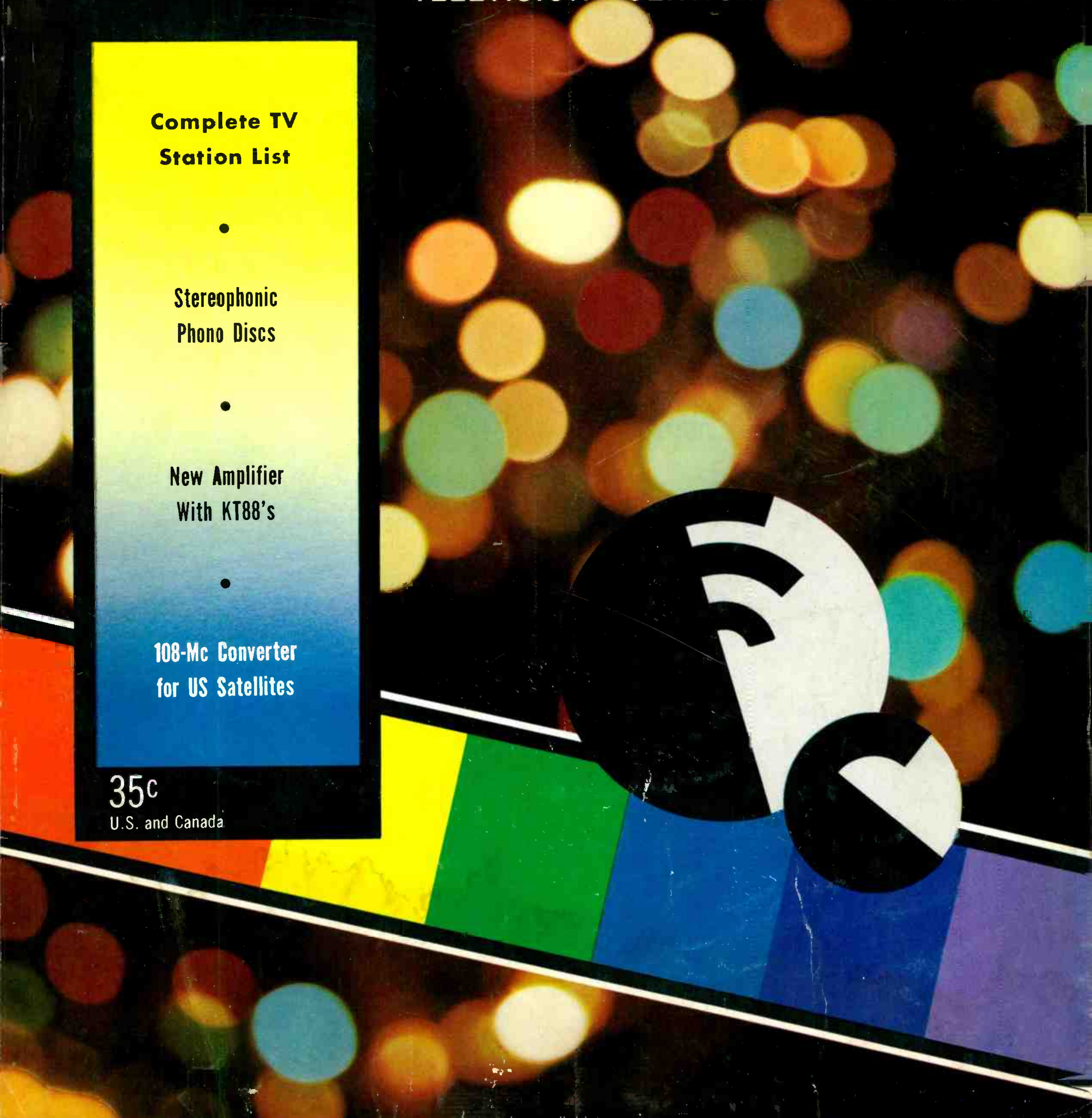

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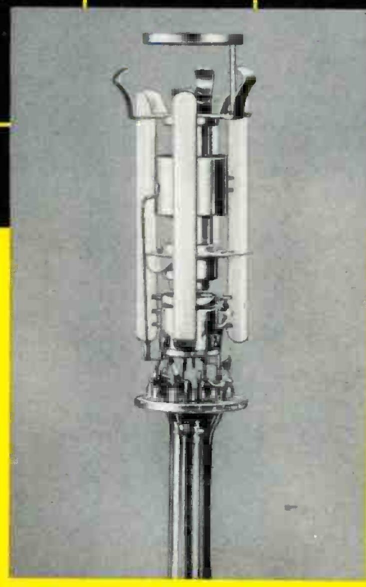

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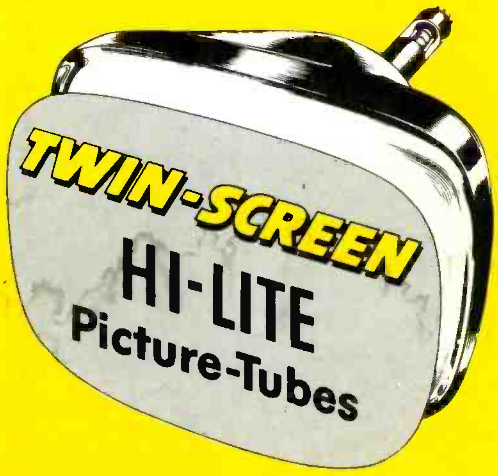

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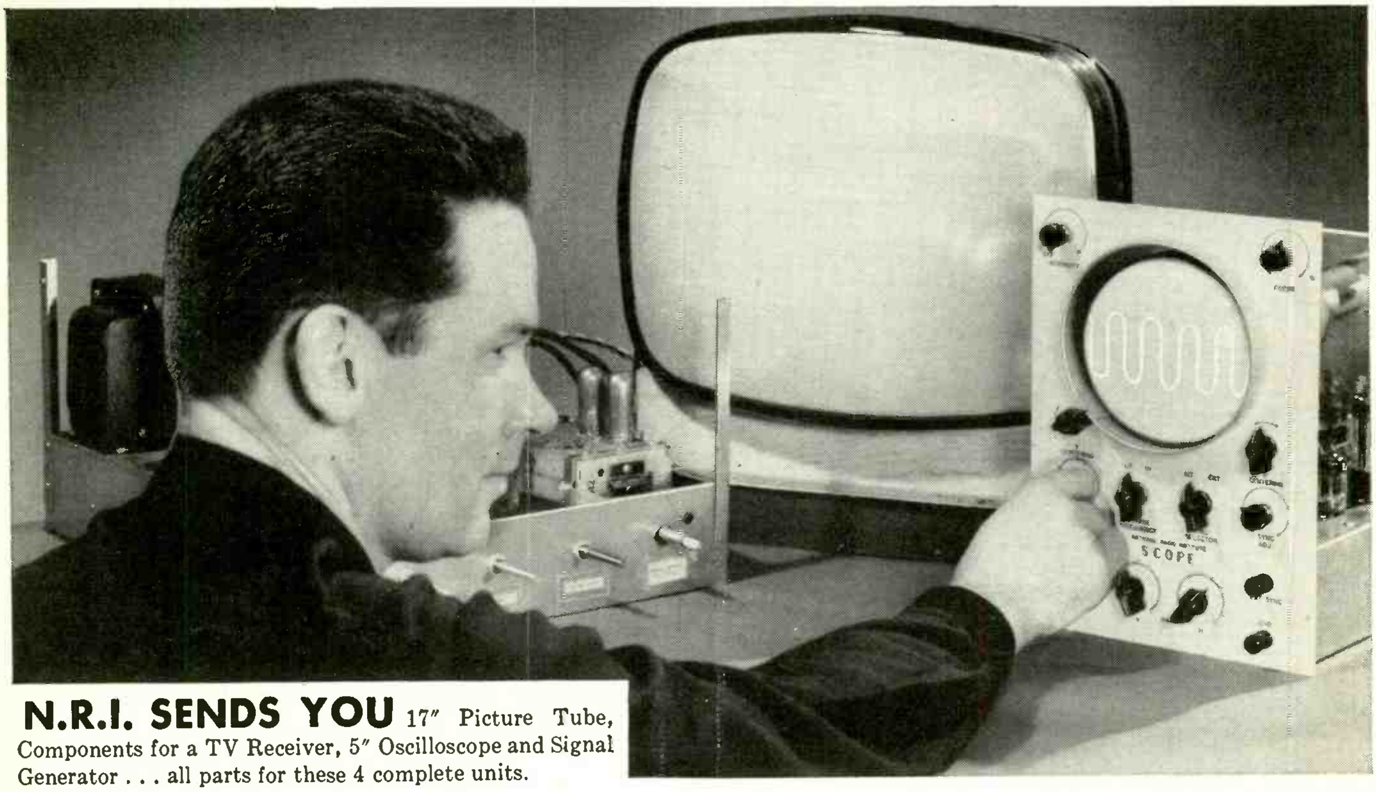

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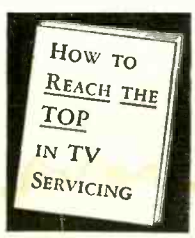

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ON THE COVER

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News Briefs

"SEEING AIDS" FOR THE BLIND may be possible as a result of experiments on direct stimulation of the brain with voltages from photocells. A New Jersey volunteer, Miss Betty Corstorphine of Newark, reported seeing flashes of light as she turned a photocell towards windows and other light sources. The photocell currents were conducted to the optic centers of the brain by fine wires, which were inserted through tiny holes drilled in the skull. Three-way cooperation made the test possible. Dr. John C. Button of East Orange, N. J., an osteopath devoted to nerve study, originated the idea. A team of physicians at Rochester (Minn.) State Hospital mapped the brain areas concerned and Dr. Tracy Putnam of Los Angeles performed the actual operation.

RADAR CONVICTION in Westchester County (N. Y.) of an alleged speeding offender was reversed by Judge Hugh S. Coyle after hearing an electrical consulting engineer, J. Kelly Johnson, testify that "even the rustling of leaves on a tree" or the "jangling of a radar patrolman's car keys" could cause inaccuracies in the radar equipment used to determine the speed of a passing vehicle.

In further testimony Mr. Johnson said that the transfer of a patrolman's revolver to another pocket, the metal on his gun belt, the patrol car's short-wave transmitter, a loose license plate on the car being timed or even vibration from the car itself could upset the radar receiver's accuracy.

In reversing an earlier decision, Judge Coyle said that evidence showed that the device in question "is accurate to the extent that it tells the existence of a moving target in proximity to the instrument but that its use for any additional purpose, such as measurement of speed of the vehicle, is subject to grave possibility or probability of error."

RADAR PATENTS are now coming out of hiding. Following close on the granting of the fundamental radar patent to Col. Wm. R. Blair (RADIO-ELECTRONICS, November, 1957) comes news that a patent has been granted to P. F. M. Gloess, a French scientist who developed the plan position indicator (PPI) radar while working in the Paris laboratories of the International Telegraph & Telephone Corp., now assignees of the patent.

The original patent application was filed in France in 1937 and in the United States a year later. PPI is the type of radar that, using a radial sweep, "paints" a rough map on the C-R tube screen, making it possible to see the distance and direction of individual objects directly. For that reason it is now the common type of radar used in surface and aerial navigation applications.

COLOR TV TAPE RECORDER was demonstrated by RCA recently at a closed-circuit demonstration. The new system uses tape 2-inches wide, which moves at 15 inches a second, on which the signal is impressed nearly crosswise by rapidly rotating heads. In this respect it is like the black-and-white system used by Ampex with which RCA has cross-licensing agreements. Ampex has not so far announced a tape recorder for color, although they have stated they will market a conversion kit for their black-and-white recorder. Both the RCA unit and Ampex adapter are expected to be available to broadcast stations sometime in 1958.

The head mechanism consists of four separate recording (or reproducing) elements. The disc carrying the heads rotates at 14,400 rpm, so that each head crosses the tape 240 times per second. During each traverse a single head records information corresponding to slightly more than 16 lines of a color TV picture. A 1-hour program can be recorded on a 12½-inch reel.

Calendar of Events

Fourth National Symposium on Reliability and Quality Control, Jan. 6–8, Statler Hotel, Washington, D. C.

High-Fidelity Music Show, Jan. 10–12, Dykmann Hotel, Minneapolis, Minn.

High-Fidelity Music Show, Jan. 17–19, Hotel Antlers, Indianapolis, Ind.

Second EIA Conference on Automation, Jan. 22–24, Arizona State College, Tempe, Ariz.

Hi-Fi Music Show, Jan. 24-26, Hotel Statler, Buffalo, N.Y.

High-Fidelity Music Show, Feb. 7–9, Hotel Cosmopolitan, Denver, Colo.

TSA Midwest Electronic Forum, Feb. 8–11, Hotel Statler, Detroit, Mich.

High-Fidelity Show, Feb. 14-16, Hotel Whitcomb, San Francisco, Calif.

Transistor and Solid State Circuits Conference, Feb. 20–21, University of Pennsylvania and Sheraton Hotel, Philadelphia, Pa.

Institute of High Fidelity Manufacturers Show, Feb. 26–Mar. 2, Hotel Biltmore, Los Angeles, Calif.

DR. ELMER ENGSTROM, color TV pioneer was granted the 1958 medal of the Industrial Research Institute. It will be presented to him at the institute's annual meeting in May.

The medal is awarded for "outstanding accomplishment in leadership in or

(*Continued on page* 10)

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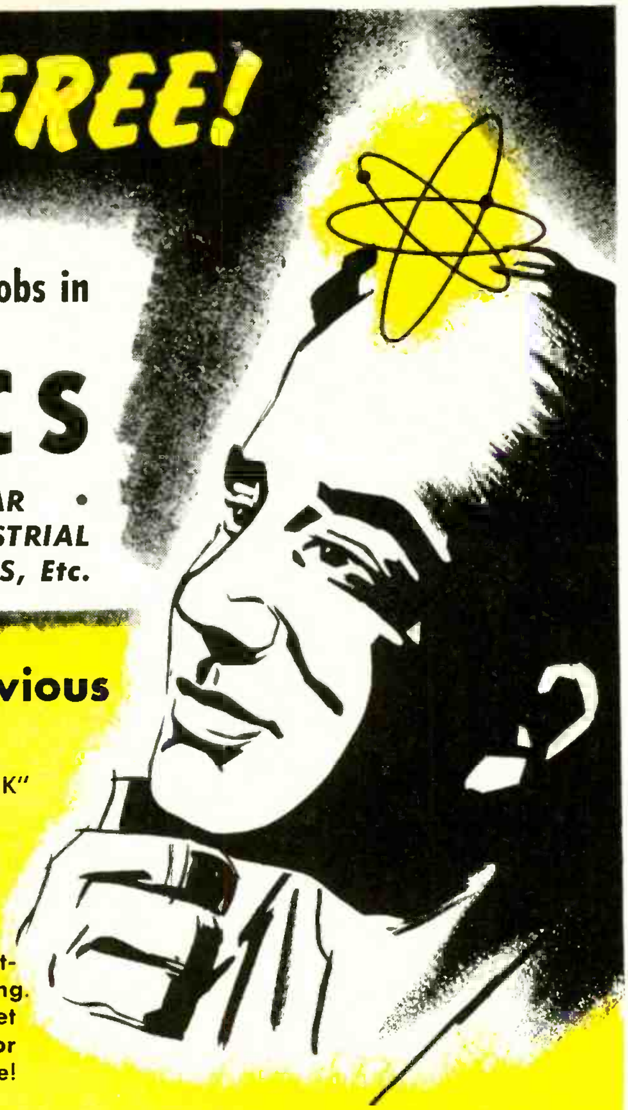

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Dr. Engstrom is senior executive vice president of the Radio Corporation of America, which he joined in 1930. He has been active throughtout his period of service in the development and improvement of color television transmission and reception techniques.

JUMP IN FM receiver sales and an upswing in the number of FM stations on the air has focused the attention of FM broadcasters on protecting the 88–108-mc band. (See also p. 98) High-fidelity manufacturers are also concerned about the possibility of a cutback on the FM band to allow for more TV stations and industrial facilities.

One FM receiver manufacturer, Granco Products Corp., states that it has increased its 1957 production of FM receivers by 30% over the previous year.

FACSIMILE SIGNALS BOUNCED off meteor trails cover a distance of almost 1,000 miles without relays.

Announced by RCA, preliminary tests between the National Bureau of Standards in Havana, Ill., and RCA Labs in Riverhead, L. I., New York, have been completed. These points are 910 miles apart.

For the experiments the material to be transmitted was recorded on 35-mm film and was scanned to produce a signal similar to that used in transmitting television films.

The signals were projected by a highly directional antenna into the earth's atmosphere where they hit ionized meteor trails and are reflected back to earth to be picked up by another directional antenna.

The system was developed for the Cambridge Research Center of the Air Research and Development Command. The three principal scientists on the job were Warren H. Bliss, R. J. Wagner, Jr., and G. B. Wickizer. All are employees of RCA.

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The new technique, which was developed by G. M. Houton and P. R. White of the Bell Telephone Laboratories, uses an already available alloy sold under the trade name of *Zamak 3* for making zinc castings. It contains aluminum, copper, and magnesium as well as zinc. The soldering technique is equally effective for joining galvanized surfaces without a flux.

TV LIBRARY at the University of Virginia now permits students to read books by remote control, without even entering the main buildings where the stacks are kept. Students may phone their requests from either of the two library branches and have the book of their choice placed in view of the TV camera. After having finished a page at the remote viewer, they can turn pages with a remote control device. A considerable saving in time and energy may result, since the books can be made available to students on the other side of the 510-acre campus without any delay.

HI-FI TRAPS WILDLIFE. Sportsman have discovered that recordings of geese and ducks while feeding makes an effective lure to draw game within range of the hunter. Recorded with high-fidelity equipment, the sounds are played back by portable tape recorders or record players and are amplified and beamed in the proper direction with directional speakers. One such device helped bring down 1,285 geese during the last hunting season.

The Interior Department's Fish & Wildlife service (FWS), worried over the effectiveness of this equipment, plans to ban these devices. Canada has already put such a ban into effect. When the United States ban goes into effect, it is expected to apply only to the use of recordings to attract game birds.

RADIO STREET-LAMP CONTROL was declared a success under New York City traffic conditions after a Fire Department test of the new equipment. Temporary radio-controlled portable signal lights were mounted at three intersections. The lights were controlled by FM transistor radio units in the cabs of two fire trucks. At the approach of a fire truck the flashing signal came on. The light continued to operate until the truck had passed. The system is adaptable to use by all emergency vehicles.

TV IN JAPAN has shown a tremendous growth in the 4½ years since the first station went on the air transmitting to 866 registered receivers. Today there are 68 stations on the air and 629,595 licensed receivers. This number is increasing by 40,000 a month. All programs are monochrome, but color is expected. Present price of a TV receiver is about $200 for a 14-inch screen, high for the average Japanese, but only half of its cost a year ago. END

Correspondence

THE RIGID-CONE SPEAKER

Dear Editor:

Mr. Klipsch pays me a handsome compliment in his October article, but is rather unkind in calling me an elder statesman (Bernard Baruch or Winston Churchill type?). Damn it all, I'm not that old and I still feel full of energy and ideas. I cannot reply at length to his article at this moment. I had promised you a new analysis of speaker performance and this is being prepared; but perhaps I may suggest, with a sly grin, that Mr. Klipsch hasn't completed his course in hermeneutics. He is still being fooled by those carefully checked figures. He hasn't appreciated that they do apply only to speakers with paper cones.

My data, referred to in my first letter, was taken with Bakelite cones; hence the disagreement. The letter from Mr. Harold Luth (September) was, in my opinion, of great importance; what he wrote was what I believed. I have just returned from seeing what he is doing and all he has found confirms what I found—the paper cone is a dead dog.

It requires no great technical knowledge to understand that for a given size a rigid piston will push more air than a flexible one. A paper cone is a flexible piston, and when driven hard by the voice coil it folds up to some extent and so its air-pushing efficiency is lowered—some of the applied energy is dissipated in bending the cone instead of pushing the air. My prewar Bakelite cones were more rigid than paper, but had certain undesirable properties and that led me to revert to paper, but treated in various ways to make it a better piston material. This approach was demonstrated by the Hartley 215 speaker.

That speaker is well liked by a lot of people but it never satisfied me. Some said it had insufficient bass because it was too small. I believed it had insufficient bass because the cone wasn't stiff enough. The 217 speaker has a cone in which the paper is converted into something quite different, much more rigid, and without any other change in the speaker the undistorted output at very low frequencies went up more than 100%.

Luth revealed to me the fundamental principles of the work he has been doing. He proved to my satisfaction that, if one wholly rejects conventional notions of cone design, it is possible to achieve the most striking results. If a cone, a piston, does not distort in

shape when driven by the voice coil, there will be no distortion in the sound created by the moving air. This was an endorsement of the sort of thinking that has been in my mind for a long time, yet I did not allow myself to be fooled. I had to be convinced before I would go along with him. I was convinced.

Even so, Mr. Klipsch is right in his first statement: "Much air must be moved to radiate appreciable power at low frequencies." What he has not appreciated is that we are not bound to accept a paper cone as the only device to move the air. We might as well criticize the performance of an automobile after running it on kerosene. Adopt a rigid cone and the size of the speaker is not important, so long as enough air is moved. The Hartley-Luth 220 speaker introduced at the New York High Fidelity Show is a demonstration of the thought processes of its designers. The public can judge if we are crazy or not.

H. A. HARTLEY

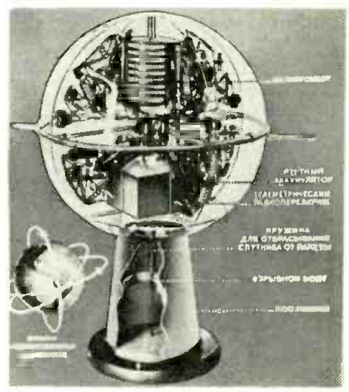
"On tour"
New York City

WHOSE SATELLITE MODEL?

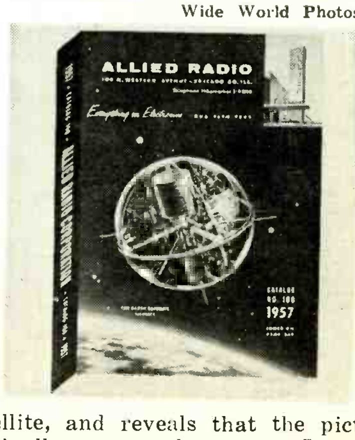
Dear Editor:

Attached is an article which appeared in the *Chicago Sun-Times* on Saturday Oct. 12, 1957.

This article states that the Soviet journal *Young Technique* showed a cutaway diagram of an alleged Russian



Wide World Photos



satellite, and reveals that the picture originally appeared in the January, 1956, issue of *Popular Science* and on the four-color cover of *Allied Radio's 1957 Catalog.* Many Chicago residents saw the plastic model in December,

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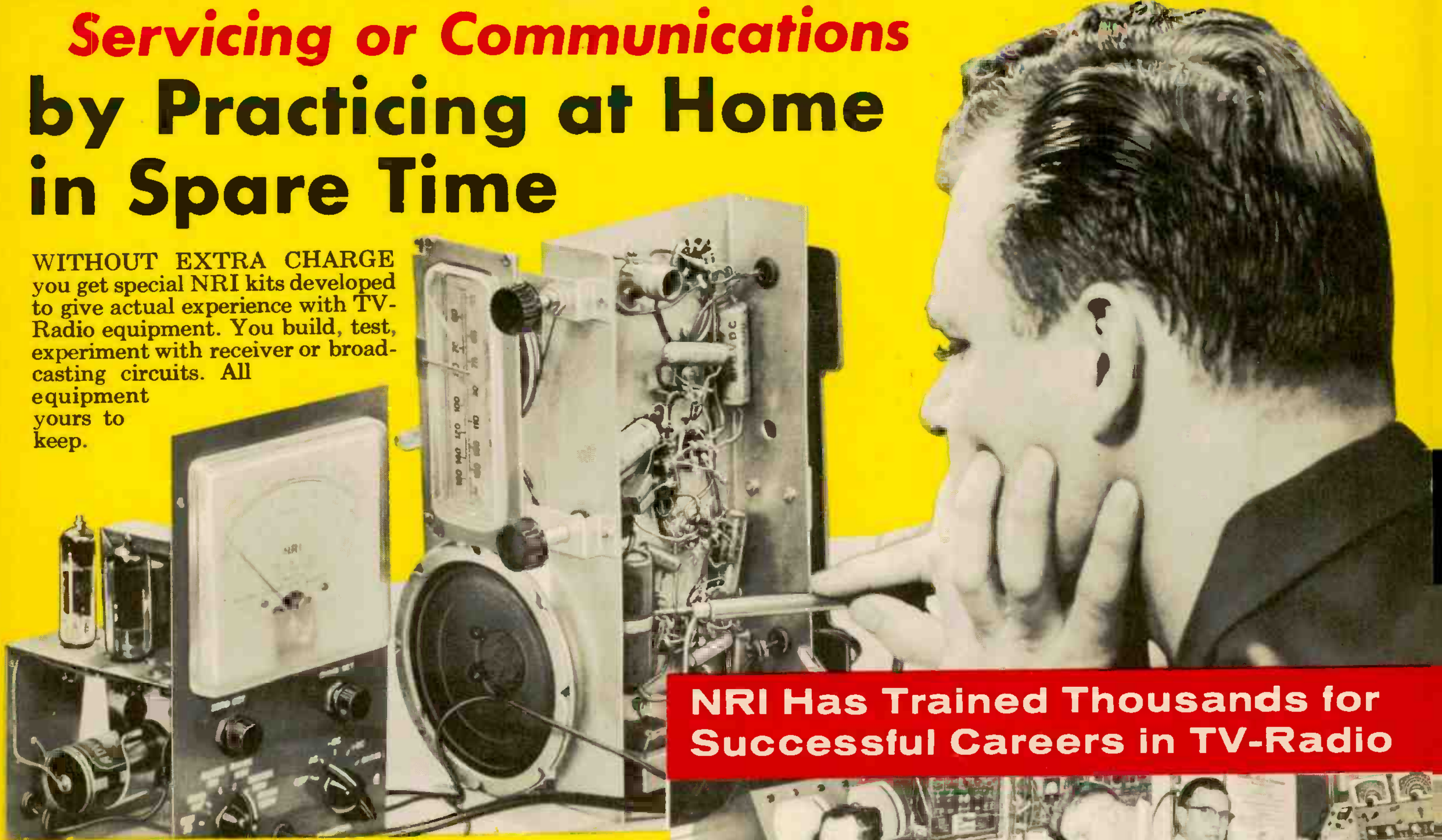

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"Since finishing NRI Course I have repaired more than 2,000 TV and Radio sets a year. NRI training certainly proved to be a good foundation." H. R. GORDON, Milledgeville, Ga.

Has Good Part Time Business
"Quite early in my training I started servicing sets. Now have completely equipped shop. My NRI training is the backbone of my progress." E. A. BREDA, Tacoma, Wash.

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People *look up to* and depend on the Technician, more than ever before. Offices, plants, homes everywhere are obliged to buy his knowledge and services. His opportunities are great and are increasing. Become a TV-Radio Technician. At home, and in your spare time, *you* can learn to do this interesting, satisfying work—qualify for important pay. To ambitious men everywhere *here* in the fast growing Television-Radio field is rich promise of fascinating jobs, satisfaction and prestige as well as increasing personal prosperity.

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A steady stream of new Electronic products is increasing the job and promotion opportunities for Television-Radio Technicians. Right now, a solid, proven field of opportunity for good pay is servicing the tens of millions of Television and Radio sets now in use. The hundreds of TV and Radio Stations on the air offer interesting jobs for Operators and Technicians.

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NRI students find it easy and profitable to start fixing sets for friends and neighbors a few months after enrolling. Picking up $10, $15 and more a week gives substantial extra spending money. Many who start in spare time soon build full time TV-Radio sales and service businesses.

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ACCREDITED MEMBER, NATIONAL HOME STUDY COUNCIL

1955, when it was on display at the Chicago Museum of Science and Industry.

The photographs show the Soviet version and the Allied Radio Catalog cover, which was photographed from the displayed model.

J. W. RUBIN

Allied Radio Corp.

(The original model which was displayed in Chicago, weighed 25 pounds. It was built at a cost of $150 by Herbert R. Pfister, associate editor of *Popular Science.*—Editor)

DOPPLER DISTORTION

Dear Editor:

The latest round shows the complete state of superstition existing in some minds. Mr. Luth ("More About Speakers", page 18, September, 1957) implies a different cone material will eliminate doppler distortion. It must be pointed out, repeated and emphasized that doppler distortion is a function of a moving sheet of air, not a fault of a speaker. Regardless of how the air is moved, with a plutonium diaphragm or just some more air, the fact that it is in motion produces the frequency modulation. Thus the solution lies in reducing the amplitude and velocity of motion by increase in area. Obviously — or is it obvious when everybody seems to want to belabor the point — if the distortion is due to air in motion, the diaphragm material cannot affect this form of distortion, be it either paper, glass, lead or Styrofoam.

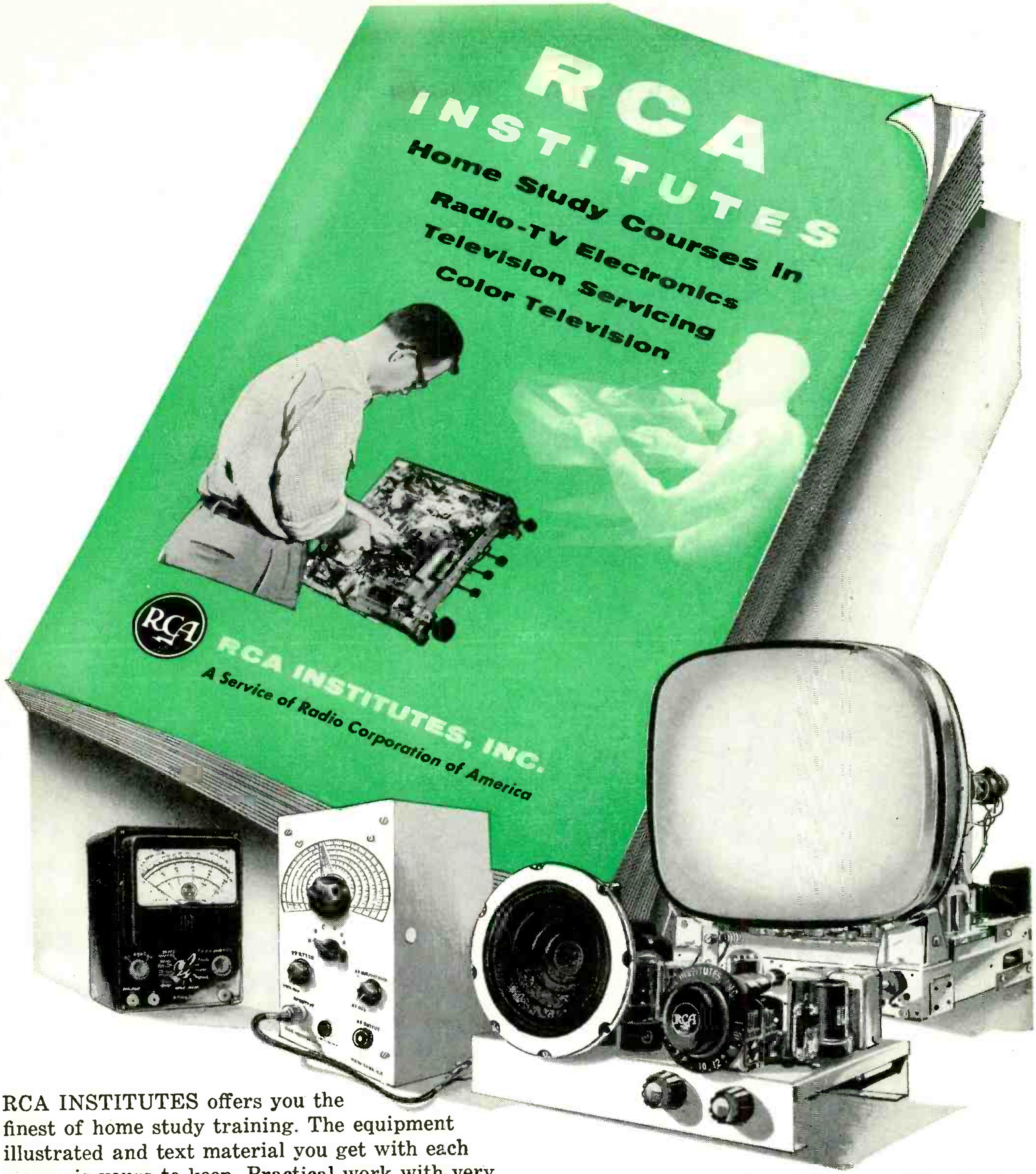
To reiterate, doppler frequency distortion is a function of the air in motion, regardless of how it is caused to move.

For the late readers, this is about the frequency modulation of one frequency by another. A sheet of air, as moved by a cone speaker, for example, or by any other means, carrying simultaneously some low frequency (like 50 cycles) and some higher frequency (like 500 cycles) will produce a frequency shift of a higher frequency in the form of a flutter at the lower frequency. A motion of .06 inch of the sheet of air at 50 cycles will produce about 1% peak-to-peak frequency shift or flutter, an amount which is plainly audible.

The obvious remedy is to increase the area so a given amount of energy can be radiated at a lower energy density per unit area. The pressure-velocity transforming function of a horn is useful in accomplishing this. In well designed horns the diaphragm needs to move through only a slight excursion; and the virtual diaphragm at the horn mouth (simply a sheet of air) can be several square feet in area and transmit up to an acoustic watt or more with negligible distortion, even at very low frequencies.

Hope, Ark. PAUL W. KLIPSCH

END



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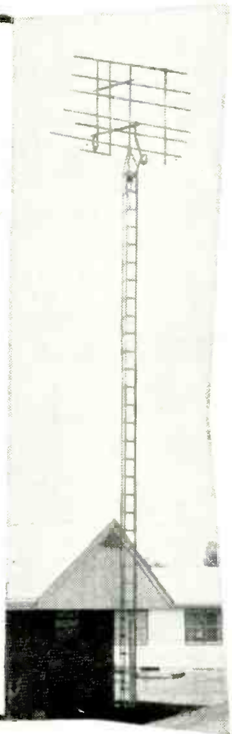
ROHN TOWERS
cover 3 fields
Bigger Profits for You!

Rohn Manufacturing Company is the largest *exclusive* manufacturer of home television towers! Thousands of distributors, dealers and servicemen have handled, sold and installed Rohn Towers for years! They've proved to themselves that *there's more money in Rohn Towers and accessories than any other line!* Rohn Towers now *dominate the field* and profits for those handling this line are better than ever. Why? Because Rohn offers profits in all 3 major tower fields:

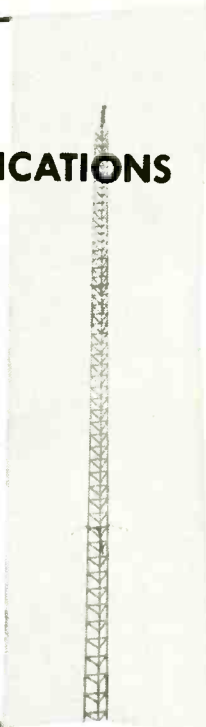
1 HOME TV

By far the biggest usage of Rohn products has been and still is for home TV installations. In addition to finest of self-supporting towers, the Rohn line includes telescoping masts, tubing, roof towers and all other types of accessories for installations of all kinds. Wise dealers and servicemen rely *entirely* on the Rohn line for *all* installation requirements. This means BIGGER PROFITS.



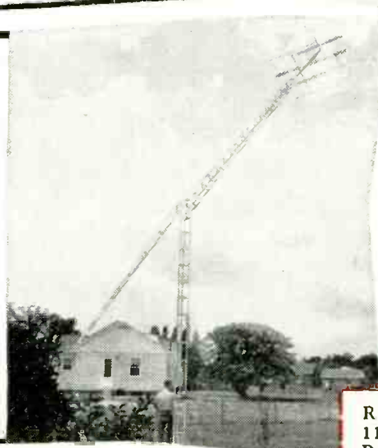
2 COMMUNICATIONS

Many distributors, dealers and servicemen are making EXTRA PROFITS by stocking or handling the heavier type Rohn Towers that are suitable for communications purposes. There is a demand in *every area* for radio communications towers, micro-wave towers, radio telephone towers and industrial towers. You can supply this need in your area. Special new literature is available for your use.



3 AMATEUR USE

Another major field of usage for Rohn Towers is in the field of amateurs and experimenters. The especially designed "fold-over" tower is the *best in the field* for the amateur because it allows working on the antenna *on the ground.* Thousands of amateurs use Rohn Towers with a tremendous demand still to be sold. You can supply this demand in your area and capture BIG PROFITS for yourself.



look at these ROHN exclusives

- **HOT DIPPED GALVANIZED**
  The finest, most durable finish is available for ROHN Towers and accessories . . . all done entirely on the ROHN premises under careful ROHN supervision.
- **UNEQUALLED DESIGN AND ENGINEERING**
  ROHN is the only design that has stood up over the years. ROHN has been first and foremost . . . and always the *leader* in new products to meet the changing demands.
- **MASS PRODUCTION FOR LOW COSTS**
  ROHN was the first to utilize mass production techniques to build a superior tower at the most competitive prices. This means no sacrifice in quality yet far greater profits for you.
- **UNIVERSAL CUSTOMER ACCEPTANCE**
  Thousands and thousands of installations prove the ROHN line first in customer satisfaction.
- **PIONEER MANUFACTURERS**
  Pioneers in tower manufacturing—and today one of the world's largest manufacturers of this type equipment. The ROHN Company was built on satisfaction on the part of distributor, dealer and customer alike.
- **COMPLETE LINE**
  Only ROHN offers a full line—*one* dependable one-stop source for all TV installation equipment. Save headaches, save shipping costs, save time . . . use ROHN unequalled service *exclusively.*

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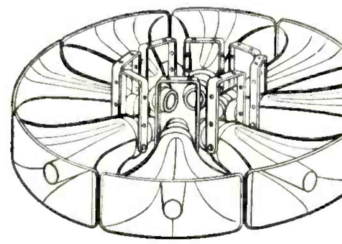
MODEL

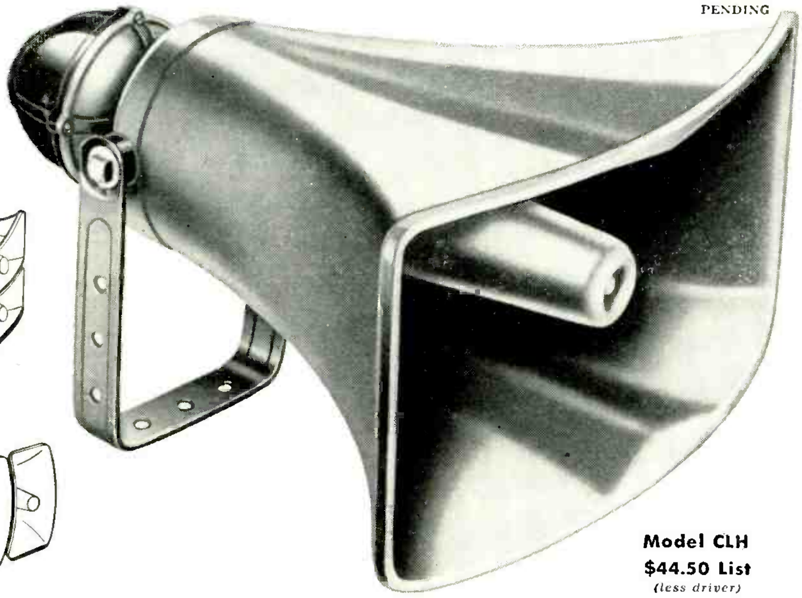
CLH

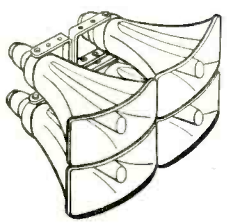
WIDE-ANGLE PROJECTOR

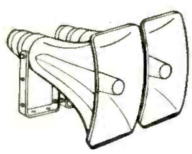
Meets FCDA specifications for Civil Defense applications



PATENTS PENDING

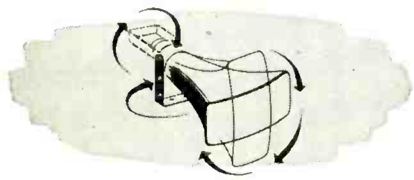






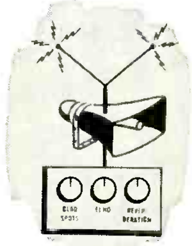
Model CLH
$44.50 List
(less driver)

EXCLUSIVE OMNI-DIRECTIONAL MOUNTING



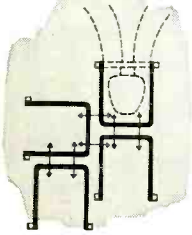
Horn *bell* rotates full 360° on its axis, while the 'U' mtg. bracket provides better than 180° vertical and 360° horizontal adjustment of *projector* positioning. Thus, sound can be distributed in *any* direction regardless of projector location.

"TUNE OUT" ECHO & REVERBERATION



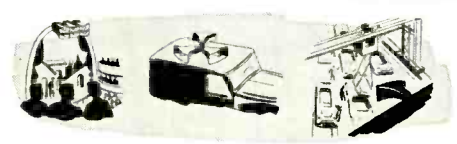
The unique *pin-point adjustment* possible with the CLH at last provides the long-awaited answer to coverage of "dead spots" and control over troublesome echo and reverberation—regardless of structural or physical placement limitations!

USE SINGLY OR STACKED



The 'U' mounting bracket of the Model CLH is specially designed to link two or more projectors into *any* configuration, achieving *exactly* the sound distribution pattern required. Even diagonal or alternating projections are just as easy to achieve as "standard" patterns.

VERSATILITY & ADAPTABILITY UNLIMITED



Meets every soundcasting requirement. Use the CLH wide-angle projector with *any* University driver to get exactly the frequency response, efficiency and power handling capacity you need. Here is dependable performance and *real* economy—for actual dollar savings you can count on year after year.

SPECIFICATIONS: Air Column, 4½ ft.; Horn Cut-off, 120 cps; Dispersion, 120° x 60°; Bell Mouth, 21½" x 11½"; Depth (less driver), 20"; $44.50 List.

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THE MOST COMPLETE SELECTION OF DRIVERS IN THE INDUSTRY NOW AVAILABLE FOR USE WITH THE CLH

Model PA-50. Features extended high and low frequency range, highest continuous duty power capacity, greatest conversion efficiency, husky *built-in* multi-match transformer with terminals conveniently located at base of unit. The answer to the toughest sound problem. Nothing finer!

Response: 70 to 10,000 cps. Power Capacity: Full Range 50 watts; Adjusted Range 100 watts; List Price: $57.50.*

Model PA-HF. For applications requiring the greatest power handling capacity, maximum sensitivity, widest range frequency response, *plus* rugged lifetime construction. *Completely die-cast* aluminum housing. Increased sound output cuts amplifier requirements in half!

Response: 70 to 10,000 cps. Power Capacity: Full Range 50 watts; Adjusted Range 100 watts; List Price: $47.50.*

Model SA-30. "Battleship" construction for maximum durability against abuse or in hazardous environments. *Completely die-cast* aluminum housing and *built-in* matching transformer for connection to high impedance lines or "constant voltage" systems.

Response: 80 to 10,000 cps; Power Capacity: Full Range 30 watts; Adjusted Range 60 watts; List Price: $47.50.*

Model SA-HF. Will deliver that extra punch needed to cut through heavy noise. Use for speech or high quality music.

Response: 80 to 10,000 cps.; Power Capacity: Full Range 30 watts; Adjusted Range 60 watts; List Price: $36.00.*

Model MA-25. Low in cost, high in quality, featuring high efficiency magnet, tropicalized 2" voice coil, "rim-centered" breakdown-proof bakelite diaphragm.

Response: 85 to 6500 cps.; Power Capacity: Full Range 25 watts; Adjusted Range 50 watts; List Price: $27.50.*

**Program response adjusted to horn cut-off.*

ACCESSORIES

2YC Connector enables two driver units to be used with one CLH trumpet for up to 200 watts output. Now you can get the Super-Power you want...when you want it, using standard stock drivers.

PMA Adapter fits standard ½" dia. threaded pipe to the CLH 'U' mounting bracket. Takes the headache out of mounting on pipe!

NEW! 12-WATT Williamson-type HIGH FIDELITY INTEGRATED AMPLIFIER HF12 with Preamplifier, Equalizer & Control Section

KIT 34^{95} WIRED 57^{95}

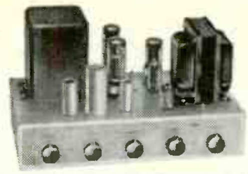
Compact, beautifully packaged & styled. Provides complete "front-end" facilities and true high fidelity performance. Direct tape head & magnetic phono inputs with NARTB (tape) & RIAA (phono) feedback equalizations. 6-tube circuit, dual triode for variable turnover bass & treble feedback-type tone controls. **Output Power:** 12 w cont., 25 w pk. **IM Dist.** (60 & 6000 cps @ 4:1): 1.5% @ 12 w; 0.55% @ 6 w; 0.3% @ 4 w. **Freq. Resp.:** 1 w: ±0.5 db 12 cps – 50 kc; 12 w: ±0.5 db 25 cps – 20 kc. **Harmonic Dist: 20 cps:** 2% @ 4.2 w; ½% @ 2.5 w; **30 cps:** 2% @ 11 w; ½% @ 6.3 w; **40 cps:** 1% @ 12 w; ½% @ 9.3 w; **2000 cps:** ½% @ 12 w; **10 kc:** 1% @ 10 w; ½% @ 6 w. **Transient Resp:** excellent square wave reproduction (4 usec rise-time); negligible ringing, rapid settling on 10 kc square wave. **Inverse Feedback:** 20 db. **Stability Margin:** 12 db. **Damping Factor:** above 8, 20 cps – 15 kc. **Speaker Connections:** 4, 8, 16 ohms. **Tone Control Range:** @ 10 kc, ±13 db; @ 50 cps, ±16 db. **Tubes:** 2-ECC83/12AX7, 1-ECC82/12AU7, 2-EL84, 1-EZ81. Size: HWD: 3⅝" x 12" x 8¼". 13 lbs. Mounts in or out of cabinet.

NEW! 50-WATT Ultra-Linear HIGH FIDELITY POWER AMPLIFIER

HF50 KIT 57^{95} WIRED 87^{95}

Like the HF60 shown below, the HF50 features **virtually absolute stability, flawless transient response** under either resistive or reactive (speaker) load, & **no bounce or flutter** under pulsed conditions. **Extremely high quality output transformer** with extensively interleaved windings, 4, 8, & 16 ohm speaker connections, grain-oriented steel, & fully potted in seamless steel case. Otherwise identical to HF60. **Output Power:** 50 w cont., 100 w pk. **IM Distortion** (60 & 6000 cps @ 4:1): below 1% at 50 w; 0.5% @ 45 w. **Harmonic Dist.:** below 0.5% between 20 cps & 20 kc within 1 db of rated power. **Freq. Resp.** at 1 w: ±0.5 db 6 cps —60 kc; ±0.1 db 15 cps —30 kc at any level from 1 mw to rated power; no peaking or raggedness outside audio range. **All other specs identical to HF60 below.** Matching cover **Model E-2, $4.50.**

NEW! 50-WATT Ultra-Linear HIGH-FIDELITY INTEGRATED POWER AMPLIFIER HF52 with Preamplifier, Equalizer & Control Section



KIT 69^{95} WIRED 109^{95}

Combines a power amplifier section **essentially identical to the HF50 power amplifier with a preamp-equalizer control section similar to HF20 below.** Provision for use with electronic crossover network & additional amplifier(s). See HF50 for response & distortion specs; HF60 for square wave response, rise-time, inverse feedback, stability margin, damping factor, speaker connections; HF20 for preamplifier, equalizer & control section description. Hum & noise 60 db below rated output on magnetic phono input (8 mv input for rated output), & 75 db below rated output on high level inputs (0.6 v input for rated output). Matching cover **Model E-1, $4.50.**

The specs are the proof....

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NEW HIGH FIDELITY PREAMPLIFIER

#HF61A KIT 24^{95}, WIRED 37^{95}

With Power Supply: #HF61 KIT 29^{95}, WIRED 44^{95}

Will not add distortion or detract from the wide-band or transient response of the finest power amplifiers at any control settings. High quality feedback circuitry throughout plus the most complete control & switching facilities. Heavy-gauge solid brushed brass panel, concentric controls, one-piece brown enamel steel cabinet for lasting attractive appearance. **Feedback-type, sharp cut-off (12 db/octave) scratch & rumble filters. Low-distortion feedback equalization:** 5 most common recording curves for LPs & 78s including RIAA. **Low-distortion feedback tone controls:** provide large boost or cut in bass or treble with mid-freqs & volume unaffected. **Centralab printed-circuit Senior "Compentrol" loudness control with concentric level control. 4 hi-level switched inputs** (tuner, tv, tape, aux.) **& 3 low-level inputs** (separate **front panel low-level input selector permits** concurrent use of changer & turntable). **Proper pick-up loading & atenuation** provided for all quality cartridges. **Hum bal. control.** DC superimposed on filament supply. 4 convenience outlets. **Extremely flat wideband freq. resp.:** ±1 db 8-100,000 cps; ±0.3 db 12-50,000 cps. **Extremely sensitive. Negligible** hum, noise, harmonic or IM distortion. Size: 4-7/8" x 12-5/16" x 4-7/8". 8 lbs.

NEW 60-WATT Ultra-Linear HIGH FIDELITY POWER AMPLIFIER #HF60 with ACRO TO-330 OUTPUT TRANSFORMER

KIT 72^{95} WIRED 99^{95}

Superlative performance, obtained through finest components & circuitry. EF86 low-noise voltage amplifier direct-coupled to 6SN7GTB cathode coupled phase inverter driving a pair of Ultra-Linear connected push-pull EL34 output tubes operated with fixed bias. **Rated power output:** 60 w (130 w peak). **IM Distortion** (60 & 6000 cps at 4:1): less than 1% at 60 w; less than 0.5% at 50 w. **Harmonic Distortion:** less than 0.5% at any freq. between 20 cps & 20 kc within 1 db of 60 w. **Sinusoidal Freq. Resp.:** at 1 w: ±0.5 db 6 cps — 60 kc; ±0.1 db 15 cps — 35 kc at any level from 1 mw to rated power; no peaking or raggedness outside audio range. **Square Wave Resp.:** excellent from 20 cps to 25 kc, 3 usec rise-time. **Sensitivity:** 0.55 v for 60 w. **Damping Factor:** 17. **Inverse Feedback:** 21 db. **Stability Margin:** 16 db. **Hum:** 90 db below rated output. **ACRO TO-330 Output Transformer** (fully potted). **Speaker Taps:** 4, 8, 16 ohms. **GZ34 extra-rugged rectifier** (indirectly-heated cathode eliminates high starting voltage on electrolytics & delays B+ until amplifier tubes warm up). **Input level control.** Panel mount fuse holder. Both **bias** and **DC balance** adjustments. Std octal socket provided for pre-amplifier power take-off. Size: 7" x 14" x 8". 30 lbs. Matching cover **Model E-2 $4.50.**

NEW COMPLETE with Preamplifier, Equalizer & Control Section 20-WATT Ultra-Linear Williamson-Type HIGH FIDELITY AMPLIFIER #HF-20

KIT 49^{95} WIRED 79^{95}

A low-cost, complete-facility amplifier of the highest quality that sets a new standard of performance at the price, kit or wired. **Rated Power Output:** 20 w (34 w peak). **IM Distortion (60 & 6000 cps/4:1) at rated power:** 1.3%. **Max. Harmonic Distortion between 20 & 20,000 cps at 1 db under rated power:** approx. 1%. **Mid-band Harmonic Distortion at rated power:** 0.3%. **Power Response (20 w):** ±0.5 db 20-20,000 cps; ±1.5 db 10-40,000 cps. **Freq. Resp.** (¼ w): ±0.5 db 13-35,000 cps; ±1.5 db 7-50,000 cps. **5 feedback equalizations** for LPs & 78s. **Low-distortion feedback tone controls:** large boosts or cuts in bass or treble with mid-freqs. & volume unaffected. Loudness control & separate level set control on front panel. Low Z output to tape recorder. **4 hi-level switched inputs:** tuner, tv, tape, aux; **2 low-level inputs** for proper loading with all cartridges. **Hum bal. control.** DC superimposed on filament supply. **Extremely fine** output transformer: interleaved windings, tight coupling, careful balancing, grain-oriented steel. 8½" x 15" x 10". 24 lbs. Matching cover **Model E-1, $4.50**

NEW COMPLETE with FACTORY-BUILT CABINET — 2-WAY HI-FI SPEAKER SYSTEM #HFS1 39^{95}

Genuine 2-way book-shelf size speaker system. **Jensen** heavy duty 8" woofer (6.8 oz. magnet) & matching **Jensen** compression-driver exponential horn tweeter with level control. Smooth clean bass & crisp extended highs free of coloration or artificial brilliance. **Factory-built** tuned bass reflex birch hardwood cabinet (**not a kit**) constructed to high quality standards. Neutral acoustical grille cloth framed by a smooth-sanded solid birch molding. **Freq. Resp.** measured 2 ft. away on principal axis in anechoic chamber with 1 watt input — **Woofer:** ±4 db 80-1800 cps; **Tweeter:** ±2 db 2800-10,000 cps; **Crossover Region:** 1800-2800 cps, shift in level over this region depends on tweeter level control setting. Power-handling capacity: 25 watts. Size: 23"x11"x9". 25 lbs. **Wiring Time:** 15 min.

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Radio-Electronics
Hugo Gernsback, Editor

ELECTRONICS IN SPACE

... The Space Age Will Bring Many Electronic Changes ...

The Space Age, ushered in on Oct. 4, 1957, by the first man-made satellite, served a sharp and poignant notice on all technologists that henceforth their thinking must embrace a new viewpoint—outer space.

Since the dawn of humanity, man has been confined to the very bottom of a vast protective ocean—the atmosphere. Now he is venturing forth into airless space and into a vacuum far more perfect than any vacuum tube he has ever produced on earth. At the same time, he will be exposed to the fierce interstellar cold, not far from absolute zero (when screened from the sun), and, as if this were not sufficient, to an array of dangerous radiations ranging from cosmic to X-rays. Man's leap into space is certain to be far more exciting and have far greater consequences than Columbus' discovery of the New World.

A whole new and vastly complex space technology is now in the making. It affects every technician, whether he is a chemist, a metallurgist, a mechanical, electrical or electronics technician. All must revise their thinking if they do not wish to be left hopelessly behind.

Take such a comparatively simple space object as the Russian sputniks. Consider the electronic gear, the transmitter and receiver. Then reflect that while they are in the sun for 45 minutes, they become fiercely hot from solar radiation. Then for 45 minutes they travel in the earth's shadow, when if they remained there they would cool to below −200° Fahrenheit! Fortunately, the satellite traveling at 18,000 miles an hour will acquire a mean temperature after a few revolutions around the earth. To further this, the Russians pumped an inert gas into their sputnik to keep the inside temperature from fluctuating too violently. Nevertheless, the transmitter's and receiver's components often undergo greater temperature stresses than on earth and must be engineered accordingly.

Much of this changes once we leave the warming rays of the sun. Suppose that—as will soon happen—a technical crew is working on the dark side of the moon. Here the night lasts for about 14 (earth) days. The temperature goes down to around −400° F. soon after sundown. What will then happen to an exposed radio transmitter and receiver? You wouldn't, for instance, install electrolytic capacitors; they would cease operating long before the −400° freeze. One must also consider the fact that at extreme low temperatures various electronic components become extremely brittle and have a tendency to fall apart. Batteries? The Leclanché carbon–manganese–zinc type is probably the most efficient in cold weather. At 70° we have a 100% capacity (output); at 20°, 48%; at 0°, 27%; at −20°, 6%; at −400°? Long before that point is reached, they would have burst open. Hence, in the dark of interplanetary space we would have to use a different means of current supply, such as hand- or foot-operated generators or, more likely, in the near future, atomic batteries.

Curiously, too, as the temperature falls, our electronic circuits improve vastly—the colder it gets the lower the electrical resistance of a conductor. Finally, a few degrees above absolute zero (−459.72°F.), many conductors lose all resistance—they become *superconductors*. On earth we already have superconductive circuits in which an induced electric current has been kept going without stopping for many months without any outside current supply!

If you ponder this statement—space-wise—you will appreciate what electronic revolutions are coming in the future. This does not mean that we will get electrical energy for nothing, but rather that we will get energy for less effort, at incredible efficiency.

In outer—or even nearby—space, the electronic technician will find other surprises. You do not need a *vacuum* tube in space—it will be far more efficient *without* the glass envelope. This holds true only if the tube is out in open space; it is not true within a pressurized spaceship.

Transistors, too, work efficiently at lower temperatures. They have been operated routinely by scientists down to —40° F. where they perform quite well. What about transistors at near-absolute zero in the superconductivity region? We suspect that at such temperatures there will be some more electronic surprises—but right now this is strictly hush-hush information.

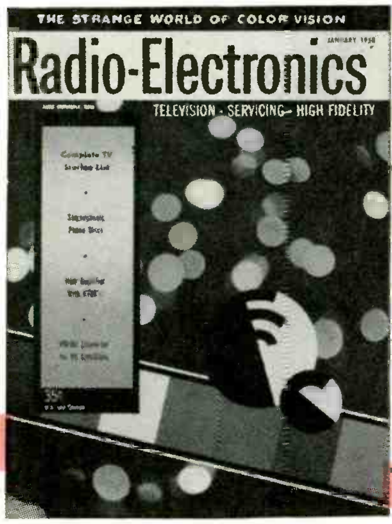
What about the comparatively new semiconductor, the solid-state solar cells? These cells are now being used increasingly in space rockets and will be used in most man-made satellites, replacing the old type dry-cell batteries. We talked about this with Bell Laboratories' Dr. D. M. Chapin, one of the inventors of the solar cell. On earth on a clear day, the average output of the cell is about 10 milliwatts per square centimeter. Above the atmosphere in airless space, there is 30% to 35% more radiation and at least part of this increase is in useful frequencies. *Also the voltage of the solar cells increases as the temperature decreases.* Thus, in space, the solar cell's output will be up considerably, generally speaking. This, then, means that future spaceships equipped with a bank of efficient solar-cell batteries will obtain much of their electrical energy directly from the sun.

At this point we should qualify some of the above statements regarding solar radiation. They hold true only in the vicinity of the earth's orbit. Near Mars, the solar energy from the sun is only 0.44 (earth is 1.00), while near Venus it is up to 2.04. Near Saturn's orbit, it is only .011. Finally, in the orbit of the outermost planet, Pluto, solar cells would be almost completely useless.

Nor would it be simple to communicate with a spaceship in the vicinity of Pluto. It would take an average of 6 hours and 25 minutes for a radio message to bridge the distance between Pluto and earth, or 12 hours and 50 minutes for a short two-way conversation.

Weightlessness in space, as far as humans are concerned, has never been explored except for short periods up to 30 seconds at a time. The first manned satellite will have at least one human completely wired with all sorts of electronic gear, from electroencephalic to cardiac, to study human physical and psychic behavior during extended states of weightlessness. From what we already know, zero gravity will probably benefit most individuals. Extended periods of the weightless state may even cure or ameliorate certain ailments and diseases. —*H.G.*

The strange world of color vision



By ROBERT G. MIDDLETON
TELEVISION CONSULTANT

THE COVER

Our cover this month is an abstraction based on a suggestion by Mr. Middleton to illustrate this article. The two odd-looking discs are used to produce sensations of color from black and white elements only. (See Fig. 6.) The bar slanting across the bottom is, of course, the color spectrum as most of us know it, and the upright panel is the color spectrum of a color-anomalous or "color-blind" person, whose world of color is based on stimuli from two instead of three primaries. The floating colored dots or bubbles, chosen to produce a random display of color, are actually a nighttime color photograph of colored lights on a Ferris Wheel deliberately shot out of focus. The picture was taken by Jay Maisel.

Color is by no means simple—it is often incomprehensible and always tricky; but its apparent inconsistencies make compatible color television possible

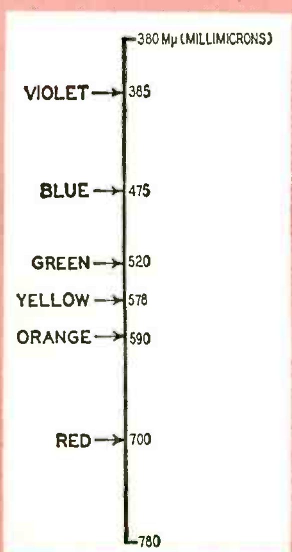


Fig. 1 — As wavelength of electromagnetic waves is raised from 380 to 780 millimicrons, we see in succession all the colors of the rainbow.

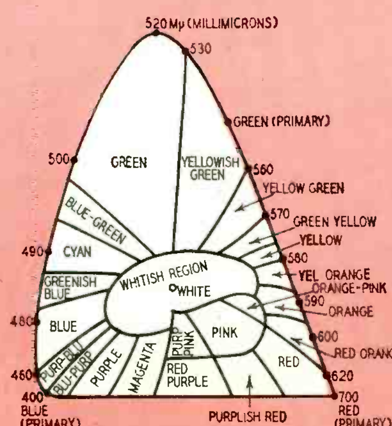


Fig. 2—The standard color map or chromaticity diagram. All colors are arranged around white as an optical center.

CHILDREN and simple folk suppose that the colors they see really exist in nature and scoff at the idea that colors exist only in the mind.

Physicists explain that the colors we see correspond to waves of electromagnetic energy from 4 to 8×10^{14} cycles per second. Electromagnetic waves used in radio and television transmission have longer wavelengths.

Of course, light waves are not *color*, any more than radio waves are color. Physicists do not attempt to explain further and physiologists cannot. Psychologists are baffled and philosophers offer various theories which cannot be proved or disproved.

In spite of the unsatisfactory state of our knowledge concerning color vision, many interesting laws have been discovered, upon which the technology of color television rests. Some of these laws are well known while others are familiar only to specialists.

Trichromatic vision

Of all our body's organs, the eye is most remarkable. Loss of hearing is a personal tragedy but loss of sight is a calamity—our eyes provide us with more information concerning the external world than any other organ.

It was once supposed that the eye is a frequency-sensitive organ because we see various colors when electromagnetic waves of various frequencies enter the eye. As shown in Fig. 1, a wavelength of 475 mμ (millimicrons) causes us to see blue, 520 mμ green, 578 mμ yellow and 700 mμ to see red.

Fig. 1 shows in a limited manner the information given in Fig. 2. The chromaticity diagram (Fig. 2) shows around its border the wavelengths of light corresponding to the common colors. Note that there are colors along the base of the diagram to which no single wavelength of light corresponds. This is a rather unexpected fact which is discussed later in the article.

In view of such experimental data, it is reasonable to conclude that each color we see has a corresponding frequency or wavelength. However, there are difficulties which make this conclusion unacceptable.

When we mix red light with green light, we do not see either of these two colors. Instead we see a new color: yellow. On this basis, we must abandon the definition that yellow corresponds to a wavelength of 578 mμ, since yellow is also produced by a combination of two other wavelengths.

In fact, investigation has shown that the many thousands of colors which we see can be obtained by mixing only three colored lights—red, green and blue—in various proportions. Color television operates upon this law, the law of trichromatic vision. Fig. 3 illustrates how the primary colors of red, green and blue combine by pairs to form the complementary colors of yellow, cyan and magenta. Fig. 4 shows how the three primary colors combine to form white.

To obtain compatible operation of black-and-white and color TV receivers, wavelengths of light are transmitted as various phase angles of a color subcarrier. This is shown in Fig. 5. Burst is taken as the reference frequency. Red, which has a wavelength of 700 mμ, is transmitted as a phase angle of 76.5°. Magenta, which is a combination of 700 mμ and 475 mμ, is transmitted as a phase angle of 119°.

The colors seen in the spectrum of a prism are 100% saturated. They are pure colors. Saturated colors are vivid. Desaturated colors are pale—they have a pastel shade. The wavelength of a desaturated color is the same as the wavelength of the same saturated color. However, white light is mixed with a saturated color to make a desaturated color. In Fig. 5, the relative voltages of the saturated colors are shown by the lengths of the vectors. Now, if we shorten the length of the red vector to half that shown in Fig. 5, we transmit *pink*—a desaturated red.

It is no mystery that hues are transmitted in terms of phase, and that saturations are transmitted in terms of voltage. These values are easily calculated throughout. We encounter the unknown only when we attempt to understand how a color such as yellow is seen when the eye is viewing a mixture of red and green lights. Perhaps we shall never know.

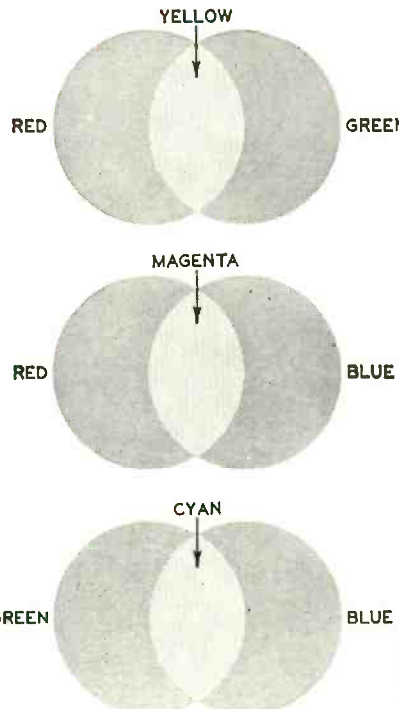


Fig. 3—Red and green combine to form yellow; red and blue combine to form magenta; green and blue combine to form cyan.

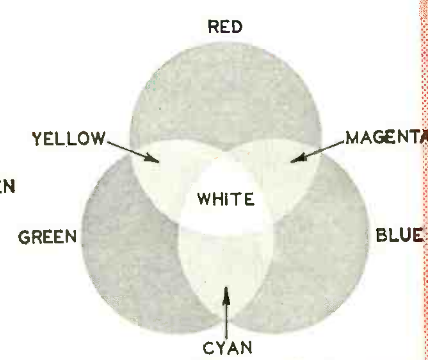
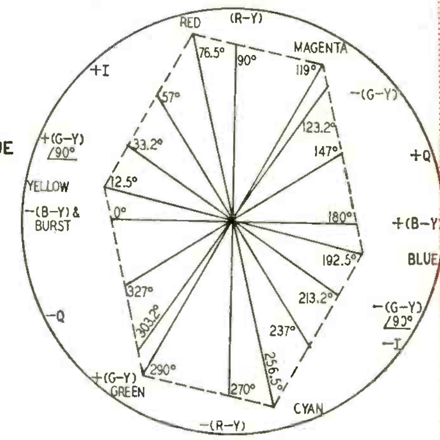


Fig. 4—Red, green and blue combine to form white.

Fig. 5—Each color signal voltage has a phase as well as an amplitude.



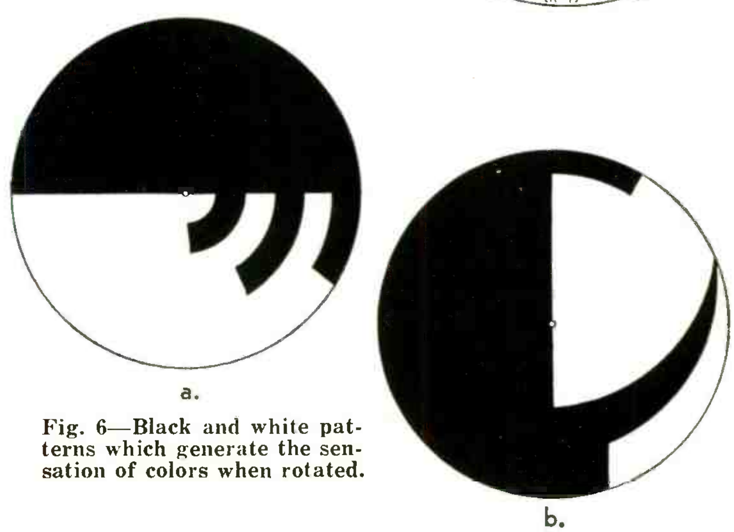


Fig. 6—Black and white patterns which generate the sensation of colors when rotated.

Producing color

White is a mixture of red, green and blue. Black is the absence of visible electromagnetic wave energy. As white can be produced from colors, conversely, colors can be produced by suitable arrangements of black and white. For example, when we mount the disk shown in Fig. 6-a on the shaft of a variable-speed motor, we see an arc of color in the rotating pattern. As the speed of the motor is varied, the hue of the color changes accordingly. A disk which produces red and yellow is shown in Fig. 6-b.

It is thought that there may be three types of color receptors in the retina of the eye, with peak responses to wavelengths in the regions of red, green and blue. These color receptors are not sharply tuned but have overlapping responses or considerable bandwidth. Furthermore, when these color receptors are simultaneously energized by white light which is then suddenly stopped, the response of the color receptors does not fall to zero at once, but requires a small time interval to decay to zero.

Because the color receptors have differing decay times, a residual unbalance of response occurs from the receptors during the decay time so that we see color in the black-and-white whirling pattern, which attacks the eye with sudden changes from black to white and vice versa. The disk should be rotated counterclockwise at a speed on the borderline of persistence of vision, and the level of daylight or artificial light adjusted to produce the maximum intensity of color in the whirling pattern. Thin, fairly intense red rings, blue tails and yellow fields will appear under suitable conditions.

The known facts of "color blindness" also support the theory of three color receptors in the retina, responding in the regions of red, green and blue.

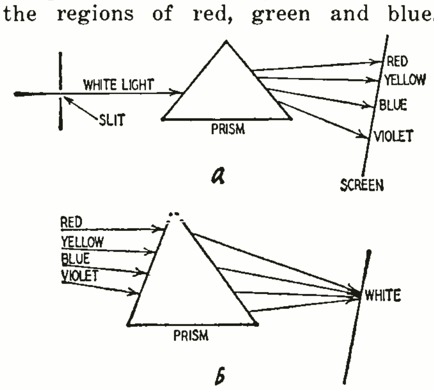


Fig. 7-a—Splitting white light into a color spectrum; b—recombination of color spectrum produces white light.

Test charts are available, which reveal the presence of various types of color blindness in afflicted persons. Some persons are completely color-blind, but still get about quite handily, since black-and-white vision remains (provided by the rods in the retina) although the color receptors (cones) are incapable of response.

All of us are color-blind in dim light. If you walk out of a lighted room into a dimly lit hall and look at a color chart, you will find that all the colors appear to be in shades of gray.

We are also color-blind to very small patches of color and semi-color-blind to somewhat larger patches. All colors seem to drift into orange or cyan hues as a patch of the color is reduced in size. This is the I axis of color television and is the basis of wide-band color transmission.

Development of the eye

In an embryonic infant, the retina develops as an outgrowth of the forebrain. However, the function of vision is located in the hind-brain and persons who suffer injury to the hind-brain are as blind as if their eyes had been put out.

If a person has the hind-brain intact, but his eyes have been injured, he may still see flashes of light and colors as a result of mechanical stimulation of the exposed ends of the optic nerves. A somewhat similar response is observed by normal persons. If the eyelids are closed and pressure is applied to the edge of the eyeball, rings of yellowish light are seen.

How the sensation of light is produced in the mind when the optic nerves are energized is not known. As far as color television is concerned, it is essential only that we know the laws of

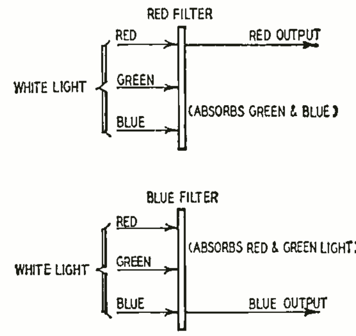


Fig. 8—Optical filters use resonant electrical circuits which are provided by nature in the electronic orbits of the atoms comprising the filter glass.

color mixture whereby any desired color can be synthesized by a suitable mixture of the three primary colors.

Fig. 7-a shows how a prism can decompose white light into a spectrum of its color components. Fig. 7-b shows how the color spectrum can be recombined into white light again. This is not a very striking demonstration. However, we find that we can *remove*

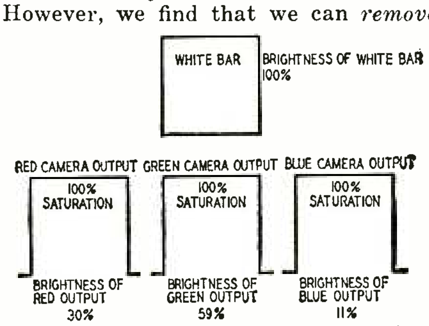


Fig. 9—The brightness of a white bar, like that of a color bar, is equal to the sum of the brightness of its components.

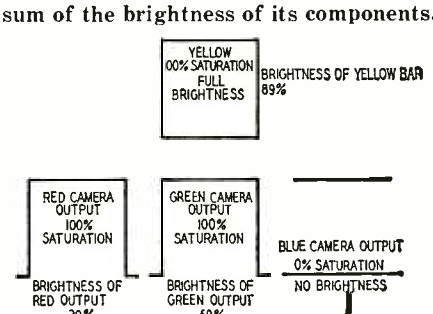


Fig. 10—The brightness of a color is equal to the sum of the brightness of its components.

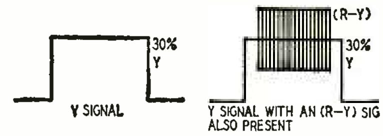


Fig. 11—Color is characterized by three quantities: brightness, hue and saturation. Color brightness is determined only by Y-voltage value and is not affected by chrominance voltage.

large regions of the spectrum, leaving only the colors at the extreme ends and a color at the middle, and still obtain white on recomposition. This robbed white is quite undistinguishable by the human eye from the first white.

If we were unable to rob the spectrum in this manner, color television as we know it today would be impossible. It is hard enough to transmit three primary-color signals in a 6-mc channel containing a black-and-white signal and sound signal without contending with individual signals for tens of thousands of particular hues.

Robbing the color spectrum

A rainbow spectrum of light is conveniently robbed by use of filters, as depicted in Fig. 8. Optical filters operate like electric or electronic filters,

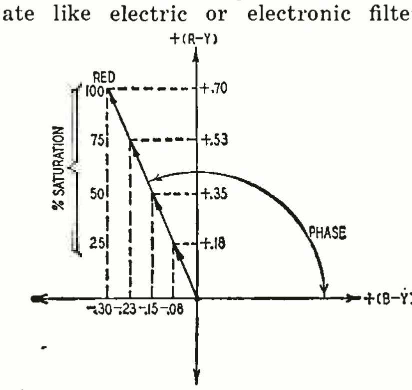


Fig. 12—The chrominance voltages produced by scanning 25%, 50%, 75% and 100% saturated red. Length of chrominance vector is directly proportional to color saturation. Its phase does not change with change in saturation.

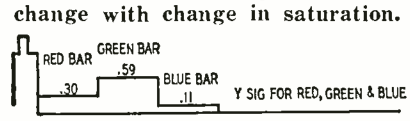


Fig. 13—Compatability of color-TV and black-and-white TV requires that the Y signal as used in black-and-white transmission be unaltered.

except that the resonant circuits utilized are contained in the electronic orbits of the atoms in the filter.

All matter is an arrangement of electrical forces or fields. The electrons comprising a substance have a certain frequency of rotation about the nucleus of the atom and are coupled to external space just as an antenna is coupled to space. Incident electromagnetic energy can be absorbed by electrons in certain orbits, just as a tuned circuit absorbs electromagnetic energy from an antenna.

Thus, an optical filter is an electronic wavetrap, of atomic dimensions, which is tuned to the frequency of the electromagnetic energy recognized by us as a given color. There is no basic difference between an optical filter and a wave trap except that the wave-lengths used in the optical filter are shorter.

Color can be specified on a technical basis in terms of brightness, hue and saturation. Fig. 9 shows that the brightness of a white bar is equal to the sum of the brightnesses of its components (red, green and blue). The brightness of red, as seen on a black-and-white picture tube, is 30%; the brightness of green is 59%; the brightness of blue is 11%—hence, the brightness of white is 100%.

Fig. 10 shows that the brightness of a color is equal to the sum of the brightnesses of its components. Yellow has a brightness, as seen on a black-and-white picture tube, of 89%. Yellow is comprised of green which has a brightness of 59% and of red which has a brightness of 30%—hence, the brightness of yellow is the sum of these brightnesses, or 89%.

The brightness of a color, as transmitted from a color TV station, is given by the level of the Y (black-and-white) signal component, as shown in Fig. 11. To this brightness signal level is added a 3.58-mc chroma signal. The chroma signal specifies hue and saturation. Fig. 12 shows how the voltage of the chroma signal specifies the saturation (vividness) of the color. We have already seen how the *phase* of the chroma signal specifies color (hue).

This particular (NTSC) signal arrangement has been established to provide compatibility in black-and-white and color TV reception. Fig. 13 shows how a succession of red, green and blue bars is transmitted as a series of video levels at 30%, 59% and 11%. This is the only part of the complete color signal which is seen by a black-and-white TV receiver.

The chroma signal has a relatively high frequency (3.579545 mc) which is largely filtered out in the if and video amplifier of a black-and-white TV receiver. In a color TV receiver, however, the chroma signal component is not rejected, but is processed through the chroma circuits of the color receiver.

The color receiver responds to the phase of the chroma signal by displaying a corresponding hue; it responds to the voltage of the chroma signal by displaying a corresponding color saturation. This is how we get compatibility. END

DEFINITIONS

A translator picks up vhf or uhf signals, both audio and video, amplifies both and then retransmits them on one of the upper vhf channels.

A booster (or reflector) is simply a rf amplifier.

A satellite is, according to some sources, a booster or translator operated by a TV station itself to reach a "shadowed" area. Others refer to satellites as any amplifier that rebroadcasts a signal that it does not originate itself.

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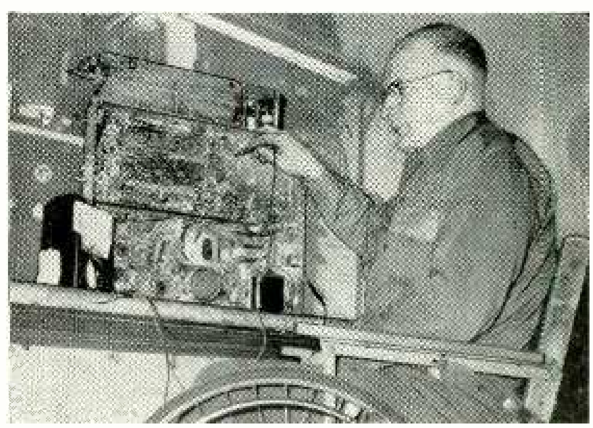


Albert Johnson, Moscow, Idaho, radio-TV repair man at work on modern TV receiver.

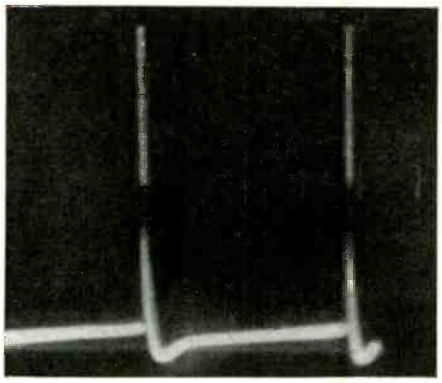
REPAIRING complex modern electronic circuits is a long step from keeping crystal radios in good repair, but that is the span of work covered by Albert Johnson of Moscow, Idaho, during his 24 years as an electronic technician.

Injured in an automobile accident and confined to a wheelchair, Johnson gives Milo T. Means of the State Vocational Training Department the credit for starting him on the road to success.

In 1934, after a period of training, Johnson rented a store and began to repair radios. He has had a store in several different locations before settling at his present place of business.

Now, there are five full-time employes working for him, servicing and selling radio and TV sets. Johnson's comment on his success, "I've been awfully lucky."

An illustrated discussion of retrace blanking, vertical peaking and yoke-damping defects

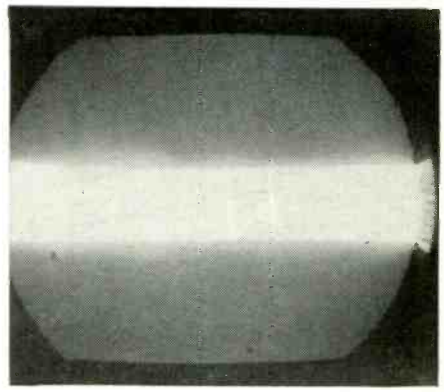


A

B

By CHARLES J. GARRETT

more about auxiliary circuits



C

THE last time we got together we talked about those deep dark corners of a television receiver's horizontal circuits. This time, let's take a look into a few more ignored spots in the receiver's circuitry. The vertical output stage should be a good place to begin.

Retrace blanking defects

The vertical output circuit contains a simple network that in its many forms has been used more and more in the last year or two. This network for retrace blanking is shown in Fig. 1-a. In normal operation it supplies a vertical retrace pulse of the proper polarity and spike shape to the picture tube to cut it off during the vertical retrace period. Photo A shows the scope pattern of the blanking pulse applied to the picture tube. It is during this interval that slanting horizontal lines (retrace lines) can form on the screen. Photo B shows retrace lines caused by reversed polarity of the blanking pulse.

The values of the circuit components are chosen and arranged to pass only the quicker retrace pulse and very little of the actual vertical sweep voltage which would harmfully affect screen brightness.

Troubles in retrace-blanking circuits are usually caused by one or both of the capacitors developing leakage or a direct short. A short or leakage in capacitor C1 (circuit 1-a) can reduce vertical size as well as allowing retrace lines to form. A shorted or leaky C2 can black out the screen because it injects practically the full vertical sweep voltage into the picture tube. An open component in this circuit will be indicated by the presence of retrace lines and the absence or distortion of the retrace-blanking pulse.

Vertical peaking

When the sawtooth capacitor in a vertical blocking oscillator opens (Fig. 2-a), the condition shown in Photo C develops. If the resistor shorts or loses resistance, vertical interlace is destroyed and double the number of retrace lines form. Photo D shows a normal number of retrace lines. Photo E shows the result of a shorted resistor in the sawtooth-forming network.

The sawtooth capacitor in a combination vertical-multivibrator–vertical-output circuit (circuit 2-b) can produce vertical-sweep distortion, like that shown in Photo F, when it opens. When the resistor in this network goes down in value, severe nonlinearity, like that seen in the spacing of the cross-hatch pattern in Photo G, occurs. Waveforms at the input plate in this circuit are similar to those in vertical-blocking oscillators except that a sharper square wave is formed when the sawtooth capacitor opens as in Photo H.

Yoke damping defects

The two 560-ohm resistors across the vertical yoke coils (circuit 1-b) have a purpose similar to that of the damper tube in the horizontal output transformer's secondary. The damper tube loads down the circuit, making it difficult for any transient oscillations to exist.

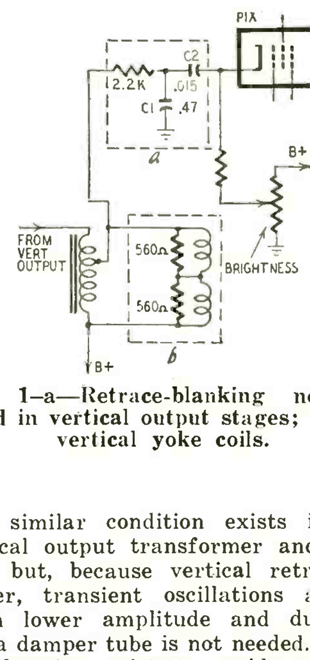
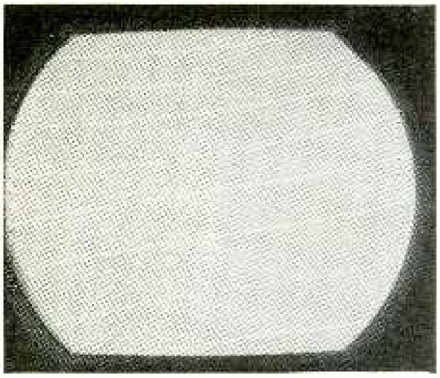


Fig. 1—a—Retrace-blanking network found in vertical output stages; b—the vertical yoke coils.

A similar condition exists in the vertical output transformer and yoke coils but, because vertical retrace is slower, transient oscillations are of much lower amplitude and duration and a damper tube is not needed. These two shunting resistors provide sufficient loading so that transient oscillations cannot exist. They also damp out any voltage peaks or spikes that might be picked up from the horizontal yoke coils.

Abnormal operation may not always be apparent—with these resistors disconnected, many older sets will still perform normally—it depends on the yoke efficiency or Q. On modern high-efficiency yokes, if these resistors are removed or open, ripples will form on the left edge of the screen that are

D



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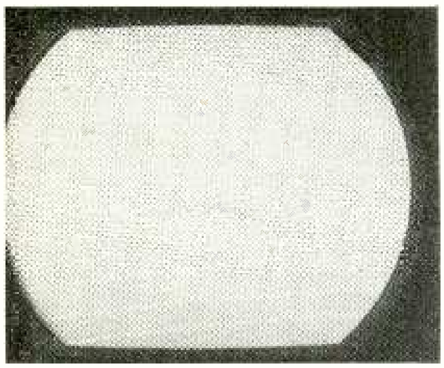

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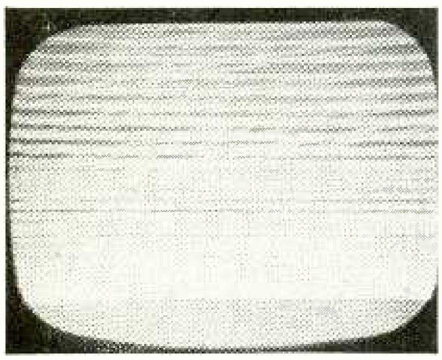

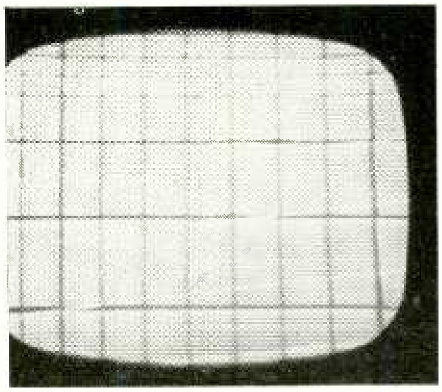

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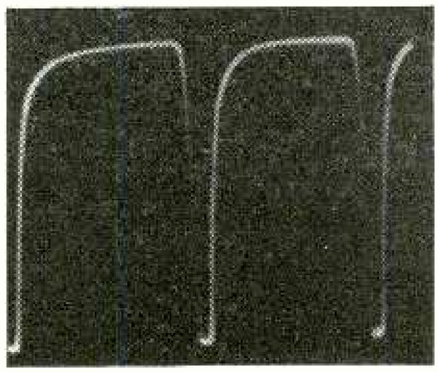
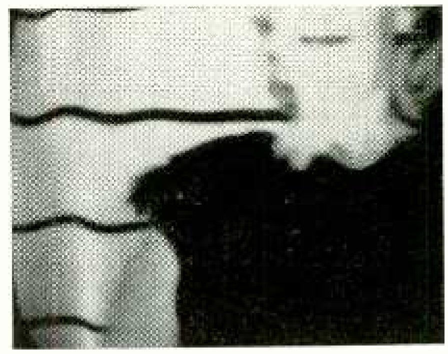
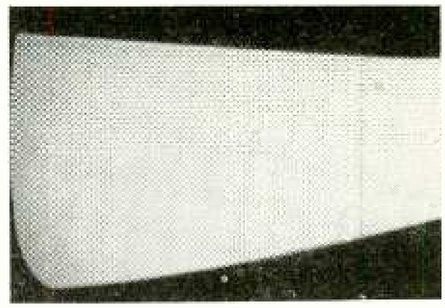


H

I



J



K

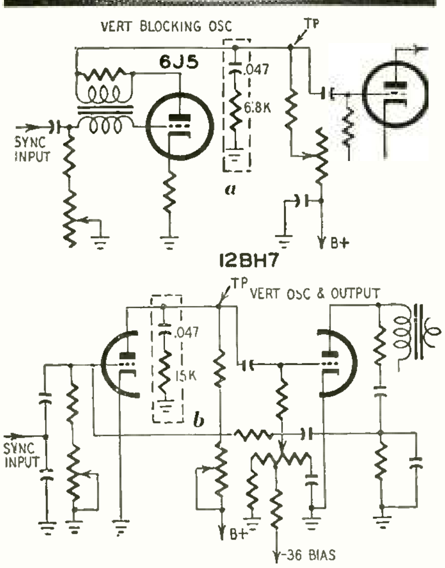


Fig. 2—a—Sawtooth capacitor in a vertical blocking oscillator; b—sawtooth capacitor in a vertical multivibrator — vertical output circuit.

indistinguishable from those caused by an improper-size horizontal yoke capacitor (see Photo I). Direct substitution is the best test in this case.

A shorted resistor can cause vertical raster keystoning like that produced by a shorted yoke coil (see Photo J). Therefore, an ohmmeter check of these vertical yoke-shunting resistors should be made before replacing a yoke for vertical keystoning.

The small capacitor across the high side of the horizontal yoke coils (Fig. 3) has somewhat of a damping action, also. Ripples on the left side of the screen can also be due to interaction or crosstalk between the vertical and horizontal deflection coils.

The basic purpose of this capacitor across the top half of the horizontal deflection coils, the half farthest from B plus, is to balance the capacitance of both horizontal yoke coils (with respect to ground). Thus any coupling to the vertical deflection coils from the horizontal coils is equally out of phase. Interaction and crosstalk can thereby be nullified.

However, even on many new sets, some ripples are evident on the left edge of the screen. Assuming that the vertical yoke resistors are not defective in these sets, an adjustment of the value of the horizontal yoke capacitor can correct or improve this condition.

A mica trimmer adjustable from 10 to 100 $\mu\mu f$ can be temporarily substituted for the original yoke capacitor and adjusted for best results. When the best setting is found, the capacitor can be carefully removed and measured. The indicated value will be correct for the horizontal yoke capacitor for that particular yoke and set.

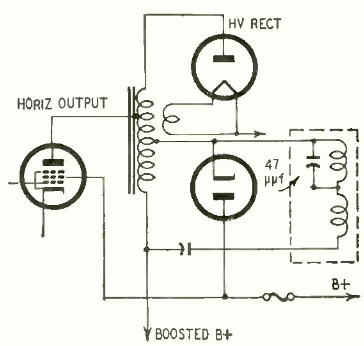


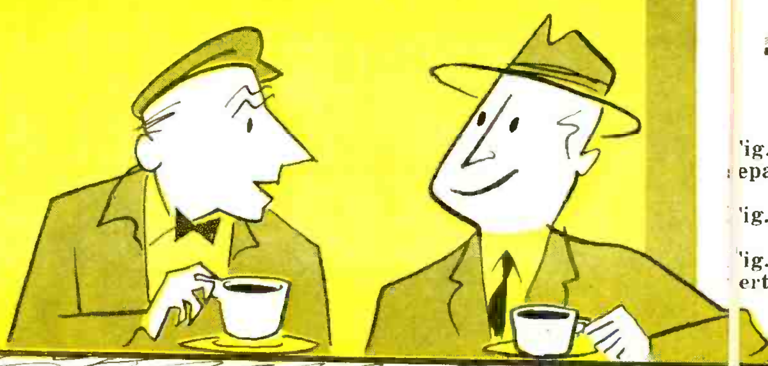
Fig. 3—A capacitor across the top half of the yoke coils has a damping action.

Another common trouble that can be caused by this capacitor is horizontal keystoning when it shorts out. This defect is shown in Photo K. Incidentally, a replacement horizontal yoke capacitor should be rated at 1,500 volts or more due to the high spike voltage present in yoke circuits. END

Fuzz is still learning about color TV—the hard way

Red and Fuzzball on convergence

By ROBERT G. MIDDLETON



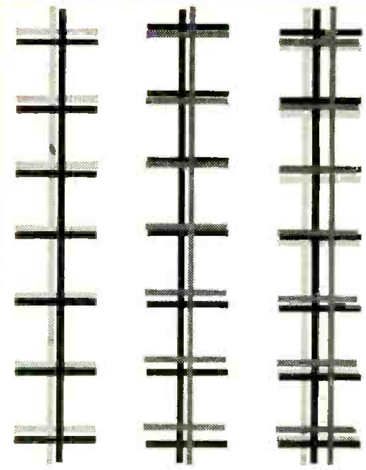


Fig. 1—(left) Blue lateral corrector separates blue and green vertical lines for easier checking.
Fig. 2—(center) Make the red and blue lines parallel.
Fig. 3—(right) Red, green and blue vertical center lines must all be parallel.

"HAVE I still got a job?" asked Fuzzball anxiously, as he sat down beside Red at the counter.

"Take it easy," Red replied. "Old Fatpants is late himself this morning—he don't even know that you didn't show."

Fuzz' hand shook visibly as he reached for the cup of coffee. "So where you been, anyhow?" Bess asked curiously.

"It worked out to be sort of a lost weekend for me," Fuzzball explained. "I took one too many and . . ."

"There are times," Red chuckled, "when Fuzz lives in a world of his own."

"There *ain't* no such world," Bess snorted, and flounced off.

"There was a good reason for me falling off the wagon though," Fuzz said in self-defense.

"Always is," Red agreed. "What's yours?"

"It's that installation out on the South Side," said Fuzz. "Line voltage drifts up and down so much that I can't converge the picture tube for sour apples."

"That's easy," replied Red. "All you got to do is put in an automatic line-voltage regulating transformer."

"That's easy?" Fuzzball asked. "This guy won't even buy an outdoor antenna. I can't get him off my back."

"Lord have mercy," Red breathed. "The penny-pinching public again."

"What can I do?" Fuzzball asked helplessly.

"Ignore him," Red advised.

"Suppose he calls up Old Fatpants and complains?"

"Let him. I'll talk to Fatpants. I been on these hey-rube runs before."

"Red."

"What now?"

"Can you cash me a check?"

"The answer is no. Here's a fin I'll *give* you. That way nobody ain't kidding nobody."

"Thanks, Red. I dunno what I'd do without a buddy like you."

"*I* know what you'd do—and so do you."

A shortcut?

"Not to change the subject, but I got a new way to converge a picture tube that I like better."

"What's that?"

"When I start making the vertical dynamic, I kill the red gun and line up the green dots with the blue dots."

"Nothing wrong with doing it that way, if you want to."

"The way you started me out," explained Fuzzball, "I left the red gun on. It's less complicated to adjust the green by itself."

"At the beginning, yes," Red agreed. "But it's a sure bet that after you get some more experience, you'll be leaving the red gun on."

"I suppose you're right," Fuzzball remarked. "Right now, it seems easier to work with two colors at a time."

"After you get experience," Red explained, "you'll learn to pay no attention to the colors you're not working with. It will just be a bother to you, then, to be turning guns off and on."

"I see what you mean," Fuzz replied.

"Tell me this," said Red, "do you keep the green and blue dots converged in the center?"

"I took your hint before, Red. I use crosshatch to start the job and I found it's easier that way."

"Thought you would."

"But I don't keep the green and blue lines converged at the center unless I'm working in a real dark room."

"You're learning fast."

"Hope so," Fuzz replied. "I found that when there's light shining on the screen, it's easier to judge if the green and blue lines are straight with each other if I keep them separated a little bit." (See Fig. 1.)

"Most techs would agree with you on that one," Red assured him.

"One thing the set manufacturers have done that really helps on this convergence, though."

"Namely?"

"They are either mounting the dynamic controls on the front of the set or on a box that you can bring around to the front."

"You can say that again. It's cut convergence time just about in half."

"OK. I will say it again," Fuzzball grinned.

"You're a real character," Red replied disgustedly. "But what are you doing after you line up the green and blue vertically?"

"Well, then I kill the green gun and turn the red gun back on."

"That's OK."

"I adjust the red beam magnet or the blue lateral corrector to separate the red and blue lines a little bit."

"What next?"

"Just like the green. I adjust the red vertical amplitude and tilt controls to make the red and blue lines straight with each other up and down the screen." (See Fig. 2.)

"I hope you mean you are watching just the vertical center column on these vertical adjustments," Red interjected.

"What do you think I am. Stupid?" Fuzzball asked.

"I'd rather not answer that question yet," Red observed. "Then what next?"

"That's when I turn the green gun back on and check to see whether the green light is still straight." (See Fig. 3.)

"A little green touchup might be in order," Red agreed.

Finishing up

"Finally, I adjust the beam magnets and the lateral corrector to bring the three color lines together and make a white line."

"How's your luck running?"

"Sometimes there's a little tattle-tale color showing at the top or bottom," Fuzzball admitted.

"You'll never get it 100% perfect," Red reassured him. "We discussed that before."

"But you can't see it very far back from the set," Fuzz said.

"Better hadn't, at viewing distance anyhow."

"It's a funny thing," Fuzzball mused, "when there's a little color showing at the top of the white line, the dynamic adjustments will shift the color fringing to the bottom of the line, or to the middle. But you got to leave a little fringing somewhere."

"You're getting hep," Red remarked, "and just where do you leave the fringing?"

"Does it make a difference?" Fuzz asked innocently.

"Sure does. You'll have lots less complaints if you leave the final fringing at the bottom."

"But why should that be?" asked Fuzz.

"Simply because programming usually carries the action above center screen —that's where John Q. Public looks the most."

"I got to admit it makes sense," Fuzzball agreed.

"Now what next?"

"That's when I switch over to white dots and work on the blue amplitude and tilt controls."

"You can keep on with the crosshatch if you want to," Red advised.

"How would you do that?"

"Well, the crossovers on the hatch give you the same use as dots."

"I guess they would, at that."

"So you can look up and down the vertical center line, and see how the crossovers are doing."

"It always looks OK at the center of the screen," Fuzzball reminded him.

"That's right. The static adjustments make it easy to bring the center in."

"But the crossovers are pretty cruddy at the top and bottom of the screen."

Now the blue

"Right again. So you should open up the blue vertical amplitude control wide and adjust the blue vertical tilt to get the *same* blue separation at both the top and bottom of the screen."

"You get away from the dot routine on this deal," Fuzz remarked.

"Naturally, because you're working with a different type of pattern."

"Well, after I get equal blue line spacing at the top and bottom, where do I go from there?"

"Next thing you do is turn down the blue amplitude to get equal blue line spacing all the way up and down the vertical center column."

"But I might have to touch up the blue tilt adjustment," Fuzzball suggested.

"Only a miracle could save you," Red agreed. "There's quite a bit of interaction."

"And, then, when the blue lines are spaced exactly the same amount from the yellow lines all the way up and down the center column, the static adjustments would give final vertical convergence."

"Fuzzball, there are times when you are so bright you dazzle me," Red said effusively. "Permit me to buy you another cup of coffee."

"That's coffee?" Fuzzball exclaimed, ducking agilely as Bess heaved a creamer at him.

"We can use crosshatch all the way on the horizontal dynamic convergence too, if we want to," Red added.

"How about giving me a rundown?" Fuzzball suggested.

"Well, you started off by telling me how you kill the red gun when you start the vertical. So you can start the horizontal the same way, killing the red gun."

"Makes it easier to remember that way," Fuzz observed.

"Then," continued Red, "turn the green horizontal amplitude and the green horizontal phase at the same time and get the green crossovers on the same side of the blue crossovers. Get the crossovers the same, all the way along the horizontal center line."

"Guess I might need to hit the beam magnets or lateral corrector a little to separate the green and blue," Fuzzball suggested.

"But definitely," Red agreed, "and positively if there is much light in the room."

"So after I get the green crossing all on the same side of the blue crossings, where do I go from there?" Fuzz asked.

"Then you get down to fine points," Red explained. "Look at the spacings between the green and blue crossings. You'll find it's dollars to doughnuts that the spacings aren't all exactly equal amounts."

"So I suppose I got to touch up the green amplitude and phase to make all the crossover spacings the same."

"Posilutely. Then, you do exactly the same thing for the red crossovers. Kill the green gun and turn on the red gun. Adjust the red amplitude and phase to get equal crossover spacings, with all the red crossings on the same side of the blue crossings."

"That makes a pretty good routine for remembering," Fuzzball remarked. "What do I do next?"

"Turn the green gun back on. Both the red and green crossovers will be pretty near even from the blue crossovers. A little touchup on the red and green controls should do it about right."

"What about the blue horizontal dynamics?" Fuzz asked.

"I'm getting to that," Red replied. "But, first, you want to make sure you are satisfied with the job so far. Get on the static adjustments and make the pattern white in the center of the screen. Then, you might want to do just a little more touching up to get real good crossovers at the same points all along the horizontal center line."

"Then I go to the blue horizontal controls?" asked Fuzz.

"Absotively. Now we straighten up the blue line and bring it in with the yellow line."

"So far, I've always been resonating the blue phasing coil," Fuzz ventured.

"Saves time," Red agreed. "You should do it on this all-crosshatch routine also. Open up the blue horizontal amplitude and adjust the blue horizontal phasing coil for a peak, smack in the center of the screen."

"That's just like we were using dots."

"Right. Then, back off on the amplitude until the blue line is as near parallel with the yellow as possible."

"But I'll probably need to touch up the blue phasing here."

"You're reading my mind," Red stated. "The touchup will give the parallel spacing you're looking for between the blue and yellow lines."

"And the static controls will give me final overall convergence," Fuzz suggested.

"Just about," Red agreed. "But there are a couple of little points to keep in mind."

"Such as?"

"Look carefully at the vertical convergence. You might have knocked it out a trifle, and need to touch it up a wee bit."

"Anything else?" asked Fuzz.

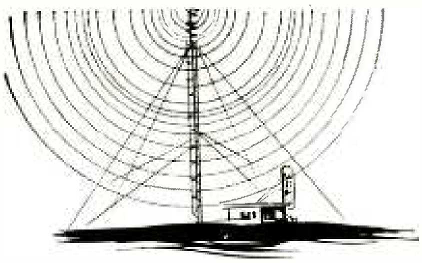
"Yep. Check the corners of the screen. There's no adjustment here, but sometimes if you see a little fringing in the corners, you can compromise a little to improve it, without hurting other parts of the screen noticeably."

"Whoof!" exclaimed Fuzzball, blowing hard. "And I took up television for a living. I could of had a job in a putty-knife factory and nothing to worry about."

"Maybe you could get a job as a pilot on a rocket to the moon," Bess suggested.

Fuzzball rose to his feet. "Give the gal her money, Red, and let's get out of this booby trap."

Bess banged another creamer on the door behind the fast-moving Fuzzball's back. END



This list includes all United States, Canadian and Mexican stations.

Correct to Dec. 2, 1957

Television Station List

Compiled by MURIEL SCHILLER

Alabama
WAIQ	Andalusia	2
WABT	Birmingham	13
WBIQ	Birmingham	10
WBRC-TV	Birmingham	6
WMSL-TV	Decatur	23
WTVY	Dothan	9
WOWL-TV	Florence	15
WALA-TV	Mobile	10
WKRG-TV	Mobile	5
WCOV-TV	Montgomery	20
WSFA-TV	Montgomery	12
WTIQ	Munford	7

Alaska
KENI-TV	Anchorage	2
KTVA	Anchorage	11
KFAR-TV	Fairbanks	2
KTVF	Fairbanks	11
KINY-TV	Juneau	8

Arizona
KVAR	Mesa–Phoenix	12
KOOL-TV	Phoenix	10
KPHO-TV	Phoenix	5
KTVK	Phoenix	3
KGUN-TV	Tucson	9
KOLD-TV	Tucson	13
KVOA-TV	Tucson	4
KIVA	Yuma	11

Arkansas
KRBB	El Dorado	10
KFSA-TV	Fort Smith	22
KNAC-TV	Fort Smith	5
KARK-TV	Little Rock	4
KTHV	Little Rock	11
KATV	Pine Bluff–Little Rock	7

California
KBAK-TV	Bakersfield	29
KERO-TV	Bakersfield	10
KHSL-TV	Chico	12
KIEM-TV	Eureka	3
KFRE-TV	Fresno	12
KJEO	Fresno	47
KMJ-TV	Fresno	24
KABC-TV	Los Angeles	7
KCOP	Los Angeles	13
KHJ-TV	Los Angeles	9
KNXT	Los Angeles	2
KRCA	Los Angeles	4
KTLA	Los Angeles	5
KTTV	Los Angeles	11
KVIP-TV	Redding	7
KBET-TV	Sacramento	10
KCRA-TV	Sacremento	3
KSBW-TV	Salinas–Monterey	8
KFMB-TV	San Diego	8
KFSD-TV	San Diego	10
KGO-TV	San Francisco	7
KPIX	San Francisco	5
KQED	San Francisco	9
KRON-TV	San Francisco	4
KSAN-TV	San Francisco	32
KNTV	San Jose	11
KSBY-TV	San Luis Obispo	6
KEYT	Santa Barbara	3
KOVR	Stockton	13

Colorado
KKTV	Colorado Springs	11
KRDO-TV	Colorado Springs	13
KBTV	Denver	9
KLZ-TV	Denver	7
KOA-TV	Denver	4
KRMA-TV	Denver	6
KTVR	Denver	2
KREX-TV	Grand Junction	5
KFXJ-TV	Montrose	10
KCSJ-TV	Pueblo	5

Connecticut
WICC-TV	Bridgeport	43
WHCT	Hartford	18
WTIC-TV	Hartford	3
WNBC	New Britain–Hartford	20
WNHC-TV	New Haven–Hartford	8
WATR-TV	Waterbury	53

Delaware
WVUE	Wilmington	12

District of Columbia
WMAL-TV	Washington	7
WRC-TV	Washington	4
WTOP-TV	Washington	9
WTTG	Washington	5

Florida
WESH-TV	Daytona Beach	2
WITV	Fort Lauderdale–Miami	17
WINK-TV	Fort Myers	11
WFGA-TV	Jacksonville	12
WJCT	Jacksonville	7
WMBR-TV	Jacksonville	4
WCKT	Miami	7
WPST-TV	Miami	10
WTHS-TV	Miami	2
WTVJ	Miami	4
WDBO-TV	Orlando	6
WLOF-TV	Orlando	9
WPTV	Palm Beach	5
WJDM	Panama City	7
WEAR-TV	Pensacola	3
WSUN-TV	St. Petersburg	38
WFLA-TV	Tampa–St. Petersburg	8
WTVT	Tampa–St. Petersburg	13
WEAT-TV	W. Palm Beach	12

Georgia
WALB-TV	Albany	10
WAGA-TV	Atlanta	5
WLWA	Atlanta	11
WSB-TV	Atlanta	2
WJBF	Augusta	6
WRDW-TV	Augusta	12
WRBL-TV	Columbus	4
WTVM	Columbus	28
WMAZ-TV	Macon–Warner Robins	13
WROM-TV	Rome	9
WSAV-TV	Savannah	3
WTOC-TV	Savannah	11
WCTV	Thomasville–Tallahassee (Fla.)	6

Guam
KUAM-TV	Agana	8

Hawaii
KHBC-TV	Hilo	9
KGMB-TV	Honolulu	9
KHVH-TV	Honolulu	12
KONA	Honolulu	2
KULA-TV	Honolulu	4
KMAU-TV	Wailuku	3
KMVI-TV	Wailuku	12

Idaho
KBOI-TV	Boise	2
KIDO-TV	Boise	7
KID-TV	Idaho Falls	3
KLEW-TV	Lewiston	3
KLIX-TV	Twin Falls	11

Illinois
WCIA	Champaign	3
WILL-TV	Champaign–Urbana	12
WBBM-TV	Chicago	2
WBKB	Chicago	7
WGN-TV	Chicago	9
WNBQ	Chicago	5
WTTW	Chicago	11
WDAN-TV	Danville	24
WTVP	Decatur	17
WSIL-TV	Harrisburg	22
WEEQ-TV	La Salle	35
WEEK-TV	Peoria	43
WTVH	Peoria	19
WGEM-TV	Quincy–Hannibal (Mo.)	10
WREX-TV	Rockford	13
WTVO	Rockford	39
WHBF-TV	Rock Island	4
WICS	Springfield	20

Indiana
WTTV	Bloomington–Indianapolis	4
WSJV	Elkhart	12
WFIE	Evansville	2
WTVW	Evansville	7
WANE-TV	Fort Wayne	5
WKJG-TV	Fort Wayne	13
WFBM-TV	Indianapolis	6
WISH-TV	Indianapolis	8
WLWI	Indianapolis	3
WFAM-TV	Lafayette	9
WLBC-TV	Muncie	9
WNDU-TV	Notre Dame–South Bend	6
WSBT-TV	South Bend	4
WTHI-TV	Terre Haute	10
WINT	Waterloo–Fort Wayne	5

Iowa
WOI-TV	Ames–Des Moines	5
KCRG-TV	Cedar Rapids	9
WMT-TV	Cedar Rapids	2
WOC-TV	Davenport	6
KRNT-TV	Des Moines	8
WHO-TV	Des Moines	13
KQTV	Fort Dodge	1
KGLO-TV	Mason City	3
WPTA	Roanoke	1
KTIV	Sioux City	4
KVTV	Sioux City	9
KWWL-TV	Waterloo–Cedar Rapids	7

Kansas
KTVC	Ensign–Cimarron	6
KCKT	Great Bend	2
KTVH	Hutchinson–Wichita	2
KOAM-TV	Pittsburg–Joplin (Mo.)	7
WIBW-TV	Topeka	3
KAKE-TV	Wichita	0
KARD-TV	Wichita	3

Kentucky
WEHT	Henderson	0
WKXP-TV	Lexington	7
WLEX-TV	Lexington	8
WAVE-TV	Louisville	3
WHAS-TV	Louisville	1
WPSD-TV	Paducah	6

Louisiana
KALB-TV	Alexandria	5
WAFB-TV	Baton Rouge	8
WBRZ	Baton Rouge	2
KLFY-TV	Lafayette	0
KPLC-TV	Lake Charles	7
KTAG-TV	Lake Charles	5
KLSE	Monroe	3
KNOE-TV	Monroe	8
WDSU-TV	New Orleans	6
WJMR-TV	New Orleans	0
WWL-TV	New Orleans	4
WYES-TV	New Orleans	8
KSLA-TV	Shreveport	2
KTBS-TV	Shreveport	3

Maine
WABI-TV	Bangor	5
WTWO	Bangor	2
WMTW	Poland Spring	8
WCSH-TV	Portland	6
WGAN-TV	Portland	3
WAGM-TV	Presque Isle	8

Maryland
WBAL-TV	Baltimore	1
WJZ-TV	Baltimore	3
WMAR-TV	Baltimore	2
WBOC-TV	Salisbury	6

Massachusetts
WCDC	Adams–Pittsfield	9
WBZ-TV	Boston	4
WGBH-TV	Boston	2
WHDH-TV	Boston	5
WNAC-TV	Boston	7
WRLP	Greenfield	2
WHYN-TV	Springfield–Holyoke	55
WWLP	Springfield	22

Michigan
WPAG-TV	Ann Arbor	20
WNEM-TV	Bay City–Saginaw	5
WWTV	Cadillac	13
WJBK-TV	Detroit	2
WTVS	Detroit	56
WWJ-TV	Detroit	4
WXYZ-TV	Detroit	7
WKAR-TV	East Lansing	60
WOOD-TV	Grand Rapids	8
WKZO-TV	Kalamazoo	3
WJIM-TV	Lansing	6
WDMJ-TV	Marquette	6
WKNX-TV	Saginaw–Bay City	57
WPBN-TV	Traverse City	7

Minnesota
KMMT	Austin	6
KDAL-TV	Duluth–Superior	3
WDSM-TV	Duluth–Superior	6
KMGM-TV	Minneapolis–St. Paul	9
WCCO-TV	Minneapolis–St. Paul	4
WTCN-TV	Minneapolis–St. Paul	11
KROC-TV	Rochester	10
KSTP-TV	St. Paul–Minneapolis	5
KTCA-TV	St. Paul–Minneapolis	2

Mississippi
WCBI-TV	Columbus	4
WDAM-TV	Hattiesburg	9
WJTV	Jackson	12
WLBT	Jackson	3
WTOK-TV	Meridian	11
WTWV	Tupelo	9

Missouri
KFVS-TV	Cape Girardeau	12
KOMU-TV	Columbia	8
KHQA-TV	Hannibal–Quincy (Ill.)	7
KRCG	Jefferson City	13
KODE-TV	Joplin	12
KCMO-TV	Kansas City	5
KMBC-TV	Kansas City	9
WDAF-TV	Kansas City	4
KTVO	Kirksville–Ottumwa (Iowa)	3
KFEQ-TV	St. Joseph	2
KETC	St. Louis	9
KSD-TV	St. Louis	5
KTVI	St. Louis	2
KWK-TV	St. Louis	4
KDRO-TV	Sedalia	6
KTTS-TV	Springfield	10
KYTV	Springfield	3

Montana
KOOK-TV	Billings	2
KXLF-TV	Butte	4
KXGN-TV	Glendive	5
KFBB-TV	Great Falls	5
KGEZ-TV	Kalispell	9
KSMO-TV	Missoula	13

Nebraska
KHAS-TV	Hastings	5
KHPL-TV	Hayes Center	6
KHOL-TV	Kearney	13
KOLN-TV	Lincoln	10
KUON-TV	Lincoln	12
KETV	Omaha	7
KMTV	Omaha	3
WOW-TV	Omaha	6
KSTF	Scottsbluff	10

Nevada
KLRJ-TV	Henderson–Las Vegas	2
KLAS-TV	Las Vegas	8
KSHO-TV	Las Vegas	13
KOLO-TV	Reno	8

New Hampshire
WMUR-TV	Manchester	9

New Jersey
WATV	Newark	13

New Mexico
KGGM-TV	Albuquerque	13
KOAT-TV	Albuquerque	7
KOB-TV	Albuquerque	4
KAVE-TV	Carlsbad	6
KICA-TV	Clovis	12
KSWS-TV	Roswell	8

New York
WCDA	Albany	41
WTRI	Albany–Schenectady–Troy	35
WINR-TV	Binghamton	40
WNBF-TV	Binghamton	12
WBEN-TV	Buffalo	4
WBUF	Buffalo	17
WGR-TV	Buffalo	2
WCNY-TV	Carthage–Watertown	7
WSYE-TV	Elmira	18
WCDB	Hagaman	29
WABC-TV	New York	7
WABD	New York	5
WCBS-TV	New York	2
WOR-TV	New York	9
WPIX	New York	11
WRCA-TV	New York	4
WPTZ-TV	Plattsburg	38
WHEC-TV*	Rochester	10
WROC-TV	Rochester	5
WVET-TV*	Rochester	10
WRGB	Schenectady	6
WHEN-TV	Syracuse	8
WSYR-TV	Syracuse	3
WKTV	Utica	13

*Share time.

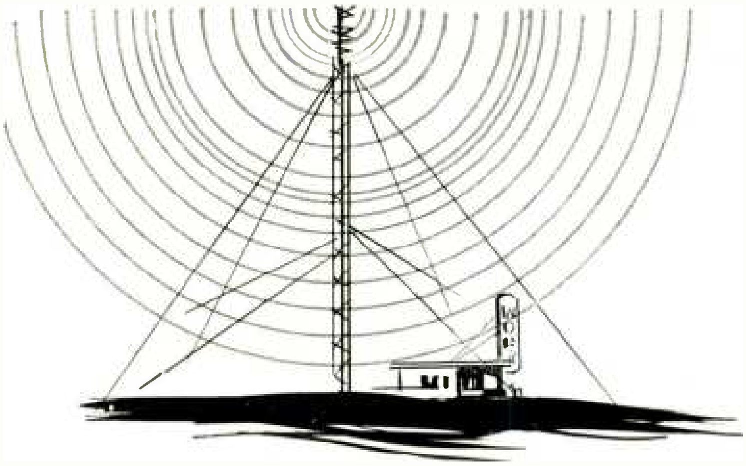
North Carolina
WISE-TV	Asheville	62
WLOS-TV	Asheville	13
WUNC-TV	Chapel Hill	4
WBTV	Charlotte	3
WSOC-TV	Charlotte	9
WUTV	Charlotte	36
WTVD	Durham	11
WFLB-TV	Fayetteville	18
WFMY-TV	Greensboro	2
WNCT	Greenville	9
WNAO-TV	Raleigh	28
WRAL-TV	Raleigh	5
WITN	Washington	7
WMFD-TV	Wilmington	6
WSJS-TV	Winston-Salem	12

North Dakota
KBMB-TV	Bismarck	12
KFYR-TV	Bismarck	5
KDIX-TV	Dickinson	2
WDAY-TV	Fargo	6
KNOX-TV	Grand Forks	10
KCJB-TV	Minot	13
KXJB-TV	Valley City	4
KUMV-TV	Williston	8

Ohio
WAKR-TV	Akron	49
WCET	Cincinnati	48
WCPO-TV	Cincinnati	9
WKRC-TV	Cincinnati	12
WLWT	Cincinnati	5
KYW-TV	Cleveland	3
WEWS	Cleveland	5
WJW-TV	Cleveland	8
WBNS-TV	Columbus	10
WLWC	Columbus	4
WOSU-TV	Columbus	34
WTVN-TV	Columbus	6
WHIO-TV	Dayton	7
WLWD	Dayton	2
WIMA-TV	Lima	35
WSTV-TV	Steubenville	9
WSPD-TV	Toledo	13
WFMJ-TV	Youngstown	21
WKBN-TV	Youngstown	27
WKST-TV	Youngstown	45
WHIZ-TV	Zanesville	18

tv dx for 1957

By ROBERT B. COOPER, JR.



IN seven years of active television dxing, I have seen the coming and going of many dx-ers, not a few of whom had top-notch potential in their day. The average life of the red-hot dx-er seems to run to about three years, and then, suddenly, dxing takes a back seat to other interests.

With the number of television stations presently operating, a station total of 150 is not too much of a task for a diligent dx-er in a year's time, provided he lives east of the Mississippi River, where station concentration is high. In the Mountain States or along the West Coast, 100 stations may prove to be a formidable task when 80–90 of these must come via some form of skip reception. But, given time, even the Western dx-er can reach the 150-station mark.

The dyed-in-the-wool dx-er works hard at his hobby. Make no bones about it, dxing throughout a 4-hour session of fast-changing E-skip conditions can be tiring both physically and mentally. Yet, there must be a reason or reasons for a person perfectly sane in most other respects to spend a whole week-end at the dials of his (or her) television set, continually flipping the dials, rotating the antenna and keeping a written record of everything seen. Do you know what that reason is? If you do, you must be a dx-er. If you don't, then I suggest that you find out. Come on in, the water's fine!

'57—Good in spots

The year 1957 proved very interesting to all long-distance television fans. Generally speaking, the summer E-skip conditions over the North American continent left much to be desired. For the first year in many, very few existing records were broken, perhaps indicating that even the limits of TV dxing have almost been reached. However, some of the new records set this year may be only stepping stones to better things to come in 1958.

Riding the peak of the sunspot cycle, the world's record for television dxing was pushed out to 10,800 miles with the reception of England's BBC channel 1 in various parts of Australia. (See TV Dx Column, RADIO-ELECTRONICS, March, 1957.) Here in the Western Hemisphere, the high-band (channels 7–13) television dx record was extended to approximately 2,300 miles on Aug. 2,

Oklahoma		
KTEN	Ada	10
KVSO-TV	Ardmore	12
KGEO-TV	Enid	5
KSWO-TV	Lawton	7
KTVX	Muskogee–Tulsa	8
KETA	Oklahoma City	13
KWTV	Oklahoma City	9
WKY-TV	Oklahoma City	4
KOTV	Tulsa	6
KVOG-TV	Tulsa	2
Oregon		
KOAC-TV	Corvallis	7
KVAL-TV	Eugene	13
KOTI	Klamath Falls	2
KBES-TV	Medford	5
KGW-TV	Portland	8
KLOR	Portland	12
KOIN-TV	Portland	6
KPIC	Roseburg	4
Pennsylvania		
WFBG-TV	Altoona	10
WICU-TV	Erie	12
WSEE	Erie	35
WCMB-TV	Harrisburg	71
WHP-TV	Harrisburg	55
WTPA	Harrisburg	27
WARD-TV	Johnstown	56
WJAC-TV	Johnstown	6
WGAL-TV	Lancaster	8
WLBR-TV	Lebanon	15
WCAU-TV	Philadelphia	10
WFIL-TV	Philadelphia	6
WHYY-TV	Philadelphia	35
WRCV-TV	Philadelphia	3
KDKA-TV	Pittsburgh	2
WIIC	Pittsburgh	11
WQED	Pittsburgh	13
WARM-TV	Scranton	16
WGBI-TV	Scranton	22
WBRE-TV	Wilkes-Barre	28
WILK-TV	Wilkes-Barre	34
WNOW-TV	York	49
WSBA-TV	York	43
Puerto Rico		
WORA-TV	Mayaguez	5
WAPA-TV	San Juan	4
WKAQ-TV	San Juan	2
Rhode Island		
WJAR-TV	Providence	10
WPRO-TV	Providence	12
South Carolina		
WAIM-TV	Anderson	40
WCSC-TV	Charleston	5
WUSN-TV	Charleston	2
WIS-TV	Columbia	10
WNOK-TV	Columbia	67
WBTW	Florence	8
WFBC-TV	Greenville	4
WSPA-TV	Spartanburg	7
South Dakota		
KDLO-TV	Florence	3
KOTA-TV	Rapid City	3
KPLO-TV	Reliance	6
KELO-TV	Sioux Falls	11
KSOO-TV	Sioux Falls	13
Tennessee		
WDEF-TV	Chattanooga	12
WRGP-TV	Chattanooga	3
WDXI-TV	Jackson	7
WJHL-TV	Johnson City	11
WATE-TV	Knoxville	6
WBIR-TV	Knoxville	10
WTVK	Knoxville	26
WHBQ-TV	Memphis	13
WKNO-TV	Memphis	10
WMCT	Memphis	5
WREC-TV	Memphis	3
WLAC-TV	Nashville	5
WSIX-TV	Nashville	8
WSM-TV	Nashville	4
Texas		
KRBC-TV	Abilene	9
KFDA-TV	Amarillo	10
KGNC-TV	Amarillo	4
KTBC-TV	Austin	7
KFDM-TV	Beaumont	6
KEDY-TV	Big Spring	4
KBTX	Bryan	3
KRIS-TV	Corpus Christi	6
KSIX-TV	Corpus Christi	10
KRLD-TV	Dallas	4
WFAA-TV	Dallas	8
KELP-TV	El Paso	13
KROD-TV	El Paso	4
KTSM-TV	El Paso	9
KFJZ-TV	Fort Worth	11
WBAP-TV	Fort Worth	5
KGUL-TV	Galveston	11
KGBT-TV	Harlingen	4
KPRC-TV	Houston	2
KTRK-TV	Houston	13
KUHT	Houston	8
KHAD-TV	Laredo	8
KCBD-TV	Lubbock	11
KDUB-TV	Lubbock	9
KTRE-TV	Lufkin	9
KMID-TV	Midland	2
KOSA-TV	Odessa	7
KPAC-TV	Pt. Arthur-Beaumont	4
KCTV	San Angelo	8
KCOR-TV	San Antonio	41
KENS-TV	San Antonio	5
KONO-TV	San Antonio	12
WOAI-TV	San Antonio	4
KPAR-TV	Sweetwater–Abilene	12
KCEN-TV	Temple	6
KCMC-TV	Texarkana	6
KLTV	Tyler–Longview	7
KWTX-TV	Waco	10
KRGV-TV	Weslaco	5
KFDX-TV	Wichita Falls	3
KSYD-TV	Wichita Falls	6
Utah		
KSL-TV	Salt Lake City	5
KTVT	Salt Lake City	4
KUTV	Salt Lake City	2
Vermont		
WCAX-TV	Burlington	3
Virginia		
WCYB-TV	Bristol	5
WVEC-TV	Hampton–Norfolk	15
WSVA-TV	Harrisonburg	3
WLVA-TV	Lynchburg	13
WTAR-TV	Norfolk	3
WTOV-TV	Norfolk	27
WXEX-TV	Petersburg–Richmond	8
WAVY-TV	Portsmouth–Norfolk	10
WRVA-TV	Richmond	12
WTVR	Richmond	6
WDBJ-TV	Roanoke	7
WSLS-TV	Roanoke	10
Washington		
KVOS-TV	Bellingham	12
KBAS-TV	Ephrata	43
KEPR-TV	Pasco	19
KCTS	Seattle	9
KING-TV	Seattle	5
KOMO-TV	Seattle	4
KHQ-TV	Spokane	6
KREM-TV	Spokane	2
KXLY-TV	Spokane	4
KTNT-TV	Tacoma	11
KTVW	Tacoma	13
KRTV	Walla Walla	8
KIMA-TV	Yakima	29
West Virginia		
WHIS-TV	Bluefield	6
WCHS-TV	Charleston	8
WBOY-TV	Clarksburg	12
WHTN-TV	Huntington	13
WSAZ-TV	Huntington–Charleston	3
WOAY-TV	Oak Hill	4
WTAP	Parkersburg	15
WTRF-TV	Wheeling	7
Wisconsin		
WEAU-TV	Eau Claire	13
WBAY-TV	Green Bay	2
WFRV-TV	Green Bay	5
WKBT	La Crosse	8
WHA-TV	Madison	21
WISC-TV	Madison	3
WKOW-TV	Madison	27
WMTV	Madison	33
WMBV-TV	Marinette–Green Bay	11
WISN-TV	Milwaukee	12
WMVS-TV	Milwaukee	10
WTMJ-TV	Milwaukee	4
WXIX	Milwaukee	19
WSAU-TV	Wausau	7
WITI-TV	Whitefish Bay-Milwaukee	6
Wyoming		
KSPR-TV	Casper	7
KTWO-TV	Casper	2
KFBC-TV	Cheyenne	5
	Canada	
CHCT-TV	Calgary, Alta.	2
CFRN-TV	Edmonton, Alta.	3
CJLH-TV	Lethbridge, Alta.	7
CHAT-TV	Medicine Hat, Alta.	6
CFCR	Kamloops, B. C.	4
CHBC-TV	Kelowna, B. C.	3
CBUT	Vancouver, B. C.	2
CHEK-TV	Victoria, B. C.	6
CFLA-TV	Goose Bay, Labrador	8
CKX-TV	Brandon, Man.	5
CBWT	Winnipeg, Man.	4
CKCW-TV	Moncton, N. B.	2
CHSJ-TV	St. John, N. B.	4
CJOX-TV	Argentina, Nfld.	10
CFSN-TV	Stephenville, Nfld.	8
CJON-TV	St. John's, Nfld.	6
CBHT	Halifax, N. S.	3
CJCB-TV	Sydney, N. S.	4
CKVR-TV	Barrie, Ont.	3
CKSO-TV-1	Elliot Lake, Ont.	3
CHCH-TV	Hamilton, Ont.	11
CKWS-TV	Kingston, Ont.	11
CKCO-TV	Kitchener, Ont.	13
CFPL-TV	London, Ont.	10
CKGN-TV	North Bay, Ont.	10
CBOFT	Ottawa, Ont.	9
CBOT	Ottawa, Ont.	4
CHEX-TV	Peterborough, Ont.	12
CFPA-TV	Port Arthur, Ont.	2
CJIC-TV	Sault Ste. Marie, Ont.	2
CKSO-TV	Sudbury, Ont.	5
CFCL-TV	Timmins, Ont.	6
CBLT	Toronto, Ont.	6
CKLW-TV	Windsor, Ont.–Detroit (Mich.)	9
CKNX-TV	Wingham, Ont.	8
CFCY-TV	Charlottetown, Prince Edward Island	13
CKRS-TV	Jonquiere, Que.	12
CBFT	Montreal, Que.	2
CBMT	Montreal, Que.	6
CFCM-TV	Quebec City, Que.	4
CKMI-TV	Quebec City, Que.	5
CJBR-TV	Rimouski, Que.	3
CHLT-TV	Sherbrooke, Que.	7
CKCK-TV	Regina, Sask.	2
CFQC-TV	Saskatoon, Sask.	8
	Mexico	
XEJ-TV	Juarez	5
XEM-TV	Mexicali-El Centro Calif.	3
XEW-TV	Mexico City	2
XHGC-TV	Mexico City	5
XHTV	Mexico City	4
XHNL-TV	Monterrey	2
XEQ-TV	Paso de Cortes	9
XEX-TV	Paso de Cortes (Altzomoni)	7
XEZ-TV	Queretaro	3
XETV	Tijuana	6
	Chihuahua	11

Robert Seybold displaying photos of some dx TV stations he has logged.

1957, at 1900 CST, with the logging of the YVLV relay on channel 9 from Maricarbo, Venezuela, by dx-er Bobby Grimes in Little Rock, Ark. Two hours later, an old pro, Bedford Brown of Hot Springs, Ark., logged the channel-9 station, along with reception from Venezuela on channels 2, 4 and 5; Brazil on channel 2 and Argentina on channel 3.

A triple-hop channel-5 E-skip logging is noted in the report of Mrs. Doris Johnson of Longview, Wash. She reports a verification in writing for her reception of WORA, channel 5, Manaquez, Puerto Rico, at 1914 PST, on July 21 of last year—the distance, a neat 3,650 miles. Being a West Coast dx-er, I checked my log for this date and found a weird notation for 1720 hours on channel 3—a Japanese movie with Spanish subtitles! What you don't run into during a bang-up opening!

Total champs

Hitting closer to home, we find that the magic number of 300 stations logged has been achieved by two dx-ers. 1956's feature dx-er, Bob Seybold of Dunkirk, N. Y., now rests at 312 stations logged, after 5 years of tireless efforts and fighting local stations on channels 2, 4, 6, and 12 plus many grade-B signals on all vhf channels in most every direction. Bob's location may be fine for watching any number of different programs, but all those locals don't do much for dxing!

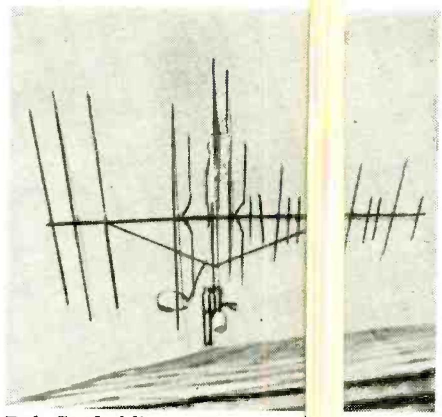
Our second over-300 man is the fellow who has been pushing Bob Seybold the greater part of the way, Bedford Brown, of Hot Springs, Ark. Bedford has made history by logging up to 76 stations in a single 24-hour period. Last year, July 24, 1956, to be exact, Bedford broke all existing short-term dx records by logging 89 skip stations and a total of 116 stations in a mere 24-hour period! Bedford's new station total is 326 TV stations logged in 5 years of dxing from Hot Springs.

Perhaps nothing stands out more than the fairly constant number of members in the Over 50 TV Dx Club. You would think that, with television dxing always on the rise as a hobby of wide acceptance, the numb of dx-ers listed would increase by aps and bounds each year. Unfortun ly, dx-ers get a little careless and neg t to keep me informed on current t ls. So, if you have a station total of er 50 and are actively engaged in dxi why not get into the regular monthl reporting habit (using RADIO-ELECTR CS report forms, of course) and join e RADIO-ELECTRONICS TV dx group.

In studying the dx repo for last spring, I noticed a tenden for long-distance east–west E-lay skip in northern latitudes during e heavy aurora sessions. The sign usually have violent fading rates, wi multiple-path characteristics evid in the video. Dx-ers should be on e lookout for such E-skip openings du g aurora displays this spring, repo g in detail any observations.

We are in the middle of e winter E-skip season. This seasor ften provides several good opening ccurring for the most part in the e afternoon and early evening h . In the past three years, the first d fourth weeks of January and t first few days of February have b best for E-skip openings.

During October, E-skip appeared with three good openings o Western areas during the first thr weeks of the month. This may indic that the level of E-skip will be high roughout the winter period (Octo through March).



Bob Seybold's receiving an a can be raised to about 60 feet above e ground.

Over 50 TV Dx Club

Observer	Location	Station Total
Bedford Brown	Hot Spri Ark.	326
Bob Seybold	Dunkirk Y.	312
Art Collins	Buffalo, .	260
B. H. Rauch	Peoria, I	239
Ed Bourgeois	Norco, I	230
Jerry Don Burch	Hot Spri Ark.	219
Frank Hill	Gallipoli io	217
Ross Brown	Tupperv Ont.	217
King Schafer	Kenmor Y.	216
Carl Lupton	Shelbyvi Ill.	214
John K. Bettersworth	State Co , Miss.	201
Ray Escoffier	New Orl . La.	195
Don Roller	Fort Wa Ind.	193
Ed Rugel	Indepen , Kan.	181
Clarence Rareshide	New Orl . La.	180
Edwin Shorey	Derby,	173
David Janowiak	Milwau Vis.	166
Paul Swartz	Gibsonb Ohio	164
Don Middleton	Sanford	156
Bill Eckberg	Walnut,	156
Bob Cooper	Fresno,	155
B. J. Bingham	Festus,	153

Bedford Brown leads the TV dx list (326 stations).

Francis E. DeGroat	Salamanca, N. Y.	136
Norman Erint	Kenmore, N. Y.	134
Al Caldwell	Brockton, Mass.	124
Larry Vehorn	Speedway, Ind.	119
W. J. Owen, Jr.	Springfield, Ohio	114
Bill Kraeb	Kewaunee, Wis.	112
Walker Ray	Baton Rogue, La.	112
Billy Meers	La Grange, Ky.	110
R. H. Gordon	Harrisburg, Pa.	110
Dibrell Ingram, Jr.	Cannay, Miss.	109
Percy Cox	Visalia, Calif.	105
Bobby Grimes	Little Rock, Ark.	104
Grant D. Ross	Marathon, Ont.	104
John Parillo	Girard, Ohio	101
J. W. Collier	Kilmarnock, Va.	100
Bob Martin	Girard, Pa.	95
Carlon Howington	Uniontown, Ohio	95
George Leach	Tampa, Fla.	89
Doris Johnson	Longview, Wash.	86
Dick Mason	Menasha, Wis.	86
Tom Ross	W. Liberty, W. Va.	80
John Comstock	Shelbyville, Ind.	79
Kenn Cooper	Fresno, Calif.	79
Dennis Smith	Wasco, Calif.	79
Morris Foote	Middleton, Idaho	77
James Howarth	Worcester, Mass.	76
Ed Hepp	Portland, Ore.	72
Eddie Albright	Medford, Ore.	69
Wayne Plunkett	Toronto, Ont.	66
John Black	Moffat, Ont.	65
Gary Ochlenschlager	Sebaka, Minn.	65
Denny Cline	Eastport, Me.	64
Al Kopec	Himrod, N. Y.	64
Ray O'Rear	Zillah, Wash.	64
Benjamin Tobin	Mattapan, Mass.	63
Dan Samuels	Mt. Vernon, N. Y.	63
A. Reise	St. Louis, Mo.	62
Alan Livingston	Tulsa, Okla.	61
Jim Dillon	Regina, Sask.	60
Ronald Boyd	Truro, Nova Scotia	58
Ed Davis	Champaign, Ill.	54
Arthur Cordts	Norfolk, Va.	54
David Beal	Tucson, Ariz.	54
Carl-Richard Kassabian	Reedley, Calif.	53
Michael Holley	Genesco, Ill.	53
Ghislain Girard	Arvida, Quebec	53
J. W. Collier	Arlington, Va.	51
Richard Gagnon	Royal Oak, Mich.	50
George S. Dunvant	Fancy Farm, Ky.	50

TV dx report forms

Once again the TV Dx column of RADIO-ELECTRONICS offers free of any charge TV dx report forms for use in reporting TV dx loggings to the column. You may obtain your set of forms by merely sending your name and address to TV Dx Column, RADIO-ELECTRONICS, 154 W. 14 St., New York 11, N. Y. END

COLOR BLIND?

By Jeanne DeGood

It's often been said
(And I guess it is true)
That roses are red
And violets blue.

But roses are blue
When they're seen on my screen,
For my color TV
Installer was green.

TV Service Clinic

I HAVE received many inquires asking "Which color-bar generator should I buy?" This question cannot be answered with "Buy the new Super Chromonator, it does everything." So rather than tell you which to buy I will describe the features of four types of color bar generators and leave the selecting up to you.

1. The simplest color signal generator is a sidelock instrument operating at 3.570545 mc minus 15,750 cycles. In the simplest instruments, the sidelock oscillator and the picture-carrier oscillator are free-running. In spite of the simplicity and lack of accuracy of such instruments, certain color servicing jobs can be done quite well with them. Adjusting the quadrature transformer is one of these jobs. However, in numerous other tests, such a generator leaves much to be desired.

2. The next more elaborate and expensive type of color generator is a sidelock oscillator with crystal control. Horizontal sync pulses are provided. These features greatly improve the accuracy of the instrument and make additional practical applications possible. This type of instrument is often packaged with white-dot and cross-hatch facilities. Thus, the instrument is sufficiently complete for installation work, and is compact and portable. However, it leaves something to be desired for bench work. As in the case of 1, the color pattern is a color-difference spectrum, comprising hues which gradually merge from one tone to another. The display is dominated by reds, greens and blues. All the hues are dim and bluish with respect to true saturated colors. One color may possibly be made normal, in some cases, by careful adjustment of the brightness control.

This type of instrument is useful in some types of bench work, such as adjustment of quadrature, check of chroma-channel gains and adjustment of the afc balance control, etc.

3. Keyed sidelock generators are also color-difference generators, though usually referred to as color bar generators. They are similar to 2, except that a multivibrator is used to key up the rainbow pattern into a number of bars (usually 10). The instrument is often called a color simulator. The signals are crystal-controlled, and accurate with respect to frequency. Each of the 10 bars is an approximation to an NTSC chroma phase, such as (R − Y), (B − Y), (G − Y), I, Q, etc. However, these are only practical approximations as the sidelock signal is changing from point to point. It is for this reason that such instruments are also referred to as linear phase sweeps. The keyed patterns make the instrument much more useful in bench work, because the chrominance axes can be identified with practical accuracy. Conclusive tests of synchronous detection and matrixing can be made with a keyed rainbow pattern. This type of generator often provides a sound sideband and an overload check, which makes it a runner up to the complete color generators.

4. The NTSC type of color bar generator—which provides 100% saturated true colors, with provision for saturation control and signal selection—is the most useful generator for general color service work. This type is expensive, but it also provides a large variety of basic color signals, either separately or in combination. A simultaneous display of the primary and complementary colors with white and black is useful in overall receiver checks as well as for checking delay lines, matrixing, color-subcarrier traps, cross-talk, burst gating and chroma detector operation (see Fig. 1). Individual color-difference signals with accurate phases are also provided, such as I, Q, (R − Y), (B − Y), and others. The (R − Y) and (B − Y) signals are usually available in combination, as well as separately. The bar widths are made unequal to provide identification during signal-tracing procedures. However, you will find that while some of the elaborate generators provide signals which are within the NTSC specifications, lower-priced instruments in this category may provide individual color fields in which the brightness component is constant for all colors. This simplifies the generator's construction, but does not provide signals within the NTSC standards of hue or saturation.

Still more elaborate color bar generators are available for laboratory use, but their price is prohibitive for most service shops.

Larger screen

I have an Emerson 686B with a 17CP4 metal picture tube. I would like to replace the 17CP4 with a glass tube such as a 19EP4 or a 19JP4. High voltage measures approximately 12,500. —C. B., Beckley, W. Va.

As your first step, make sure you have enough room for the larger tube in the cabinet. I would choose the 19JP4 as a better replacement for a 17CP4 than a 19EP4. The 19JP4 operates at a lower voltage, and your high-voltage value of 12,500 would be marginal for the 19EP4. The ion trap from the 17CP4 can be used on the 19JP4 and the flyback transformer will not have to be replaced. The 19JP4 is 2 inches longer that 17CP4, and the yoke will have to be moved back 2 inches. The same yoke can be used however. The mask, of course, will have to be replaced.

Horizontal pulling

I have a converted RCA 630TCS chassis in the shop that shows horizontal pulling whenever straight vertical lines are present in the background. If there is a closeup shot, the horizontal pulling straightens out and the lines are no longer wavy. Voltages and resistances check OK. I have replaced several coupling capacitors in the sync circuits. Do you have some suggestions? —A. R. H., Salem, Mass.

The condition of the large electrolytic capacitors in this receiver should be checked. Measure the capacitance values and power factors to see if they are up to par. Don't forget also to check for leakage between sections of the multiple units. Replace any substandard capacitors, and the horizontal pulling will probably clear up. I

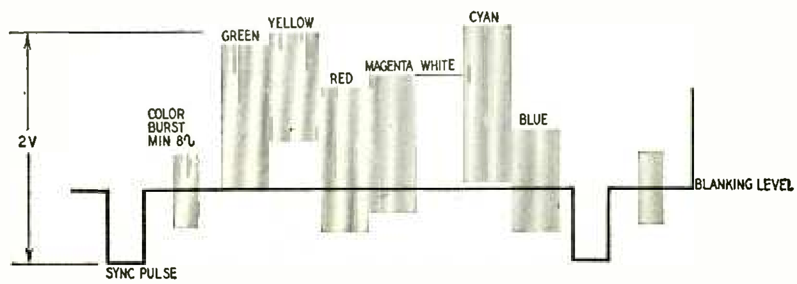


Fig. 1—Video waveform from an NTSC type of color bar generator which provides 100% saturated colors. This is the waveform of the simultaneous bar display.

suspect that you will also observe that interlace is poor and a vague and poorly defined tracery shifts through the background of the picture. It is caused by cross-talk among receiver sections, due to failing common electrolytics.

Sync buzz

I have been working on a Philco 22B4402, code 140, run 194, with sync buzz. Tubes, sound if alignment and video have been checked. By varying the volume control midway, the buzz can be heard very faintly. When the control is advanced, the buzz increases. —J. S. T., Brooklyn, N. Y.

This trouble is evidently due to an overload in either the if or video amplifier. You may have a marginal agc fault in the if system. This can be checked by operating the receiver from a battery and potentiometer dc bias source. If the receiver does not buzz when the if amplifier is operated from fixed bias, look for agc trouble. This difficulty may also be due to a leaky coupling capacitor in an if stage. There is a lesser possibility that the charging capacitor in the sound detector circuit does not have sufficient capacitance.

Burning flyback

The high-voltage section of the flyback in a Sylvania 533-2 has burned out and, since a replacement could not easily be obtained, it was rewound. The resistance of the rewound portion is 500 ohms, as per the schematic. But 3 minutes after the set was turned on, this section began to overheat. I get a picture even though the flyback is smoking and have run the set 2 hours with an electric fan at the back. The picture is short 2 inches in width and the width control has no effect.— A. L. G., Manila, P. I.

Rewinding the high-voltage section of a flyback transformer is a tricky job. The winding must be arranged to minimize the distributed capacitance of the coil and to avoid stray resonances. The smoking which you observed is probably caused by excessive circulating current in the winding due to stray resonance. Part of the winding is probably tuned by stray capacitance to 15,750 cycles and operates like a tuned secondary coupled to a primary coil—the circulating current is as many times greater than the line current as the Q of the section is greater than unity. The fact that the picture is short 2 inches means that the output voltage from the winding is excessive (which causes the electron beam in the picture tube to become "stiffer"), or it may mean that you have one or two shorted turns in the winding, which consume power. Resonant effects can result both in a resonant rise of voltage and excessive power consumption due to losses in the section with heavy circulating currents. Inasmuch as the width control has no effect on picture width, it would seem that the portion of the winding across which the control is connected contributes little to the power output—this again could easily be caused by disturbed coupling and stray resonances in the rewinding job. It would be advisable to wait for a replacement transformer from the factory.

There is also the possibility that there is nothing wrong with the high-voltage winding and that whatever caused the original winding to burn out is affecting the one you have wound. If current through the flyback is excessive (over 100 ma, measured at the cathode of the horizontal output tube), even a new factory-built flyback may not fix the set and you should look for trouble elsewhere.

Vertical-retrace blanking

Please show a basic circuit for adding a vertical retrace blanking circuit that will be usable on most TV receivers?— V. A. MacR., Franklin, N. Y.

A retrace blanking pulse can be obtained from the yoke, vertical output

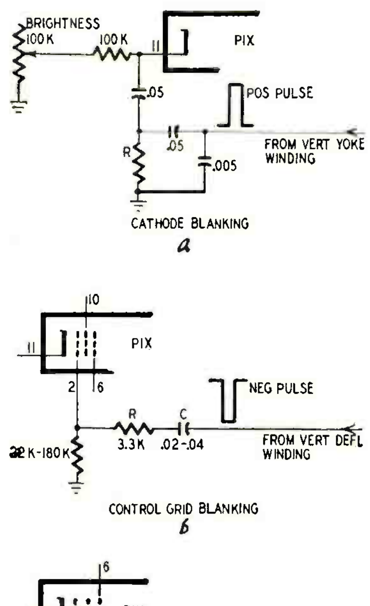


Fig. 2—Three methods of adding vertical-retrace blanking to a TV receiver: a—cathode blanked; b—control grid blanked; c—grid 2 blanked.

transformer or the vertical oscillator. A negative pulse is usually applied to the grid of the picture tube for blanking retrace. Suitable arrangements are shown in Fig. 2. Vary R and C for best blanking.

Tube plate running red

In some RCA, Admiral and Crosley receivers, I have found an occasional problem of overheating of the plate of the horizontal output tube. The 6BG6, 6CD6 or 6DQ6 will show a red-hot plate and tube substitution will not correct the trouble.

The set owners did not wish to have the chassis pulled because they figured that, as long as the receivers are working, there is nothing to worry about. What do you suggest?—J. T., East Chicago, Ill.

In response to your inquiry, the most likely cause of overheating of the plate in a horizontal output stage is too low bias on the grid of the tube. Low bias can result from a leaky coupling capacitor to the grid of the tubes, and it can also result from insufficient drive to the grid. Insufficient drive can result in overheating of the plate because most, if not all of the grid bias for the horizontal output tube is signal-developed bias. In other words, the sawtooth signal overdrives the grid into grid current and the drop of this current through the grid leak provides the necessary grid bias.

The service notes for the receiver will usually give the correct grid-bias voltage, and you can easily make a check with a vtvm to determine whether the grid bias is up to par.

Correction

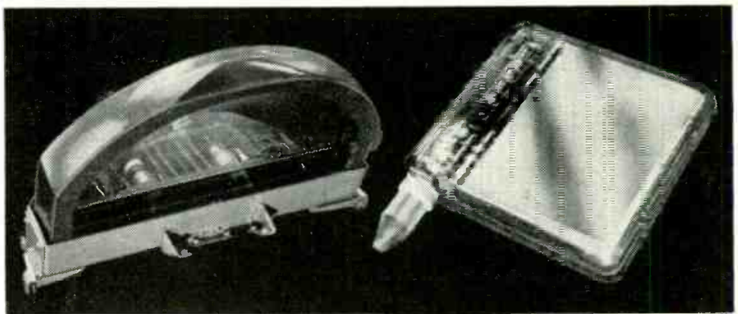
The conversion described in the September issue of RADIO-ELECTRONICS *is quite timely. I have an RCA T120 on my bench which has been converted to a pentode tuner. Two tuners have failed to give satisfactory operation, probably because the impedance matching was not observed. In regard to the instructions noted above, why do you add a third 27.25-mc trap? Was that a misprint, and did you intend to add a 19.75-mc series trap?—W. L. J., Pasadena, Calif.*

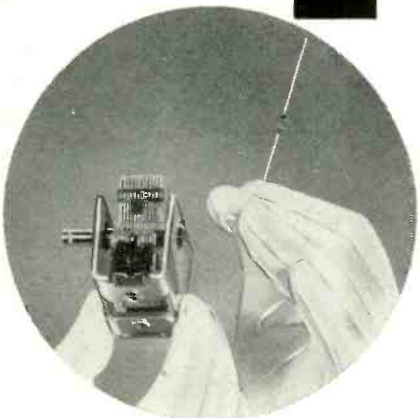
I congratulate reader W. L. J. on his 20–20 vision. The trap marked 27.25 mc in Fig. 1 should have been marked 19.75 mc. This is my error. The impedance of the plate output circuit of the tuner must be approximately the same as the input impedance to the grid of the first if amplifier, or energy transfer will be inefficient. An impedance match can be obtained with somewhat simpler conversions than shown. However, the if response will suffer more or less in bandwidth, which lowers the quality of picture reproduction. The RCA T120 is a wide-band receiver, which is capable of reproducing fine picture detail when the if response is properly maintained. In providing instructions to our readers, we always assume that the customer demands top performance from the receiver. END

NEXT MONTH

Sync Buzz

what's new?

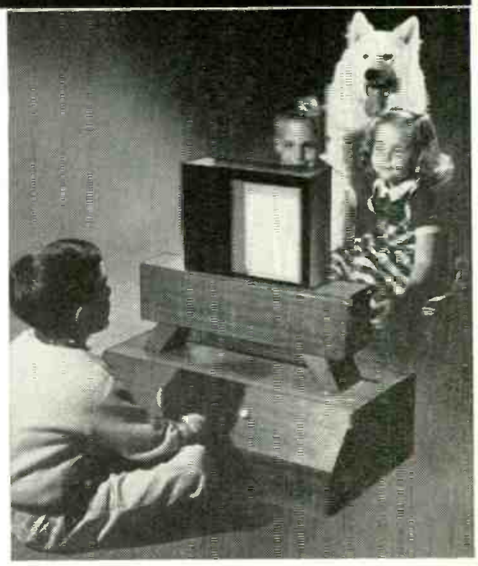




VARICAP CAPACITOR, a tiny electronic component, no larger than a teardrop, can automatically observe and maintain color fidelity in a color TV picture and perform many other functions. It is made by Pacific Semiconductors, Inc., Culver City, Calif.

The unit is a member of the solid-state device family, which includes transistors, semiconductor diodes and rectifiers. Its capacitance is varied by changing an applied bias voltage.

In one application the Varicap, a resistor and a mica capacitor replace 24 components. The photo shows a comparison between the Varicap and a standard variable capacitor which it might replace.



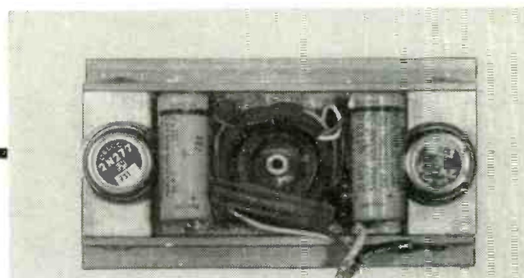
FLAT TV TUBES are foreshadowed by these transparent-screen types already in pilot production for experimental military use. Invented by William Ross Aiken, these follow the same fundamental principles as the flat tube described in this magazine, March, 1957. The electron beam, instead of starting at the back and curving up again behind the face, is injected at the bottom edge. It travels along the bottom, which is coated with a row of deflection plates. By controlling the voltage on these plates, it can be deflected up at any point. Another (transparent) set of plates on the back wall turn the rising beam ahead against the screen at the desired point. These two sets of plates sweep the beam as did the deflection plates in early TV receivers, or the coils in modern ones.

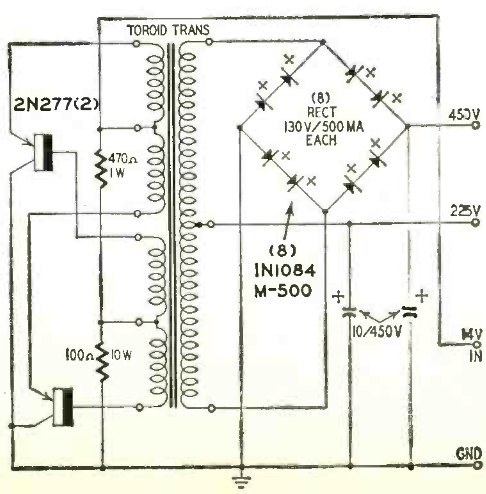
According to officials of the Kaiser Aircraft and Electronics Corp., which developed the tube, refinements in the glass envelope may be all that is needed to make picture-on-the-wall TV a reality, though they feel it is still "a long way from commercial application." One of the photos shows a standard rectangular tube and a transparent-phosphor model which fits into an airplane's windshield. The other is a pictorial prediction of the two-sided TV set of the future.

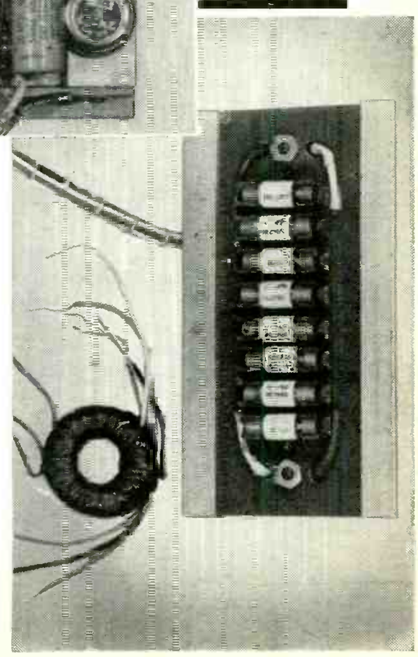
TOROID TRANSISTOR POWER SUPPLY simultaneously delivers 225 and 450 volts dc from a dc input of 12 or 24 volts. Its maximum output power is 90 watts (transmitter intermittent operation), 40 watts continuous. The compact unit fits into a 2 x 2 x 4-inch case and could move the amateur's power supply from the trunk to the glove compartment. The completely silent electronic operation is a boon to those irritated by the annoying whine of a dynamotor or hum of a vibrator.

The unit is designed around a special toroid transformer built by Sunair Electronics Inc., Ft. Lauderdale, Fla., (who also developed the circuit). The diagram shows the circuit, which uses two Delco power transistors and eight of the new Sarkes Tarzian cartridge rectifiers. The photos show the parts layout.

All rectifiers are mounted on one side of a bakelite board. On the opposite side are placed all other competents. Transistors are mounted on brass heat dissipators. The Sunair model uses a printed-circuit board, but it is not a must.







WIEN-BRIDGE ANALYZER

This third article in a series on audio testing describes a distortion analyzer with a Wien-bridge filter for a heart

By L. B. HEDGE

The completed distortion analyzer.

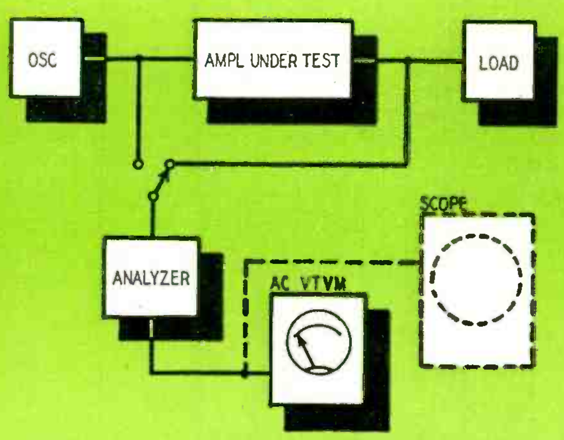


Fig. 1 — Block diagram of harmonic distortion test setup.

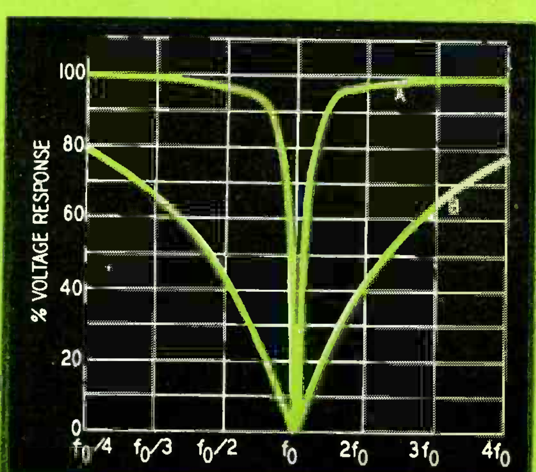


Fig. 2—Notched filter response; a—Wien-bridge with feedback amplifier; b—Wien-bridge without feedback amplifier.

To measure harmonic distortion three instruments are needed. An audio oscillator (see "Extended Range Audio Oscillator," page 36, December, 1957), an audio vtvm (see "An Amplifier–Rectifier Vtvm for Audio Testing," page 53, October 1957), and a distortion analyzer. An oscilloscope will help, but is not absolutely necessary.

A single-frequency signal from the oscillator is fed to the amplifier under test. The analyzer is connected to the amplifier's output, and the audio vtvm is connected to the output of the analyzer (see Fig. 1). The signal from the generator is amplified and the amplified signal fed to the analyzer, along with any harmonics produced in the amplifier. In the analyzer the fundamental generator signal is removed. The remaining signal, consisting of harmonics of the input signal, passes through the analyzer and is measured with the ac vtvm (and oscilloscope if one is available).

The distortion analyzer is basically a tunable filter. While many tunable filters are easily built, they tend to attenuate the harmonics of the filtered frequency as well as the fundamental frequency, which is exactly what we don't want to do. However, the notch in the filter's frequency response can be sharpened by building the filter network into the feedback loop of a high-gain high-negative-feedback amplifier. Fig. 2 shows the relative response of the network used in the Wien-bridge analyzer described in this article. Curve *a* shows its response with a feedback amplifier and curve *b* shows response without a feedback amplifier. The difference is obvious.

The analyzer circuit is shown in Fig. 3. It consists of two high-gain amplifier circuits (V1-a, V2-a), a phase-inverter–driver (V1-b) for the Wien-bridge filter with a switch (S2) for selecting the FILTER or the (filter) FREE channel for the circuit, and a cathode-follower output and feedback coupling stage.

Fig. 4 is a simplified diagram of the Wien-bridge filter circuit used in this analyzer. It represents the filter circuit with S1 of Fig. 3 in the position shown. When the bridge is balanced for some particular frequency, say 100 cycles, only signals whose frequency is above or below 100 cycles will be passed by the filter network. When a Wien-bridge is at resonance, the output at the resonant frequency is zero.[1]

Precise balance of the filter requires that the ratio between E1 and E2 be accurately adjusted. (E1 is the output

[1] F. E. Terman, *Measurements in Radio Engineering*, first edition, McGraw-Hill, 1935; page 136.

from the plate of V1-b; E2 the output from its cathode.) As it is not practical to make this an automatic adjustment, COARSE (R10–R11) and FINE (R12), BALANCE controls are provided to control E1. The adjustment range is wide enough to correct for minor capacitor (C3, C4) tracking error and resistor (range-resistor) mismatch.

Design demands

Designing the analyzer to provide a satisfactory filter notch and a minimum of distortion within the analyzer, requires a high-gain amplifier loop and large negative feedback so that the product of the loop gain and the feedback factor will be much larger than 1.[2]

The triode-amplifier stages (V1-a, V2-a) provide a gain of approximately 200, and with the feedback factor

$$\frac{R17}{R17 + R3 + R4} = \frac{10{,}000}{10{,}000 + 8{,}590} = 0.55;$$

the analyzer's overall gain—when S2 is in the FREE position, or in the FILTER position with the input frequency an octave or more away from the filter's balance frequency—is approximately 1.8.

The one R-C coupling (R6–C2) in the feedback loop provides a minimum phase shift, which is further reduced by the secondary feedback loop, R7 between V1-a and V1-b. This combination makes the unit inherently stable and insures low distortion in the analyzer.

Since distortion above 20,000 cycles is of little importance in audio amplifiers, this unit is designed to operate between 15 and 10,000 cycles. (Harmonics of signals above 10,000 cycles are higher than 20,000 cycles, the extreme upper limit of human hearing.)

Values for the R13, R14, etc., range resistor series are selected to provide substantial tuning-range overlaps.

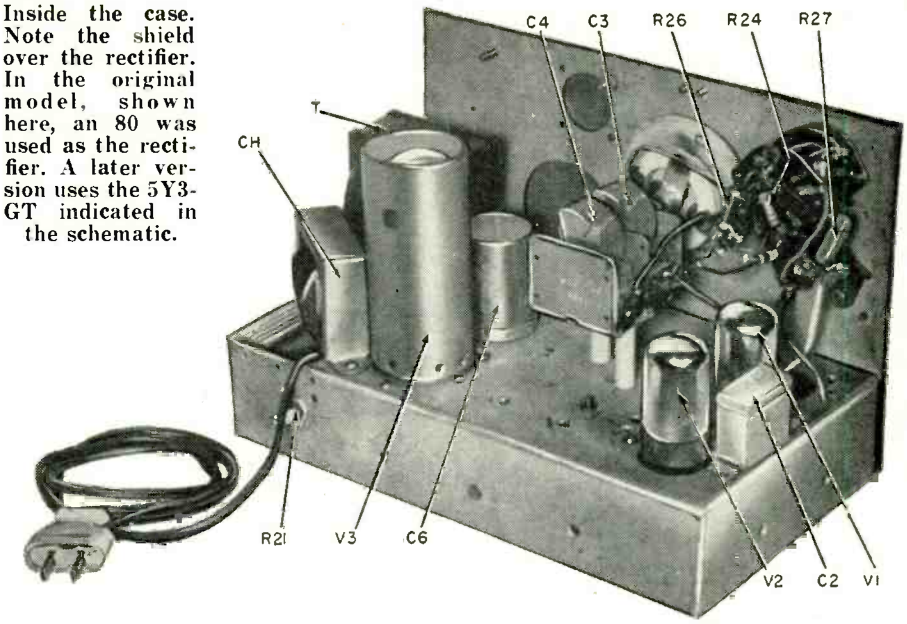
Mounting the twin capacitor on standoff insulators—to keep it as far as practical from the chassis and cabinet—reduces tracking errors due to variable stray-capacitance effects.

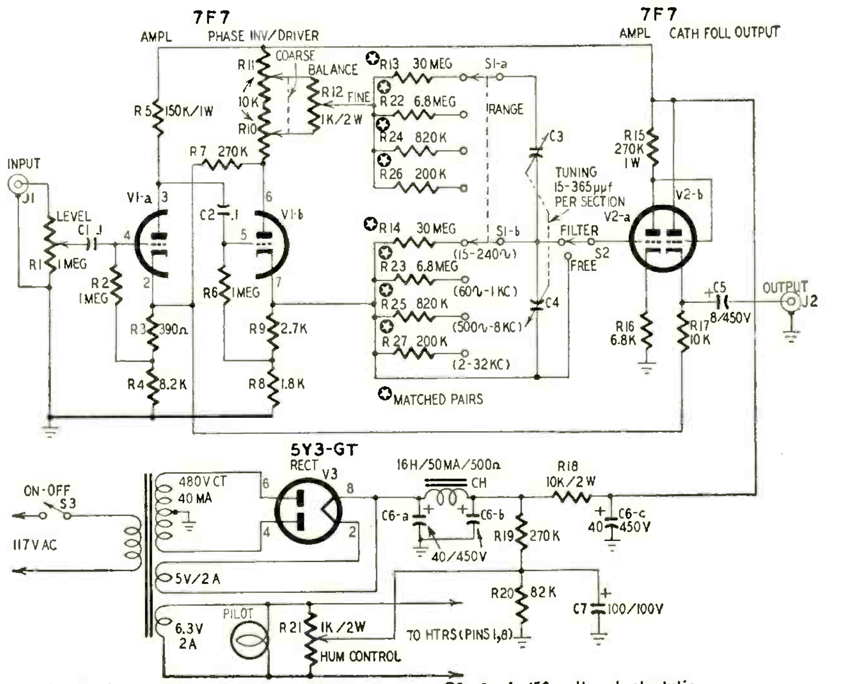
Range resistors should be matched in pairs as accurately as possible. If a bridge or other resistance balancing equipment is not available, precision resistors (2% or better) should be used. The exact values of these resistors are significant only in determining the frequency ranges, but close matching of the corresponding pairs is a real factor in providing satisfactory performance. This may not be immediately obvious, in view of the balance adjustment included in the analyzer, but it should be noted that, if the E1/E2 ratio changes from say 2.0 to 2.4 between two values of f_o, E_{out} will move in the direction of E1 rather than E2 as the unit is tuned from the first to the second frequency. Since E1 is 180° out of phase with E2, this will reverse the feedback phase, and oscillation will start! Close matching of resistors R13 and 14, R22 and 23, R24 and 25 and R26 and 27 and restriction of the C3, C4 range to its high-capacitance end will eliminate this effect, although oscillation can be started over most of the tuning range by incorrect setting of the balance controls.

Aside from these special elements of design and construction, the only critical element in the construction and alignment of the distortion analyzer is the elimination of hum. A grounded metal shield is placed around the rectifier tube to avoid hum transfer to the tuning capacitor by the electrostatic field which surrounds the tube.

[2] G. E. Valley and H. Wallman, *Vacuum-Tube Amplifiers*, Vol. 18, MIT Radiation Lab Series, McGraw-Hill, 1948.

Inside the case. Note the shield over the rectifier. In the original model, shown here, an 80 was used as the rectifier. A later version uses the 5Y3-GT indicated in the schematic.





R1—pot, 1 megohm
R2, 6—1 megohm
R3—390 ohms
R4—8,200 ohms
R5—150,000 ohms, 1 watt
R7, 19—270,000 ohms
R8—1,800 ohms
R9—2,700 ohms
R10, 11—twin pot, 10,000 ohms
R12, 21—pot, 1,000 ohms, 2 watts
*R13, 14—30 megohms
R15—270,000 ohms, 1 watt
R16—6,800 ohms
R17—10,000 ohms
R18—10,000 ohms, 2 watts
R20—82,000 ohms
*R22, 23—6.8 megohms
*R24, 25—820,000 ohms
*R26, 27—200,000 ohms
All resistors ½ watt unless noted
C1, 2—0.1 μf, 200 volts
C3, 4—twin variable, 15-365 μμf (Lafayette MS 142 or equivalent)
C5—8 μf, 450 volts, electrolytic
C6—40–40–40 μf, 450 volts, electrolytic, can type
C7—100 μf, 100 volts, electrolytic
CH—16 h, 50 ma, 550 ohms (Lafayette 105-03 or equivalent)
J1, 2—coaxial connectors
S1—2-pole 4-position rotary (shorting)
S2—spdt toggle (shorting)
S3—spst toggle
T—power transformer: primary, 117 volts; secondary, 480 volts ct, 40 ma; 5 volts, 2 amps; 6.3 volts, 2 amps (Lafayette 100-01 or equivalent)
V1, 2—7F7
V3—5Y3-GT
Chassis, 10½ x 6¼ x 2 inches
Case, 10½ x 7 x 6½ inches
Pilot-light assembly
Sockets, 8-pin loctal (2)
Socket, 8-pin octal (1)
Knobs
Miscellaneous hardware
**Matched pairs, within 2% or better*

Fig. 3—Circuit of the three-tube distortion analyzer.

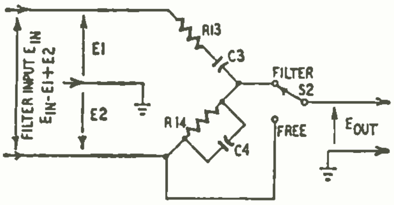


Fig. 4—Partial circuit shown Wien-Bridge analyzer filter.

Power-line leads must be kept away from the analyzer's amplifier loop circuit, and heater supply leads to the tubes should be twisted, laid close to the chassis and well spaced from the signal circuit elements. The bias network (R19–R20) places the heaters at higher potentials than the cathodes of the tubes, thus reducing heater–cathode hum leakage. R21 can be adjusted to minimize any hum which may get into the amplifier.

Final adjustment

When the analyzer is completely assembled, its tuning scales can be calibrated and its performance checked by connecting the oscillator to its input and its output to a vtvm (Fig. 1, input connection, amplifier and load omitted). Set the oscillator at a frequency in one of the analyzer tuning ranges, set S2 on the FREE position and adjust the LEVEL control (R1) to give a 1-volt reading on the vtvm. Switch S2 to the FILTER position and adjust the tuning capacitor to give a minimum voltage reading. Next adjust the COARSE balance control for minimum voltage reading and then readjust the tuning capacitor for minimum voltage. Next adjust the FINE balance control for minimum voltage and then again adjust the tuning capacitor for minimum voltage.

As these adjustments progress, the voltmeter range switch should be set to keep the meter needle somewhere in mid-scale, permitting accurate adjustment of the tuning and balance controls. When settings of the tuning and balance controls are reached which provide a voltmeter reading which increases with any change in either tuning or balance, the voltage reading will be 1/100 the percentage of harmonic content of the oscillator output (.01 volt = 1%; .006 volt = 0.6%), and the bridge will be tuned to the fundamental frequency (f_o) of the oscillator output.

R21 can be accurately adjusted by setting the oscillator to a frequency a few cycles off 60 cycles, and adjusting the analyzer tuning and balance controls as indicated above. If any hum is present in the output, the vtvm will show a fluctuating reading and R21 should be adjusted to reduce this fluctuation to a minimum. If the fluctuation cannot be eliminated by this adjustment, the hum may be present in the oscillator output and this setup can be used to check the heater potentiometer of the oscillator if it has one.

The calibration procedure should be repeated over a series of frequency values to provide calibration reference points on the tuning scales of the tuning capacitors.

A complete tuning-scale calibration is of little use since the scale is used only to provide an approximate initial setting of the tuning capacitors and final adjustment is made, as in the calibration procedure, to provide minimum voltage output reading with a given signal. On this analyzer I have five calibrated points on each range.

In application for checking harmonic distortion in an audio amplifier, connections are made as shown in Fig. 1. Provision should be made, as indicated, for connecting the analyzer input to the input and to the output of the amplifier. The harmonic content of the input and output signals should be checked without changes in the amplifier, amplifier load or oscillator adjustments between the two checks. The amplifier distortion is then determined, under the conditions and at the oscillator frequency of the test, as the difference between the percentage harmonic content of the output signal and the percentage harmonic content of the input signal.[3]

If an oscilloscope is available, it may be connected across the output of the analyzer—in parallel with the vtvm—where it will be of some help in reaching a quick balance and tuning adjustment of the analyzer. Specific applications of the oscilloscope to audio amplifier tests will be covered later in this series but, at any stage in these tests, observation of waveforms involved will be worth while. An oscilloscope provides a kind of visual perspective which is always helpful in interpreting the measurements and effects involved in the various tests and test procedures.

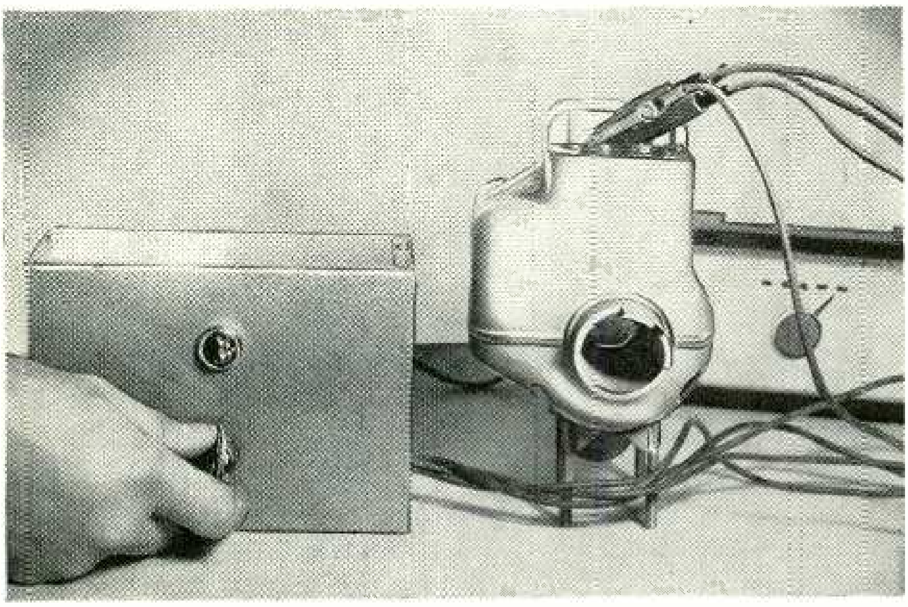
With the analyzer, oscillator and vtvm available, the first three basic tests[4] of af amplifiers—amplification (voltage and power gain), frequency response (amplitude distortion) and harmonic distortion—can be made directly. The changes in connections among the various units involved are, however, somewhat complicated. The next article of this series will cover the design and construction of a master control unit which will provide all of the necessary interconnections of the vtvm, oscillator, distortion analyzer and the amplifier under test. It will also include connections and controls for additional test units—an oscilloscope and an electronic switch—which will complete the test set up. Construction of the electronic switch and modifications to simple oscilloscopes to provide improved response, will be covered in future articles, which will also include a detailed analysis of test procedures and performance standards and specifications applicable to audio amplifiers. END

[3] RETMA Standard on Amplifiers for Sound Equipment (SE-101A), RETMA, Washington, D. C., 1949.

[4] L. B. Hedge, An Amplifier-Rectifier Vtvm for Audio Testing, RADIO-ELECTRONICS, October, 1957.

FIX THAT ROTATOR

By HOMER L. DAVIDSON



The rotator checker in use.

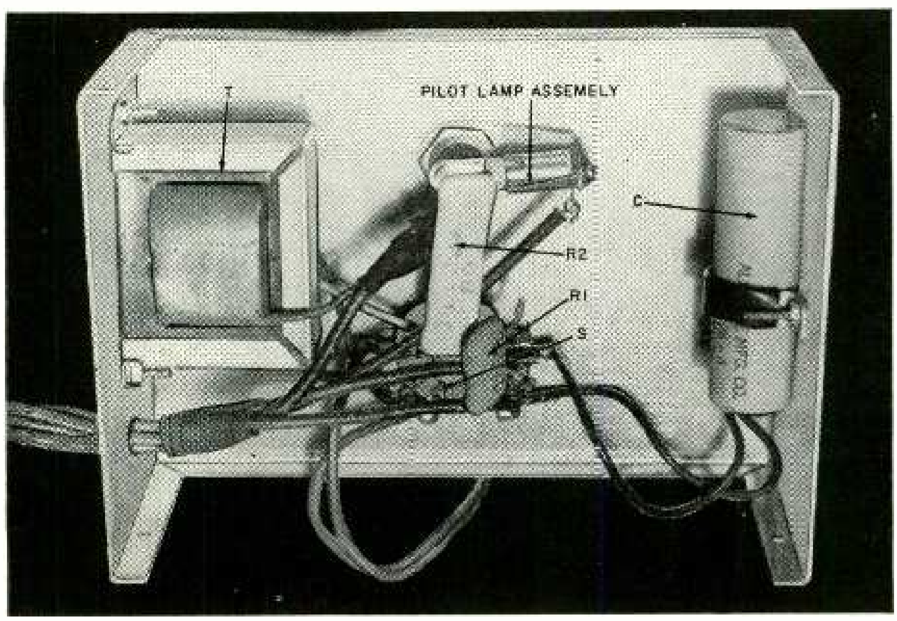
This "trained control box" makes rotator checking easier

THE instrument described in this article may be built with parts from an old rotator control box and will check at least 90% of all rotator motors.

When a service call comes in for a rotator repair, the technician picks up his tool kit, several rotator control boxes (if he doesn't know just which type is needed) and takes off. The customer usually doesn't know what kind of rotator she has or if it is an automatic or manual type. The technician must localize the trouble. Is it in the motor or the control box?

The old way to check a rotator is with a continuity tester such as an ohmmeter. With this rotator checker you can check cable continuity and the motor, and you can even turn the motor. Provision for checking the meter rheostat in the motor while in operation is included. If the rotator is the automatic type, the pulse relay switch and return lead can also be checked.

In a regular rotator hookup (see Fig. 1) the control switch is turned in the desired direction. This places an ac voltage across the power transformer's primary and completes the secondary circuit through an ac capacitor and one winding of the rotator's motor, causing the motor to turn in one direction. When the switch is pushed in the other direction, the transformer's output is applied to another winding in the motor and the rotator turns in the other direction. To indicate the direction in which the rotator is turning, a rheostat is placed in the motor housing so that its resistance varies with the position of



Inside the checker. Almost any kind of case can be used.

the antenna. A meter in the control box is wired into the circuit and provides a visual record of the direction in which the rotator and antenna are turning.

The rotator checker is essentially the same as the control box of an ordinary rotator. (See Fig. 2.) Since a meter is used in manual rotators and a relay assembly in automatic units, the tester employs a pilot light which serves as an indicator for both types. When checking we are not particularly interested in which direction the rotator is turning. We only want to know if it is turning. This job is handled best by the pilot lamp.

A No. 49 lamp is used. It is picked instead of the common No. 47 or 51 because it draws only 60 ma and will not cause the rheostat in the motor to run hot. Two 5-watt resistors, 200 and 75 ohms respectively, are connected in series to drop the voltage for the pilot lamp. By using the plain and black alligator clips on the checker, the pilot light becomes part of a continuity tester.

Rotator tests

When testing a rotator either in the home or on the workbench, the checker is hooked up according to a chart fastened to its case. (See Table I.) For example, when testing a Cornell-Dubilier-Radiant (C-D-R) TR-11 motor, the red clip is connected to terminal 1, yellow clip to terminal 2, plain clip to terminal 3 and the black clip to terminal 4. Turn the switch in one direction and, if the motor turns, the trouble lies in the control box. If the motor does not turn in either direction, it is defective. If the motor turns and the pilot lamp doesn't light, the trouble is in the rheostat in the motor, or the return cable from the rheostat is broken.

If the motor being tested is an automatic type, the pilot light will click on and off, according to the pulse switch in the motor. In fast-pulsing motors (as in the C-D-R automatics) the light will not be as bright as in a slower-pulsing motor. This is due to the difference in switching-time duration.

The tester's construction is very simple. A complete unit can be built into almost any type of case. Alligator clips are used for connections to motor terminals. The clips should be insulated to avoid shock hazards and shorts. Indicated colors do not have to be followed as long as there is some distinction between clips. If you use different colors, be sure to make corresponding changes in Table I.

This little unit has been used, tried and tested in the field where it has successfully licked many rotator problems.

The most common failures in antenna rotators are a defective rheostat in the motor assembly, wind breakage and poor automatic timing. When the control-box indicator (meter) does not work, the fault is usually an open rheostat in the motor unit. Run a continuity test to make sure the unit is defective

TABLE I

	Alliance Tenna-Rotor T12	Alliance Tenna-Rotor U98, U83	Brach, 54L, 54M	Channel-Master Golden Rotator	Cornell-Dubilier-Radiart TR-4, TR-11, TR-12	Cornell-Dubilier-Radiart AR-1, AR-2, AR-22	Crown CAR6A	JFD RT100 RT400	La Pointe VEE-D-X VB	RMS M55
Red	1	1	1	1	1	3	1	3	1	1
Yellow	2	2	2	2	2	4	4	4	2	2
Plain	3	4	4	4	3	2	2	2	3	4
Black	4	3	3	3	4	1	3	1	4	3

before pulling the motor. Pulling a motor is usually a lot of work so when it is unnecessary it should be avoided.

After the motor has been pulled, another test should be made before taking the unit apart. Replacement rheostats can be obtained from most jobbers or directly from the factory.

The motor assembly doesn't cause much trouble unless damaged by wind or struck by lightning. These small

break a wire or the wires may become grounded when the unit is installed. When placing the cover over the motor unit's terminals, be sure the rotator wire is in its proper place. Otherwise, the cover will bite into the wire and eventually short the motor unit. Another point to remember is never place a strap standoff over the rotator cable to hold it in place. The strap will cut into the cable insulation and eventually

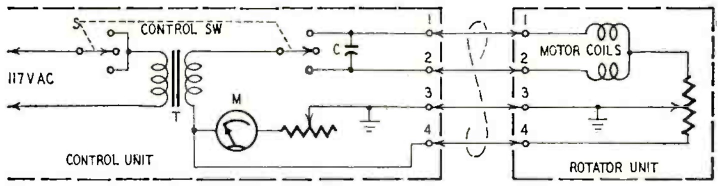
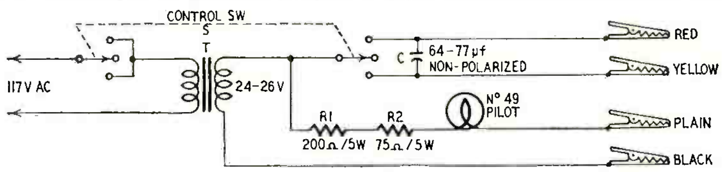


Fig. 1—Circuit of a typical rotator. Control and rotator units are shown.



R1—200 ohms, 5 watts
R2—75 ohms, 5 watts
C—64-77 uf, 60-cycle 65-volt ac type (Sprague AM-1108 or equivalent)
S—2-pole 3-position rotary, nonshorting (Mallory 3223J or equivalent)
T—rotator transformer; primary, 117 volts; secondary, 24-26 volts
Pilot-lamp assembly with No. 49 lamp
Alligator clips, insulated (4)
Case
Knob
Miscellaneous hardware

Fig. 2—The rotator checker can be made of parts from old rotator control boxes.

motors are practically trouble-free, though they can be burned out because of a defective control box. Whenever a motor is burned out, be sure that the control box has been checked.

Wind, customers, lightning

Wind is the most common cause of damage to rotator motors, especially if the unit isn't properly installed. Too large an antenna with a lot of wind resistance will strip the rotator's gears in a wind storm. A thrust bearing should be used to help support the antenna's weight and to prevent damage from constant rocking.

Many troubles are caused by the customer. He will almost invariably get an automatic control head out of time, but with a little instruction (the service technician's job) he can learn how to lock the unit in step. If this instruction is given when the unit is installed, you may save an unnecessary service call.

Occasionally a roator will stick, bind or move slowly while turning. This is generally caused by a misaligned thrust bearing or a binding floating guy ring. It should be promptly repaired as the added strain may damage the rotator's motor. Simply place a ladder alongside the rotator and align the unit while someone operates the control box.

There are times when the rotator cable causes trouble. The wind may

ground out the rotator. Either tape the rotator wires to the mast or use an insulated standoff to hold the wire securely. Most four-lead rotator cable will be held securely by ribbon-line standoffs. Control boxes often get knocked down and broken. New cabinets are available from jobbers. Switch contacts tend to become dirty and bent. Then they must be cleaned and straightened to restore normal operation. When lightning strikes a rotator, the control box is often damaged. A lightning arrester placed on the rotator cable provides some protection but does not always save the rotator unit. END

"You're pulling in a strong station from Australia, mam."

all-transistor DIRECT-READING AF METER

Portable four-transistor unit gives direct readings on a 1-ma meter

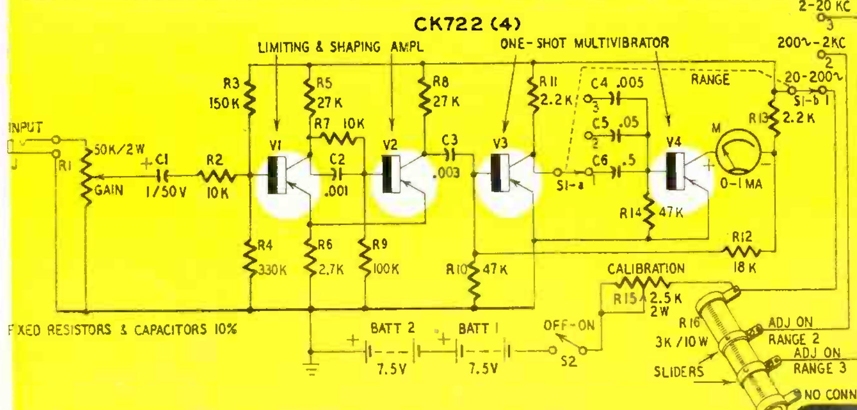
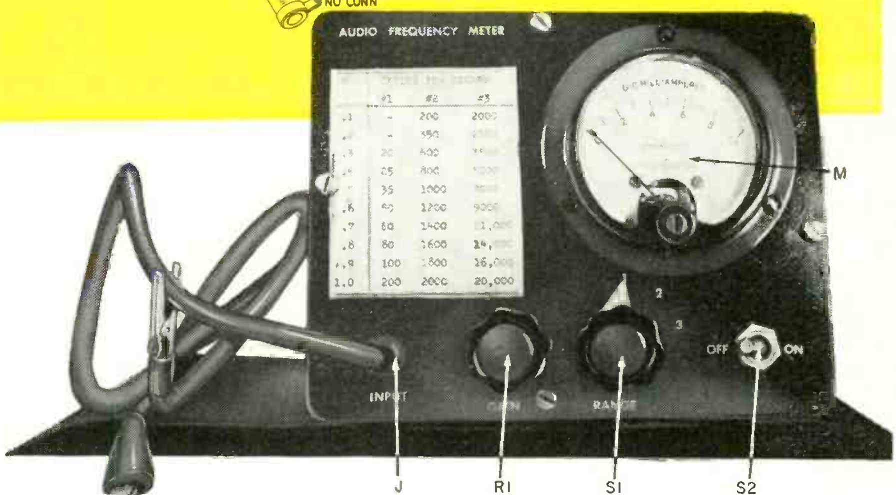


Fig. 1—Circuit of the all-transistor frequency meter.

by DAVID STONE



The completed test unit.

A DIRECT-READING audio-frequency meter is worth it's weight in gold when you have to measure unknown audio frequencies, test or calibrate audio oscillators or measure audio beat notes. In addition, you can plug a microphone into the meter and check the frequencies of pitch pipes, tuning forks, piano strings, sirens or any other single-frequency sound-producing device. For greatest convenience, add portability and eliminate the need for supplying external power. The result is a valuable tool for audio-frequency testing, outdoors, in the shop or in the lab.

This all-transistor unit fills the requirements of portability, low battery drain, accuracy and sensitivity. It covers the entire audio spectrum in three ranges: 20 to 200, 200 to 2,000, and 2,000 to 20,000 cycles. It responds to 1 volt of audio signal, making it usable for most applications where low-level audio signals are measured. Nominally priced, noncritical components are used throughout. The entire instrument is self-contained and rugged enough for the roughest servicing use.

PARTS LIST FOR FIG. 1

R1—pot, 50,000 ohms, 2 watts
R2, 7—10,000 ohms, 10%
R3—150,000 ohms, 10%
R4—330,000 ohms, 10%
R5, 8—27,000 ohms, 10%
R6—2,700 ohms, 10%
R9—100,000 ohms, 10%
R10, 14—47,000 ohms, 10%
R11, 13—2,200 ohms, 10%
R12—18,000 ohms, 10%
R15—pot, 2,500 ohms, 2 watts
R16—3,000 ohms, 10 watts, wirewound, adjustable with 2 sliders
All resistors ½ watt unless noted
C1—1 μf, 50 volts, 10%
C2—.001 μf, 10%
C3—.003 μf, 10%
C4—.005 μf, 10%
C5—.05 μf, 10%
C6—0.5 μf, 10%
BATT 1, 2—7.5 volts (Burgess C5 or equivalent)
J—phone jack
M—meter, 0–1 ma
S1—2-pole 3-position rotary
S2—spst toggle
V1, 2, 3, 4—CK722
Chassis
Cabinet
Miscellaneous hardware

Circuit description

The circuit, shown in Fig. 1, uses four CK722 transistors operating in pairs. The first two, V1 and V2, are limiting and shaping amplifiers. They convert the incoming audio sine wave (Fig. 2-a) into sharply peaked trigger pulses (see Fig. 2-b). In addition, this transistor pair saturates and keeps the amplitude of the output pulses from V2's collector at a constant voltage level regardless of amplitude or frequency variations in the input sine wave. The net result, at the collector of V2, is an output which does not vary in amplitude, but whose frequency is identical with that of the input. A pulse is produced for each cycle of frequency. If the input frequency increases, the number of trigger pulses increases. If the incoming signal decreases in frequency, the number of pulses from V2 also decreases.

The second pair, V3 and V4, is arranged in a one-shot multivibrator circuit. This is a familiar resistance-coupled amplifier with feedback from V4's collector to V3's base. V3 is normally biased to cutoff and does not conduct until a pulse arrives from V2 to trigger the circuit and overcome the bias. V3 then conducts heavily and the resulting pulse is amplified by V4. When the pulse ends, V3 goes sharply back into cutoff and V4 stops conducting. The circuit is ready for the next pulse from V2.

The output from this pair is a series of amplified current pulses (see Fig. 2-c). The number of pulses is propor-

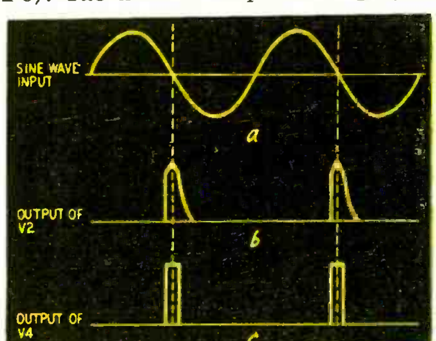


Fig. 2-a—Input waveforms; b—at output of V2; c—at output of V4.

tional to the frequency of the incoming audio sine wave at V1's input, and V4's collector current through the meter will deflect the meter needle higher for more pulses (a higher sine-wave frequency) and lower for fewer pulses (a lower sine-wave frequency). If you feed a known audio frequency into the unit and log the meter reading, you'll wind up with a standard by which unknown audio frequencies can be measured.

Since the circuit operates on a change of frequency, the coupling capacitor between V3 and V4 must be changed to allow the multivibrator circuit to operate over the 20–20,000-cycle frequency range. This is done with the RANGE switch. The unknown audio frequency's input level to V1 is controlled by the GAIN potentiometer.

Power requirements vary from 7 volts at 3 ma to 11 volts at 7 ma. The lowest range, 20 to 200 cycles, uses the higher voltage and current. A 15-volt battery pack, made from two series-connected 7.5-volt batteries, is used as the power supply and appropriate voltage-dropping resistors are selected by the RANGE switch to provide the correct voltage for each range.

A CALIBRATION potentiometer is inserted in series with the battery to compensate for battery voltage drop due to aging and use. This provides long service from a set of batteries, because the CALIBRATION potentiometer is adjusted to compensate for battery age. When battery voltage drops below 11, the pack must be discarded.

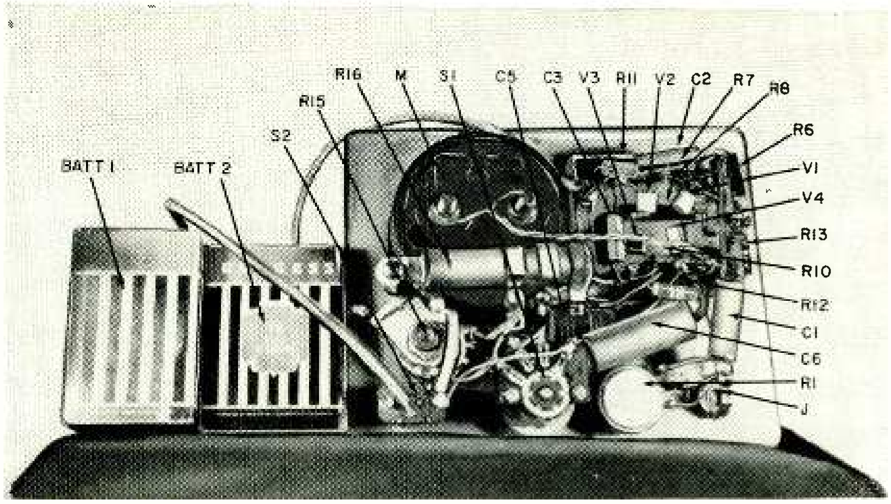
Construction hints

There is nothing critical about building this test unit. The usual precautions must be observed if the transistors are soldered directly into the circuit. Keep soldering-iron heat away from the transistors by using long-nose pliers to hold the leads between the iron and the transistor body. Wire the GAIN potentiometer in the usual volume-control hookup, so its variable resistance decreases as the control shaft is turned counter-clockwise.

Any type of wood, metal or plastic chassis and case can be used. I used a Plexiglas block on which several terminal strips were mounted for the chassis. All resistors, capacitors and wires are soldered to the terminals before the transistors are wired into place. The panel is cut, drilled, painted and all parts mounted before the chassis is attached. The final hookup is completed and the batteries are fastened inside the wood cabinet with metal straps.

If you desire, a large milliammeter (square or round) can be used, as long as it has a basic 1-ma movement. Also, it will be necessary to get an extra slider for R16. Two sliders are needed because the wirewound unit is used to drop the voltage for two ranges.

After construction is completed, connect the batteries *(observe proper polarity!)* and throw the switch to ON.



Parts layout inside the direct-reading meter. All transistors are CK722's. V4 is an older unit in a different style case.

The meter should indicate about 0.1 ma. If no reading is obtained or an appreciably higher reading is noted, something is wrong. Check the wiring, V3 and V4. The 0.1-ma reading is normal, static current. If everything seems to be in order, calibration can begin.

Calibrating the meter

An accurate signal generator is needed to calibrate the transistorized test set. The final accuracy of the frequency meter depends upon *the accuracy of the calibrating audio generator.* Be sure it is a good one. They are not as hard to find as you may think for most well-equipped service shops or schools have them. Arrangements can be made to bring the test set in for calibration. If you're in an area where these facilities are not available, try the local telephone-system maintenance shop. The shop supervisors are friendly people and most of them have good audio generators on hand. My unit was calibrated in a telephone maintenance and repair section.

If all else fails, you can use a less accurate generator, a scope and Lissajous figures, but this method is extremely tedious and should be used only as a last resort. Normally, with a good audio oscillator, calibration takes from 15–30 minutes.

First switch the RANGE selector to range 1, 20 to 200 cycles. The GAIN control should be turned to its farthest counterclockwise position (toward the grounded end). Feed a 200-cycle 2–3-volt audio signal to the input jack and slowly rotate the GAIN control clockwise. The meter reading will slowly increase, then suddenly jump toward full scale. Further clockwise rotation of the GAIN control will not result in any further increase of the meter reading. Back the GAIN control down and reset it about a quarter turn *after* the needle has jumped toward full scale. Do this two or three times and you'll find it easy to reach this point. This procedure sets the best input level for proper operation of the test set.

Observe the meter reading. It will probably be a little above or below the full-scale 1-ma level. Adjust the 2,500-ohm CALIBRATION potentiometer for exactly 1 ma with a 200-cycle input. Calibrate the rest of the range by decreasing the calibrating generator's frequency until the meter needle drops to the 0.9-ma mark. Log the frequency on the audio oscillator dial.

Go down to the next mark (0.8 ma), log the frequency and continue this procedure until you hit 20 cycles. This frequency will probably produce a reading somewhere around 0.2 ma, so the 0.1 static-current reading will not be within the frequency range. Several of these test sets have been built and none of them read appreciably below 0.2 ma for the lowest frequency in each range.

When range 1 is calibrated, switch the RANGE selector to range 2, 200 to 2,000 cycles. Feed 2,000 cycles into the frequency meter and recheck the setting of the GAIN potentiometer. Move slider 1 (*nearest* the connected end) of R16 up or down the resistor for a full-scale reading of 1 ma at 2,000 cycles. When this reading is obtained, tighten the slider permanently and proceed with lowering the frequency and logging the meter readings all the way down to 200 cycles.

Finally, turn to range 3, 2,000 to 20,000 cycles, set the calibrating oscillator to 20,000 cycles and recheck the GAIN control setting. Adjust the slider *farthest* from the connected end of the R16 for a full-scale 1-ma reading at 20,000 cycles. After this, lower the frequency of the calibrating generator and log the readings versus frequency until 2,000 cycles is reached.

The chart on the test meter in the photograph shows the meter readings and frequencies. The readings will vary between one test set and another because transistor gains vary, even among the same type and manufacturer. However, the variation will not be large. Type the chart, cover with cellophane tape or plastic and fasten it to the instrument's panel. Calibration is completed and the unit is ready for use.

Using the frequency meter

Always start with the GAIN control turned fully counterclockwise when checking an unknown audio frequency. Rotate it a quarter more, after the jump point, and compare the meter reading against the chart to determine the frequency. It's very simple to use and the GAIN adjustment takes half a second to set the input to the best level.

Make sure the incoming level is 1 volt or better. The setting of the GAIN potentiometer quickly indicates whether the input level is high enough. If you cannot reach a point where rotating the GAIN control will not increase the meter reading, the input level is too low.

To check the frequency of an audio oscillator, simply hook the input test cable of the frequency meter to the output terminals of the oscillator. The input test cable is a shielded lead or a length of coaxial cable with clips and a phone plug, as shown in the photos.

Use a carbon microphone and microphone transformer to feed the input test jack to measure frequencies produced by tuning forks and other single-frequency sound-producing gear. A crystal microphone with a suitable preamplifier can be used for the same purpose.

Place the test cable across the speaker terminals of a receiver to test for beat frequencies between two stations interfering with each other. Be sure the volume is high enough to supply the minimum 1-volt level. Use it as an indicator instead of a speaker when signal tracing PA systems fed by an audio oscillator.

A high-output crystal phono cartridge with attached phono needle has been used for a relative vibration-frequency check of machinery. The phono needle is held lightly against the vibrating surface and the cartridge produces an output voltage that activates the frequency meter. All kinds of similar applications are possible with this test unit, limited only by the imagination and ingenuity of the experimenter.

Occasionally check to see whether the battery voltage has dropped. Feed a 200-cycle signal into the set and look for a full-scale reading on range 1. If the reading is low, indicating that the battery has aged, adjust the CALIBRATION potentiometer to bring the reading to full scale again. This adjustment automatically compensates for ranges 2 and 3.

This transistor test set is an extremely versatile piece of gear, with practically no limit to the life of its components. There are no complications in construction and it takes only a short time to build. It is a useful and welcome addition to the experimenter's and technician's stock of needed test equipment. END

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Simple Signal Generator

Most experimenters and home constructors occasionally need an rf signal generator, but the need is seldom great enough to warrant purchasing one. Fig. 1 shows the circuit of a simple rf signal generator made from inexpensive or junkbox parts. The circuit originally appeared in *The Short Wave Magazine* (London, England).

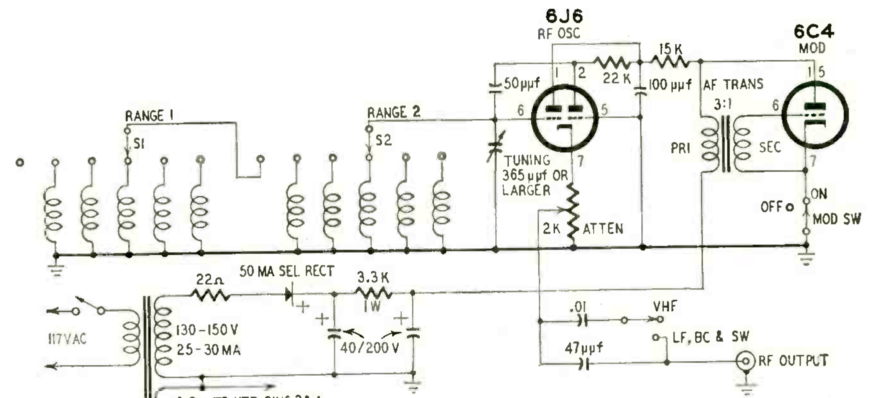


Fig.1

The author used two banks of five coils selected by range switches S1 and S2 to cover from a few kc up to 250 mc. You can select coils to fit your needs and may replace S1 and S2 with a single switch having one position for each tuning range.

Coil winding data was not given. It is recommended that coils be obtained from junked receivers and similar sources. Coils in the if range can be windings from 132-, 175-, 262- and 455-kc if transformers. For lower frequencies try TV linearity or width coils in various inductance ranges. For the broadcast and shortwave bands you can use the tuned windings of antenna, rf and oscillator coils designed for the desired frequencies. Above 18 mc or so you can wind coils experimentally, cut sections of B & W Miniductors or use CTC (Cambridge Thermionic Corp.) 30- and 60-mc slug-tuned coils and check them with a grid-dip meter or on a receiver. Above 30 mc we suggest switching to a smaller tuning capacitor—about 100 μμf—as in Fig. 2. When using this arrangement, the tuning control may be a two-section superhet type tuning capacitor with a cut-plate style oscillator tuning section. A conventional unit with an rf tuning section or around 365 μμf and an oscillator section of about 130 μμf maximum should work nicely. END

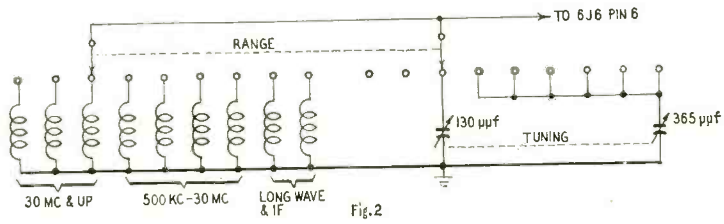
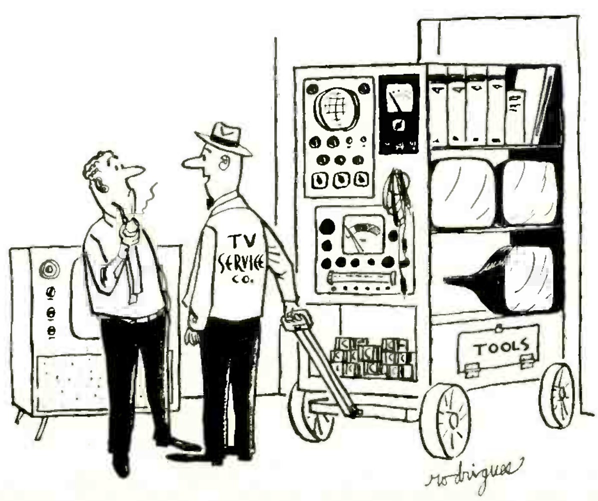


Fig.2

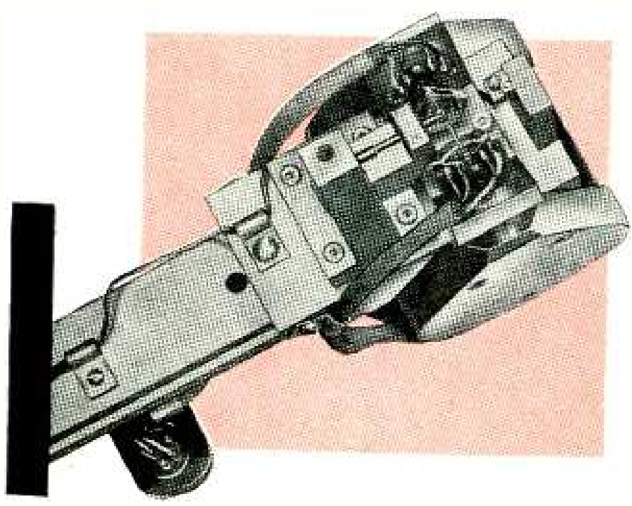


"You know our motto, sir. We fix the set in your home or no charge."

Single-Groove STEREO DISCS

Vertical and lateral recording techniques are combined in new processes that put two audio channels in one record groove

By NORMAN H. CROWHURST



Closeup of the Westrex playback head.

THE question most often asked, when the possibility of a new stereophonic system of disc recording is mentioned, is "Does it use one or two styli?" Often surprise is expressed that it should be possible to use a system with only one stylus. Of course, the Cook "binaural" record has been available for some time. It uses two pickups spaced a certain distance apart, so each plays a separate section of the record. But many people seem to visualize two styli quite close together and probably in the same pickup, either playing adjacent grooves or following each other in the same groove.

This idea probably arises from the present systems of stereophonic tape which employ two tracks and consequently require two playback heads. Systems for stereo on tape have been suggested employing magnetization at different angles on only one track. Separate playback heads, mounted at the correct angle for the program information in each channel, could then play the same magnetic track (Fig. 1).

But disc is quite a different proposition. For one thing there would be the difficulty of making sure that each stylus is in the correct groove. If the arm and head of the pickup are mounted correctly so the styli are *theoretically* in line with the groove at all positions across the record, the compliance of any modern pickup must be so large that the stylus can move a distance representing several grooves without appreciable opposition. Consequently it would still be very easy to lower the pickup in such a way that the two styli would settle in grooves two or three rotations apart instead of in the same groove. In fact it would become difficult to lower the pickup so that the two styli would rest in the *same* groove —and even more difficult to lower them so they rested correctly in adjacent grooves, if such a system should be used.

The great prospective advantage of stereophonic recording on disc is that it will be as easy to play as LP's are today. Consequently an arrangement that involves great precision in lowering the pickup to the record would invalidate its advantage. It would become no easier to handle than tape. So the only prospective system for stereophony on disc that represents an economic and utilitarian advantage is one where a single stylus is used.

Vertical–lateral

The idea of using vertical–lateral recording is not new. It has been experimented with for a long time, and good pickups for the purpose were developed in the '30's. At the moment, two completely different systems, both using vertical and lateral movement of the stylus, are being proposed for high-fidelity reproduction of stereophonic sound.

One comes from England (the London Record Co.), employing vertical for one channel and lateral for the other channel of stereophonic sound. The second is a system recently developed by Westrex, which employs 45° movement one way for one channel and 45° movement at right angles to the first for the other channel. This new system claims several advantages over the vertical–lateral system. Whether these advantages are real or theoretical remains to be proved.

One question encountered with both should first be resolved. When any system of moving the stylus both vertically and laterally is discussed, someone invariably asks won't it be difficult to press recordings of this type. The implication seems to be that it must involve some undercutting in the groove

Stereophonic disc recording is a prospect for the immediate future. Not so long ago, during the Audio Engineering Society's convention in New York City, *two* systems of stereophonic disc recording — both using a single groove and single stylus — were demonstrated. Comments of manufacturers and engineers left little doubt that commercially practical disc stereo has arrived, and it is confidently expected that major record manufacturers on both sides of the Atlantic will start producing stereo discs this year.

walls. The argument usually begins, "If the stylus moves sideways when it is at the bottom of a vertical cut . . ."

In answer to this, note that both vertical and lateral recordings use a cutter and stylus whose disposition to the record is vertical (Fig. 2). When the same cutter is used to cut vertical and lateral, or the same stylus to play it back, it is still vertical. So there can be no undercutting at any point. In fact, London Records has pressed a quantity of these recordings in their standard machines used for LP's, and demonstrations were given with these pressings. We are assured that stereo discs need cost no more for the same playing time than LP's. This, surely, is the economic answer for stereo.

To explain the principle on which these systems work, Fig. 3 shows a simplified arrangement for a magnetic pickup (or cutter) for use on each. In the vertical–lateral (London) (Fig. 3-a) vertical motion of the armature attached to the stylus alters the magnetic field between the vertical pole pieces and produces vertical output from these coils. But the movement is parallel to the lateral pole pieces and thus produces no output. For lateral movement, the reverse is true.

The so-called 45/45 (Westrex) works in exactly the same way by rotating the pole-piece portion through 45° (Fig. 3-b). Each 45° motion is at 90° to the other so the same separation of outputs works just the same. Obviously the physical arrangement shown in Fig. 3 could not be used because the stylus could never touch the record in the position shown—the magnetic assembly would get in the way. These are simplified drawings to show how it works. Nor is the principle limited to magnetic pickups. The same separation can be achieved with moving-coil, crystal, capacitance, etc., or with combinations of them.

The first and biggest advantage claimed for the 45/45 is that vertical recording has always been accompanied by a greater amount of distortion than lateral recording. This is because depression of the cutter requires a greater force than lifting it. Because of the triangular shape of the cutter, depressing it by, say, 1 mil, increases the amount of record material removed by much more than lifting it by 1 mil *reduces* the quantity removed (Fig. 4). Force required is approximately proportional to material removed. Consequently, vertical recording (or hill-and-dale, as it was called in old days) is accompanied by second-harmonic and similar forms of distortion.

For a long while this has been the reason given for the preference for lateral recording where the cutter removes a constant amount of material from the master disc, and consequently there is no inherent distortion in the cutting operation. The argument for 45/45 is that both movements involve the same proportion of vertical and lateral components (Fig. 5); consequently the quality is equal on both channels. The distortion contributed by the vertical component is not all on one channel but distributed equally between both channels.

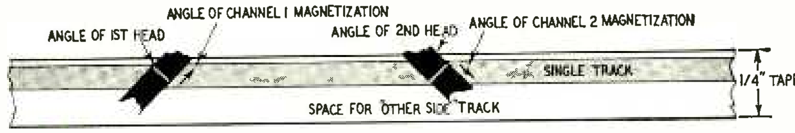


Fig. 1 — A method by which two-channel stereo might be put on a single tape track.

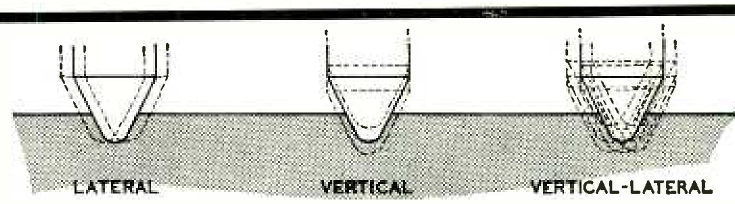


Fig. 2 — In lateral recording the stylus moves sideways; in vertical recording up and down. Vertical-lateral moves it in all directions.

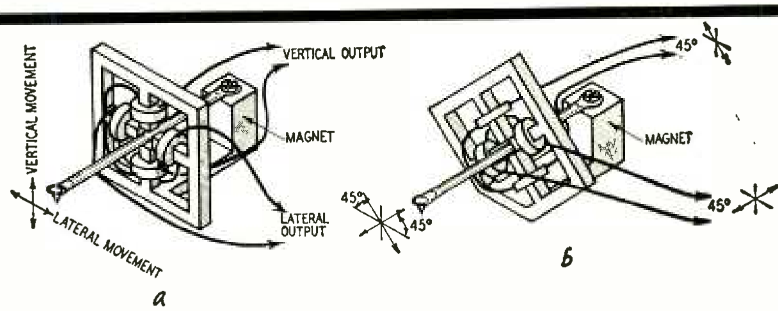


Fig. 3 — Simplified arrangement for stereo magnetic pickups: a — London method; b — Westrex method.

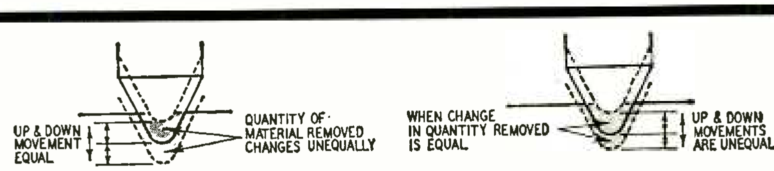


Fig. 4 — The reason for greater distortion problems with vertical recording.

Compatibility

The second claim for 45/45 is that it gives better compatibility both ways. Before going any further, let's define a little more precisely what we mean by compatibility. Complete compatibility would mean the system is capable of the following combinations:

1. A new type stereo pickup should be able to play and give satisfactory reproduction from an LP record recorded nonstereo, and

2. A nonstereo pickup and single-channel high-fidelity system should be able to play the new stereo disc with quality equivalent to reproduction from a good LP.

Compatibility in the first sense is achieved by either system. The second sense involves two further considerations. If it is possible to play the stereo disc with a nonstereo pickup and achieve high-fidelity reproduction, it would seem that the record manufacturer does not have to put out two types of discs for the same program. But there is another factor.

If the stereo disc is played with an LP type pickup, it may give satisfactory high-fidelity reproduction but still ruin the stereo disc for subsequent playing on a stereo pickup. The great majority of high-fidelity pickups today have much less vertical than horizontal compliance. In fact, one well known pickup, having a reputation among the best, has virtually zero vertical compliance. If such a pickup were used to play any stereo disc, it would completely wreck the vertical component of the stereo recording and the disc would then become useless for playing as anything but an LP.

While the hi-fi pickup would plow out most of the vertical material, it would not completely eliminate it. Consequently, whether vertical–lateral or 45/45 is used, if this disc were subsequently played on its appropriate stereo system, it would sound extremely distorted because of the damage to the vertical component. In a vertical–lateral recording one channel would get all the distortion, while the other would remain at its normal high fidelity. But with a 45/45 recording, both channels would be equally distorted.

Either way—and this is the vital factor about whether compatibility should be claimed by either system—the user is scarcely likely to blame

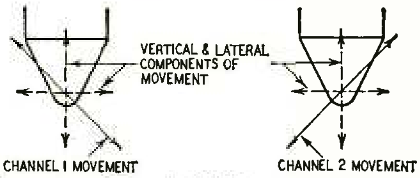


Fig. 5 — Use of 45/45, as shown here, makes each channel use a combination of vertical–lateral.

his trusted high-fidelity pickup for the damage. He is much more likely to conclude either that the record was no good in the first place or that his stereo pickup is no good, and thereby form a bad initial impression of the system.

For this reason, it would seem advantageous, whichever system is used, not to make any endeavor to claim the second form of compatibility. In their own interests, the record companies should continue to issue both types of recording, whichever system of stereo disc is ultimately chosen.

The man who goes for stereo disc will buy a stereo pickup and thereafter, because of its compatibility in the first sense, he will be able to play his monaural LP's with his stereo pickup. This is possible with both systems.

Further, it seems that with either system the user should be advised to keep his stereo disc to be played only with a stereo pickup and should be warned that any nonstereo high-fidelity pickup is likely to ruin the record. It's true that some hi-fi pickups may not ruin the record if they happen to have a high vertical compliance. But high vertical compliance is not inherently connected with the quality of an LP pickup. Consequently it would not seem advisable to differentiate between high-quality LP pickups with and without high vertical compliance. This will only be something that would confuse the consumer still further.

It would be best to play safe and recommend that stereo discs be played *only* with a stereo pickup, adding the warning that an ordinary pickup, which may give satisfactory high-fidelity reproduction, is likely to ruin the disc for playing over a stereo system.

Having settled (I hope) this question, let's investigate the comparative merits of vertical–lateral or 45/45, playing as a stereophonic system. First, let's look into this matter of distortion.

Distortion

The implication has been made that the 45/45 distributes the distortion equally between both channels. This tacitly assumes the vertical distortion is inevitable. "So we have to live with it, let's make the best of it" by putting it equally in both channels instead of having it all in one.

This seems a rather unsatisfactory attitude in view of the fact that stereophonic reproduction is intended to be a step forward from high fidelity. In high fidelity we have worked hard to eliminate or minimize all possible causes of distortion. So it seems to be a retrogressive step to provide two-channel recording at the cost of accepting a greater amount of distortion than we would tolerate with single-channel system.

The question arises "Do we really have to put up with all this distortion on vertical recording?" The idea that distortion is inherent to vertical recording dates from the days before feedback cutters were invented. Any attempt to produce vertical–lateral recording with a "straight" cutter, without the use of feedback, would undoubtedly involve considerably more distortion in the vertical than in the lateral cut.

If this were applied to a two-channel system, with the lateral for one channel and the vertical for the other, the vertical channel would have much more distortion than the lateral channel.

Whether such a cutter or one designed for the purpose were employed to produce the 45/45 system, *both* channels would have much more distortion than LP's using the simple lateral type of cut.

Fortunately, some very good feedback cutters have been developed, and

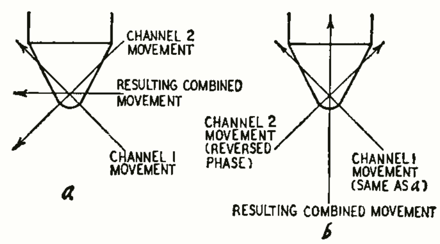


Fig. 6 — Two possible ways of phasing stereo program in 45/45 system; a — dominantly lateral; b — dominantly vertical.

a recent demonstration given by London Records for the benefit of the industry, using the vertical–lateral arrangement, proved that it is possible to record vertically with as high a quality as laterally. This particular recording made claims of going no higher than 12,000 cycles. But neither did the lateral.

The important thing here is that distortion in the vertical was no higher than distortion in the lateral, due to the excellent compensation by the feedback cutter.

This, then, eliminates the distortion comparison issue from the relative merits of the two systems. So we are left with three more factors to consider. One is the claim of compatibility already mentioned. The other two are the possible problems involved in achieving an adequate cross-talk ratio, and a space utilization factor of the record material itself, which will involve the relationship between playing length and dynamic range that can be achieved as compared with the regular LP.

There are two possibilities about the phasing of program material in the 45/45 system (Fig. 6). These principally affect the low frequencies which are responsible for the greater amplitude movement of the stylus in both directions. If the phasing is such that a signal on both channels that would result in an ultimate push forward on both loudspeaker diaphragms moves the stylus to the left, one channel's signal moving it up and the other down at the same time, this combination will result in a lateral movement to the left, the next half-cycle moving it to the right. We can call this a *lateral-dominant* movement.

Changing the phase of one of the cutters will make the same in-phase combination from the microphones move the stylus up and down—in other words a vertical-dominant movement. A lateral movement in this case would correspond with pressure at one microphone and rarefaction at the other, or in playback would result in one speaker pushing when the other pulls. This phasing can result in certain economies in groove spacing but has disadvantages from the compatibility point of view. Playing an ordinary LP with a 45/45 stereo pickup so hooked up would result in the speakers being out of phase, which produces a rather unpleasant kind of reproduction.

If the vertical-dominant connection were selected for the 45/45 system as a standard, the system would be compatible for playing LP's only by arranging a phase changeover switch in one channel.

The vertical–lateral system is also compatible. If the stereo pickup is used to play an LP disc without changing connections in any way, the whole program will seem to come from one speaker. This is, of course, obvious to the user and it is a simple matter to provide this system with a paralleling switch to feed the output from the lateral coils of the pickup to the input of both channels. This would enable both speakers to get the same program in phase.

The question of possible cross-talk is one that ties in with two other factors: the way the recording is made—that is, the kind of microphone placement and combination used—and the results of future developments in cutters and pickups which, at the present stage, are difficult to predict.

It would seem at present that it would be simpler to provide precision isolation between two movements at 90° to one another when one of these is vertical and the other lateral than when both are at an angle. Deviation of either angle of movement from a perfect 45° will result in some breakthrough onto the other channel's sound

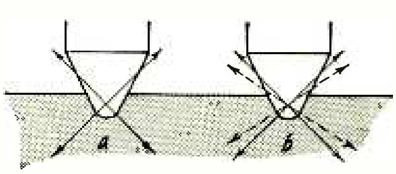


Fig. 7-a — Provided axes of movement are at precisely 45° in the cutter, cross-talk will be limited only by how well the cutter and pickup are made; — distortion of these axes (dashed lines) at some stage of the process will cause increased cross-talk.

because the two movements will no longer be at exactly 90° to one another.

Academically, of course, both methods are equally possible of as good separation. But mechanically it seems that the vertical–lateral arrangement would offer less problems in manufacture and also offer the greater potential for future development in cutter and pickup design. If anything at all should distort the vertical–lateral proportions of the recording during processing, this would produce deterioration as cross-talk (Fig. 7).

As against this, the claim for the 45/45 in this respect can be based on the use of symmetry—the fact that the two drives can be arranged in symmetrical manner, like a V-8 motor, which is not so readily possible with a vertical and lateral arrangement.

London Records demonstrated with a pickup whose cross-talk was reputed to be 25 db and they reported that a prototype has just been developed that gives a cross-talk ratio of 35 db, which is more than adequate and would seem to allow plenty for production deviation.

Price range?

In the initial development stage, the crystal transducer did not produce as good a cross-talk ratio as the other types but it was still adequate for use in a low-cost stereophonic disc system —a very important consideration for the mass market.

The tape people lay claim to the potential for highest possible quality because their playback heads have no moving parts. Of course they have magnetic circuits which can introduce their own troubles. But pickups have moving parts which make it more difficult to produce a uniform frequency characteristic. So, basically, it would seem that tape stereo offers the best *possibility* for those really interested in absolute top quality—a view that is underscored by the fact that, at present, all master recordings are made on tape, later to be dubbed on disc.

The obvious advantage of the stereo disc is its simplicity in use. It can be handled exactly the same as the present LP's. If a visitor steps in and you want to impress him with your latest recording, you can lower the stylus onto the particular passage you want to play and then, if he is further interested, play the whole disc. This is quite difficult with tapes because you cannot find the particular spot in a recording as quickly.

This and the ease of putting the stylus on the record and taking it off again will presumably result in greater popularity of stereo disc with the mass market. In fact, I would go for stereo disc in preference to tape myself, for the same reason. This being the case, we have to consider not only the possibility, but the very high probability, that stereo discs will be applied in the extremely low price range, comparable with present record players. At the same time it should be possible to produce at an economical price a system having quality comparable with the best LP reproducers.

The final matter for comparison is the space factor. With both the London and Westrex systems, maximum groove width is greater than on standard LP's. This greater width is caused by the need for the cutter to go deeper into the record to record the vertical component properly. As the cutter is chisel-shaped, the deeper it goes the wider the groove.

In theory the modulation area for the 45/45 is the same square cross-section of possible movement as for the vertical–lateral, but it is turned up on its corner so that room has to be found in the material of the disc for a spiral modulation area of square section wound corner-on as it were. This results in less economical utilization of the record material than for a spiral wound so the flat surfaces of the modulation area lay one beside the other.

But there is another factor that brings up two possibilities. If the in-phase components result in lateral movement, the out-of-phase components, which will invariably be considerably smaller in amplitude, will result in less demand on the vertical excursion of the cutter and playback stylus. This enables the unwanted distortion we mentioned earlier—and which may well be only of academic interest at this stage—to be minimized.

On the other hand, if the in-phase operation produces a vertical resultant, the principal movement of the stylus with a 45/45 system now becomes vertical and the grooves can be cut much closer together, allowing a longer amount of program material to be squeezed into the same space but requiring much deeper vertical cut. This may either result in greater distortion or, by reducing the vertical excursion permitted, will considerably reduce dynamic range.

So, on the score of both compatibility and dynamic range, the 45/45 should be phased so in-phase program produces lateral-dominant movement. This is, in fact, the phasing standardized by Westrex in their system.

Recording techniques

A further factor that should be mentioned before we leave this subject is the effect of recording techniques. Systems developed in Europe independently, the *Stereosonic* and the German *MS* systems, both employ dominantly intensity differences in the program content of the two channels rather than time differences which are more dominant in most American stereophonic recordings.

A possible advantage of the intensity-dominant channel differences is that it makes cross-talk relatively unimportant as both channels contain exactly the same program information at the same time, but with different proportions of it in each channel for different sections of the orchestra. Thus the only effect of possible breakthrough is that the directional effects intended will be slightly modified. There will be no undesirable echo or distortion products due to intermodulation from one channel to the other, such as can occur where there are time differences as well as intensity differences.

An adaptation of these recording techniques might utilize a vertical–lateral arrangement, with wide-range lateral and limited-fidelity vertical. This would offer additional possibilities for rumble reduction with low-quality turntables.

The London people, however, adopt the attitude that, in view of the improved quality in the vertical channel they have already succeeded in achieving on a production basis, this is an unnecessary limitation on the medium. Without such a limitation, it is possible to provide flexibility so that both channels can contain stereophonic information with either intensity or time differences equally well.

Sometimes stereophonic recordings deliberately contain out-of-phase components in the low and middle frequencies to get specific effects that are not obtainable with simple single-channel LP presentation. Use of a modified stereophonic or MS system would preclude this type of presentation and other possibilities of exploiting the new stereophonic medium to the utmost. Consequently, it is good to see that the vertical–lateral presentation has achieved a standard of recording and reproduction such that two high-quality channels can be provided.

The next question is shall we have both systems or only one, and, if so, which one. This is a matter for the record industry to decide. Obviously it is impractical to use both systems because, although each is compatible with single-channel LP's in its own way, neither is compatible with the other without a conversion switch to sum-and-difference combination to convert the output from the pickup from one form to the other. It would be impractical to use such a system as this because the user would never know which kind of disc he had and whether he was playing it correctly.

Consequently it would seem vital to select one system or the other and make this the standard for the industry. (Proponents of both systems agree that it is unthinkable that two incompatible systems should co-exist, and it is likely that they will agree on one of the systems before starting to make stereo discs.) From the foregoing discussion, it is evident that both systems have their possibilities and probably the decision will rest on the technique developed so far with each system and the quality it produces. This does not say the system with the inherent best possibilities will win. More likely it will be the one whose technological development at the time the decision is made has reached a higher order. END

NEW AMPLIFIER WITH KT88's

Some interesting features of the new tube are utilized in this Dyna amplifier, which has a flat response from 20–20,000 cycles at its full rated output of 60 watts

By DAVID HAFLER *

THE KT88, British big brother to the popular KT66, is now available in this country and is expected to appear in a number of commercial amplifiers in the near future. The KT88 is very similar to the American 6550 and can be used in most circuits which call for the 6550, if the bias is adjusted for the KT88. However, the new tube has some advantages which add to its utility.

The KT88 permits the use of large grid resistors (up to 120,000 ohms in fixed-bias applications), which leads to simpler driver circuits. Screen voltages as high as 560 may be used, which means that screen and plate can both be maintained at high potentials, as in triode arrangements or screen-loaded circuits, thus simplifying the power supply.

Specifications of the KT88 indicate that its operating characteristics are not critical. Primary impedances of 4,000 to 5,000 ohms match the tube for most operating conditions. According to GEC (Britain's General Electric Co.), manufacturers of the tube, screen taps of 20% to 50% give uniformly excellent performance with equal dc potentials on both plate and screen. This wide latitude differentiates the KT88 from many other beam tetrodes which exhibit the Ultra-Linear effect of maximizing performance at a relatively critical screen tapping point.

* Dyna Co., Philadelphia, Pa.

The KT88's noncritical impedance matching is a decided advantage as the shifts in *reflected* impedance which accompany the use of a loudspeaker load have relatively little unfavorable influence on performance. The normal variation of speaker impedance with frequency has less detrimental effect on performance with KT88's than with tubes in which matching conditions are more critical.

These desirable attributes have led to experiments using the KT88 in several types of circuits. One of the avenues of exploration led to using the tube in a 60-watt variation of the circuit used commercially in Dynakit amplifiers. This is shown in Fig. 1.

The KT88's are used with a Dynaco A-431 transformer, which has 4,300-ohm primary impedance with screen taps at 33% turns (11% of the primary impedance). Each tube draws 70 ma of cathode current with a 475-volt supply. Fixed bias is used and is adjusted by setting for 1.56 volts across the 11.2-ohm common-cathode resistor. Since an ordinary type-D flashlight cell, *when fresh*, reads close to 1.56 volts, this can be used as a reference standard when setting the bias.

The small *unbypassed* common-cathode resistor causes degeneration in the stage for signal components which are not canceled in the push-pull output stage. True push-pull cancellation requires accurately balanced operation under dynamic conditions. Slight deviations in driving signals or in output tube characteristics cause an unbalance which is not corrected by the push-pull action. These deviations cause a signal voltage to appear across the common-cathode resistor, and the resulting degeneration lowers distortion as per Fig. 2.

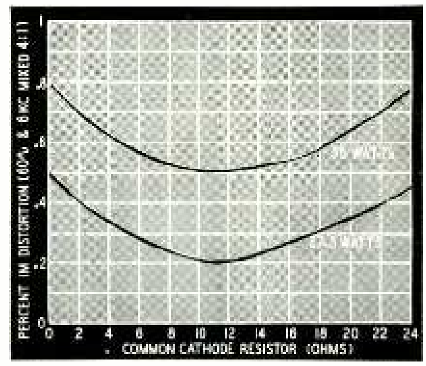


Fig. 2—Effect of unbypassed cathode resistor on IM distortion.

The correction for unbalance obtained by using this resistor is not that which is obtained by dc balancing of the output stage. The dynamic correction is one in which ac signal voltages are involved—not the static plate currents, which have little effect on performance in this particular case.

Distortion figures

Under these operating conditions, the KT88 can deliver as much as 75 watts at less than 1% distortion if the B-plus supply voltage does not fall off. However, in economical power supply arrangements, there *is* a drop in the B-plus, and a decrease in power output results. With a typical capacitor input supply, it is practical to obtain 60 watts of output, with very little distortion in the output stage.

The typical KT88 requires about 56 volts bias for these operating conditions. This in turn requires almost 40 volts rms each side from the driver. This amount of drive is normally obtained with a push-pull driver stage; but with the high supply voltage available and proper choice of tube type, a single-envelope pentode–triode can handle the job. The 6AN8 has direct coupling between pentode voltage amplifier and cathodyne phase splitter—somewhat similar to the configuration popularized by Williamson. This one tube will furnish 120 volts peak grid

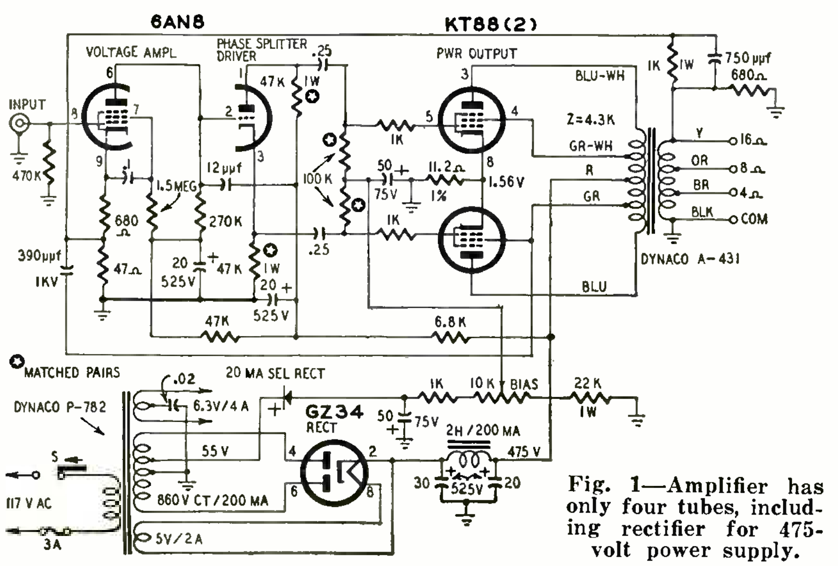


Fig. 1—Amplifier has only four tubes, including rectifier for 475-volt power supply.

to grid, enough for the KT88's, at an intermodulation figure of about 2%.

Distortion is reduced in the amplifier by negative feedback. With 20 db of feedback, the driver output stage combination delivers 60 watts at about 0.5% IM. The actual distortion figure varies slightly, depending on the tolerances in components and tubes. With matched resistors in the phase-inverter circuit, the tolerance of other components will cause distortion to range from about 0.2% to 1.0% at full output. At lower levels, distortion decreases and is well below 0.1% at the 1-watt level. Measurements below 0.1% are difficult to make because of limitations of measuring equipment and because noise levels obliterate the residual distortion.

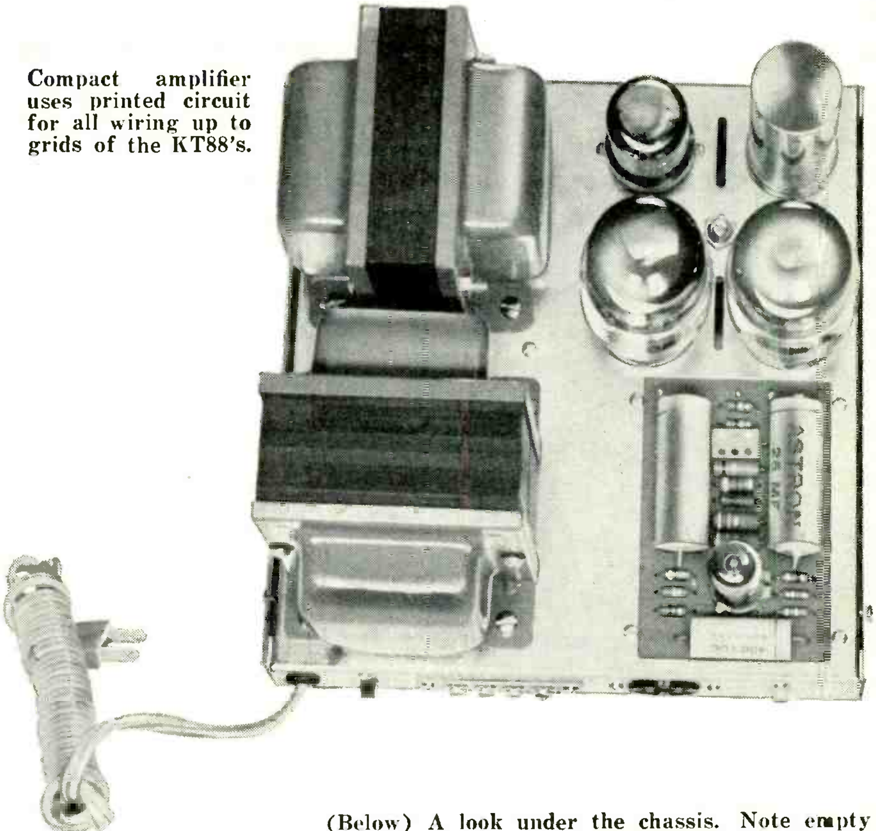
Feedback circuit

Several circuit features are included to maintain stability under feedback conditions. The most important of these are the capacitive feedback loop from the screen of one output tube to the first cathode, and the relatively *small* screen bypass capacitor. The capactive feedback loop improves high-frequency stability while the choice of screen bypass improves low-frequency stability. If this screen bypass is significantly increased or decreased in size, there will be a bump in the low-frequency response around 5 cycles, which is a symptom of incipient instability under transient conditions. The selected value gives critical damping of the low end. High-frequency stability is suitable for all types of speaker loads including the newer electrostatic types.

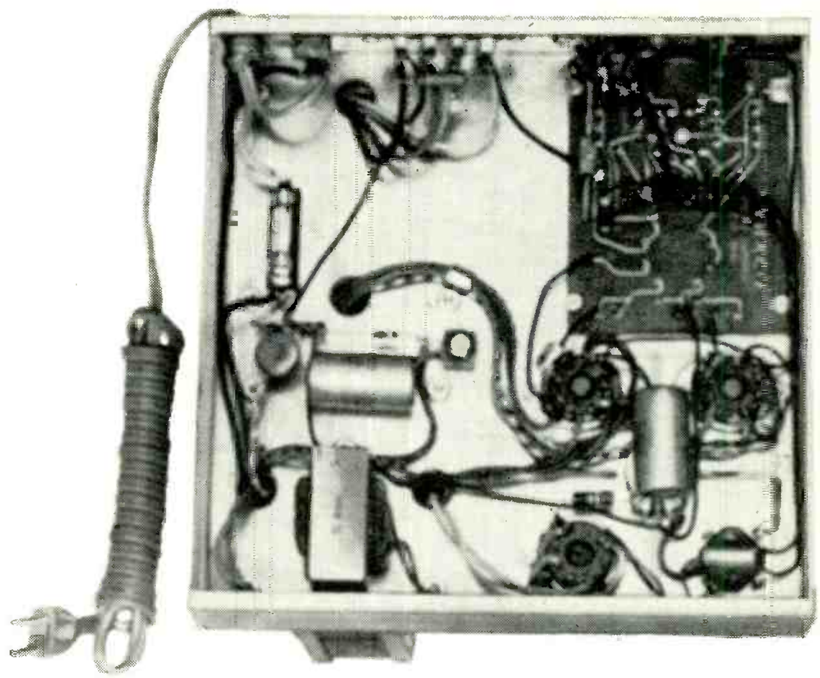
The feedback compensation reduces the total bandwidth slightly since it produces rolloff in response below 6 cycles and above 60 kc. However, within the 20–20,000-cycle range this is flat response at *any* power level up to a maximum of 60 watts. Even more important than flat response at high power is that total harmonic distortion is kept below 1% over the audio spectrum at powers up to 48 watts. The advantage of being able to handle large amounts of power cleanly at low frequencies shows up on speaker systems in which there is significant impedance variation below 100 cycles. These variations result in effective reduction of undistorted power output in the amplifier through the condition of mismatch (this type of mismatch is not corrected by variable damping circuits) brought about by a rising impedance characteristic. However, if there is a large amount of power available, the loss due to mismatch can be tolerated since sufficient undistorted reserve is retained to handle most operating conditions.

The power supply is conventional, using a GZ34 rectifier with capacitor input and choke filtering. A tap with a separate rectifier is used to obtain bias voltage. One feature of interest is the grounding of the heater center tap through a .02-μf capacitor. The inherent heater–cathode leakage of the 6AN8 causes a small charge to build up across this capacitor, automatically biasing the heater string to the lowest noise condition. If a preamp is powered from the same heater supply, its heaters should not be grounded or the benetfis of the amplifier arrangement will be destroyed. If the preamp has a hum pot or other device which requires grounding, it should be grounded through a capacitor to obtain an *ac ground* only so that the floating effect of the power amplifier arrangement is not removed.

This circuit has been constructed in several physical arrangements without any difficulty, provided normal good construction practice is followed. In the commercial kit, a printed-circuit board is used for all audio components up to the grids of the KT88's. This gives complete reproducibility of layout, but is not required to duplicate the circuit's characteristics. The photographs show the printed-circuit board and illustrate the essential simplicity of the entire amplifier. END



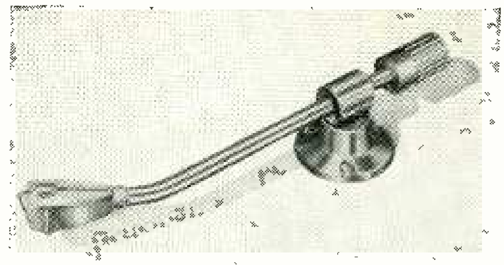
Compact amplifier uses printed circuit for all wiring up to grids of the KT88's.



(Below) A look under the chassis. Note empty appearance due to the printed circuitry.

HI-FI PICKUP ARMS

Part II: The Rek-O-Kut A-120, Pickering 194D, Leak Dynamic, Weathers, ESL 310 pickup arms. All have both pivots at essentially the same point



Rek-O-Kut A-120 pickup arm of tubular aluminum.

By JULIAN D. HIRSCH

THE first article of this series discussed a number of pickup arms whose vertical and horizontal pivots are spaced appreciably apart. A second major category includes arms which have their vertical and horizontal pivots essentially at the same point. (As in the preceding article, we will consider the vertical pivot to be the one which lets the arm move vertically and the horizontal pivot the one which lets the arm move horizontally.)

This type of arm design is the most common and is familiar to most people since virtually all record-changer arms are so designed. Perhaps its major disadvantage is that its inertia is the same in both vertical and lateral planes. High lateral inertia (mass) is desirable, to keep arm resonance below the audible range, while low vertical mass tends to minimize record wear, particularly when playing warped records. In this type of arm design, a compromise is usually necessary between these conflicting requirements.

Most (though not all) arms of this type are not laterally balanced, which makes careful leveling a necessity. Even when they are laterally balanced, the high vertical mass makes the arm rather sensitive to groove jumping when it is jarred unless viscous damping is used on the vertical pivots.

Rek-O-Kut A-120/A-160

The photos show the Rek-O-Kut A-120 arm. The A-160, designed for use with 16-inch records, is similar in appearance. This tubular aluminum arm has a removable die-cast cartridge shell, and a die-cast counterweight threaded on the rear of the arm. The pivot structure is the gimbal type, with ball bearings in both vertical and horizontal pivots.

The stylus tracking-force adjustment is unique, simple and foolproof. No external gauge or scale is needed to set stylus force accurately. With the cartridge plugged into the arm, the counterweight is adjusted by screwing it on the rear arm extension until the arm is perfectly balanced. When the counterweight is then rotated clockwise, a net downward force is exerted at the stylus. On the A-120 arm, each 1¼ turns add 1 gram to the tracking force while on the A-160 arm each 2 turns add 1 gram. A self-locking thread is used so setscrews are not needed to keep the counterweight in position after adjustment.

Although the arm body appears to be a single tube, it is actually divided into two portions. The division is visible as a line around the tubular arm body, just behind the pivot gimbals. This line is a thin piece of acoustical damping plastic which joins the front and rear sections of the arm. Its purpose is to damp the arm resonance, which is usually between 13 and 16 cycles, depending on the cartridge employed.

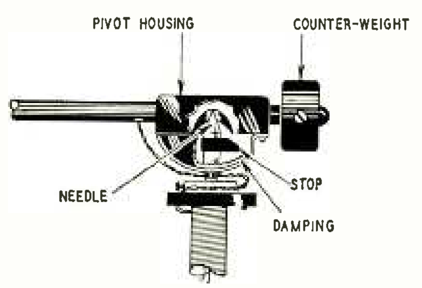


Fig. 1—Cutaway view of Leak Dynamic arm showing details of pivot.

The interchangeable cartridge shells are solidly constructed and are secured to the arm by a threaded locking ring. The front of the shell is open, permitting easy cuing of the stylus in the desired groove. This also permits the use of turnover cartridges which are rotated by a knob protruding from the front end. The pivot assembly may be moved vertically to adjust the height of the arm to the turntable.

Pickering 194D

The Pickering 194D (Unipoise) pickup is shown in the photos. It is an integrated pickup design in which simplicity is the keynote. Indeed, it would be hard to imagine an arm simpler in construction or easier to install.

The entire arm is pivoted on a single needle point, just as a compass rose is supported. The needle is made of hardened steel, and the cup into which it fits has a conical hole to receive the needle point. The needle passes through a slot in the arm and in contacted on both sides by a thin rubber membrane slitted to pass the pivot needle as the arm is raised or lowered. This membrane is intended to damp arm resonance somewhat.

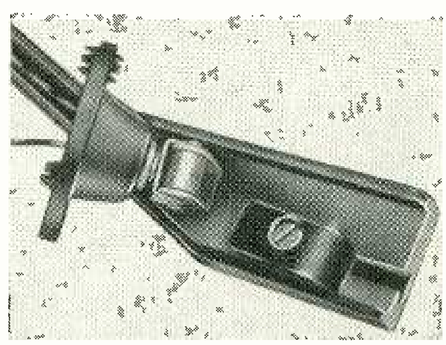
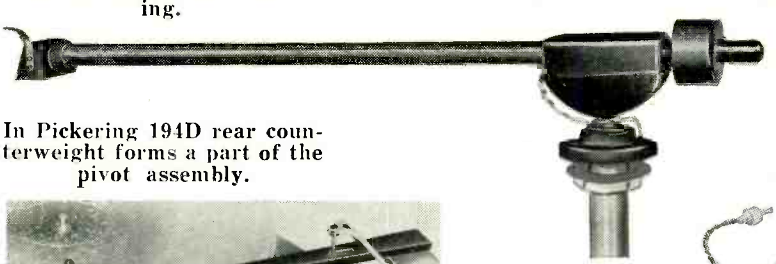


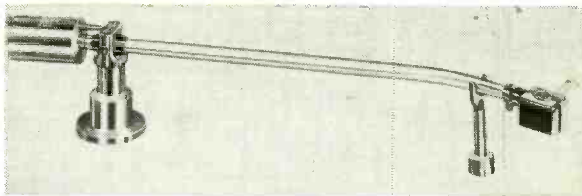
Fig. 2—Base, pivot and counterweight of the Weathers arm.

Stylus tracking force is adjustable between 1 and 6 grams by sliding a knurled knob, located under the arm, toward the front of the arm to increase force or toward the rear to decrease the force. The white dots on the side of the arm correspond to the various settings of this knob. Each dot represents approximately a 1-gram change of stylus force from the adjacent dots. Most of the weight of the arm and cartridge is counterbalanced by the rear counterweight, which is designed so it also forms a part of the pivot assembly.

In next month's installment, Julian D. Hirsch will discuss the characteristics of the ESL/BJ Super-Go tangential arm, the Orthosonic V/4 radial arm and Audio Specialities AS-30 radial arm.

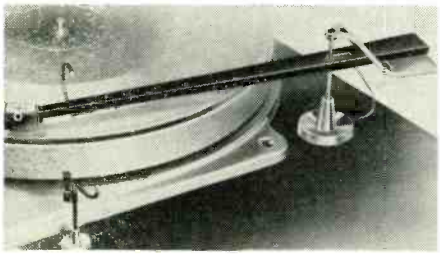
The Leak dynamic pickup. Note the single-hole mounting.





Tubular-aluminum construction and unusual counterweight are found on ESL type 310.

In Pickering 194D rear counterweight forms a part of the pivot assembly.



Weathers arm is made from lightweight wood.

Installation of the Pickering 194D is further simplified by the single-hole mounting of its base. A 11/16-inch hole is drilled in the motor board at any convenient point 8 inches from the turntable center. The pivot is fastened in this hole with a single wing nut which also holds, below the board, a bracket with a standard phono connector. Pickup height is adjusted by merely screwing the pivot needle up or down in the base. Since the pivot point is located well above the arm's center of gravity, it is self-leveling within a range of a few degrees. Therefore the only leveling operation necessary is to be sure that the turntable surface is truly horizontal.

The arm rest also mounts in a single hole. A small adjustable brush forms an integral part of the rest. This brush may be adjusted so the stylus is cleaned of lint each time the arm is returned to the rest. Although the rest merely supports the cartridge body, the magnet in the pickup is strongly attracted to it and there is no tendency for the arm to fall off the rest accidentally.

The Pickering 194D is noteworthy in that it goes one step beyond other integrated designs. The cartridge structure does not plug into the arm—it is a permanent part of the pickup. The styli are mounted in small T-shaped plastic bodies which may be slid in or out of the cartridge without difficulty. A small plastic box with a rack which holds up to eight stylus assemblies is furnished with the arm. Pickering manufactures styli in 0.5-, 1.0- and 2.7-mil radii (diamond), as well as a 2.7-mil sapphire stylus. Changing and storing these small stylus assemblies is certainly simpler than the usual practice of plugging in a different cartridge for each stylus size.

Leak dynamic pickup

The arm designed by H. J. Leak & Co. Ltd. (see photos) for their dynamic pickup is very similar in pivoting principle to the Pickering 194D. Fig. 1 is a cut away drawing of the Leak arm, showing the pivoting. The arm rotates in both planes on the point of an upright needle, resting in an inverted conical depression. The arm base mounts in a single hole and the pivot needle is adjusted vertically by loosening a setscrew. Vertical rotation of the arm is limited by a slot in a curved metal cover surrounding the needle. The pivot makes contact with a damping material as it passes through this slot. Lateral rotation of the arm is restrained to an angle of less than 90° by a projection from the side of the needle which strikes the sides of the pivot housing at the limits of arm rotation.

The pickup's tracking force is adjusted by loosening a setscrew and sliding a counterweight along the projecting rear portion of the arm.

The arm is a straight tube which receives the plug-in Leak cartridge only. The required offset for minimum tracking-angle error is built into the cartridge.

As with any arm pivoted in this manner, the Leak arm is relatively insensitive to small leveling errors. Since it is not laterally balanced, accurate leveling of the turntable surface is important, however.

ESL type 310

The Electro-Sonic type 310 tone arm, shown in the photos, is designed solely for use with ESL Professional series cartridges. Like several other arms already described, it is of simple tubular-aluminum construction. The pivots are the gimbal type, using precision ball bearings in both vertical and horizontal pivots. The pivot assembly may be adjusted vertically to adapt the arm to turntables of different heights by loosening a single setscrew. No provision is made for leveling the arm, but its design is such that minor leveling errors should not cause trouble.

The ESL 310 is unique among the pickup arms discussed in this article since it is the only one which is balanced in the horizontal plane. The counterweight is factory-set to counterbalance exactly the mass of the arm and cartridge forward of the vertical pivot. Because of this, exact leveling of the arm is not critical. To obtain a downward stylus force, a spring (which can be seen in the photo) is connected between the counterweight and the gimbal assembly. The tension of this spring may be adjusted by a knurled screw at the rear of the counterweight to set the stylus force. A calibrated scale is engraved on the counterweight, and the stylus force may be set between 0 and 30 grams.

Although the ESL 310 is carefully balanced and may operate with very low stylus forces, it has considerable vertical mass. In fact, the vertical and lateral masses are essentially the same. Because of this, the arm is quite sensitive to jarring effects and must be installed on a heavy well-mounted motorboard.

The front of the arm contains a socket into which the ESL Professional series cartridges are plugged. A knurled locking ring fastens the cartridge to the arm.

This arm does not have any damping provisions. However, its mass is considerable (it is a 16-inch arm) and this factor, combined with the high compliance of ESL cartridges, reduces the arm resonance to well below 10 cycles.

Weathers

The Weathers pickup arm is unique in several respects. It is made of a lightweight wood rather than the more usual metals used in other arms. It is designed for and may be used only with the Weathers FM capacitance pickup cartridge. The Weathers pickup arm is shown in the photos.

The base of the arm is made of a soft rubber and has small rubber feet extending above and below each of its mounting holes. When permanently installed, the mounting screws exert little or no pressure against these feet or the base, but serve merely to keep the pickup in its proper position on the motor board. The rubber feet and base isolate the arm from turntable and motorboard vibration.

The mass of the arm and cartridge is

(*Continued on page* 78)

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HEATHKIT EXTRA PERFORMANCE 70-WATT AMPLIFIER KIT

For really high performance, with plenty of reserve power, the W-6M is a natural. The full 70-watts output will seldom, if ever, be required. However, this reserve insures distortion-less sound on power peaks. The W-6M will loaf along at normal listening levels and yet is always ready to extend itself when program material demands it, without the least amount of strain. The output circuit employs 6550 tubes with a special-design Peerless output transformer for maximum stability at all power levels. A quick-change plug selects 4, 8 and 16 ohms or 70-volt output and the correct feedback resistance. A variable damping control is also provided for optimum performance with any speaker system. Extremely good power supply regulation is possible through the use of a heavy-duty transformer along with silicon-diode rectifiers, which are noted for their very long life, and yet are smaller than a house fuse. Frequency response at 1 watt is ±1 db from 5 cps to 80 kc with controlled hf rolloff above 100 kc. At 70 watts output harmonic distortion is below 2%, 20 to 20,000 cps and IM distortion below 1%, 60 and 6,000 cps. Hum and noise 88 db below full output. In addition to high performance, its fine appearance makes it a pleasure to display in your living room. Proper layout of chassis insures ease of assembly by eliminating those cramped and difficult places to get at. Clear instructions—and top-quality components. Get started now and make this amplifier the heart of your hi-fi system. Shipped express only. Shpg. Wt. 50 lbs.

MODEL W-6M $109.95

MODEL W-6: Consists of W-6M kit, plus WA-P2 preamplifier. Express only. Shpg. Wt. 59 lbs. $129.70

HEATHKIT HIGH FIDELITY FM TUNER KIT

This tuner can bring you a rich store of FM programming, your least expensive source of high fidelity material. It covers the complete FM band from 88 to 108 mc. Stabilized, temperature-compensated oscillator assures negligible drift after initial warmup. Features broadbanded circuits for full fidelity, and better than 10 uv sensitivity for 20 db of quieting, to pull in stations with clarity and full volume. Employs a high gain, cascode RF amplifier, and has AGC. A ratio detector provides high-efficiency demodulation without sacrificing hi-fi performance. IF and ratio transformers are prealigned, as is the front end tuning unit. Special alignment equipment is not necessary. Edge-lighted glass dial for easy tuning. Here is FM for your home at a price you can afford. Shpg. Wt. 8 lbs.

MODEL FM-3A $25.95 *(with cabinet)*

HEATHKIT BROADBAND AM TUNER KIT

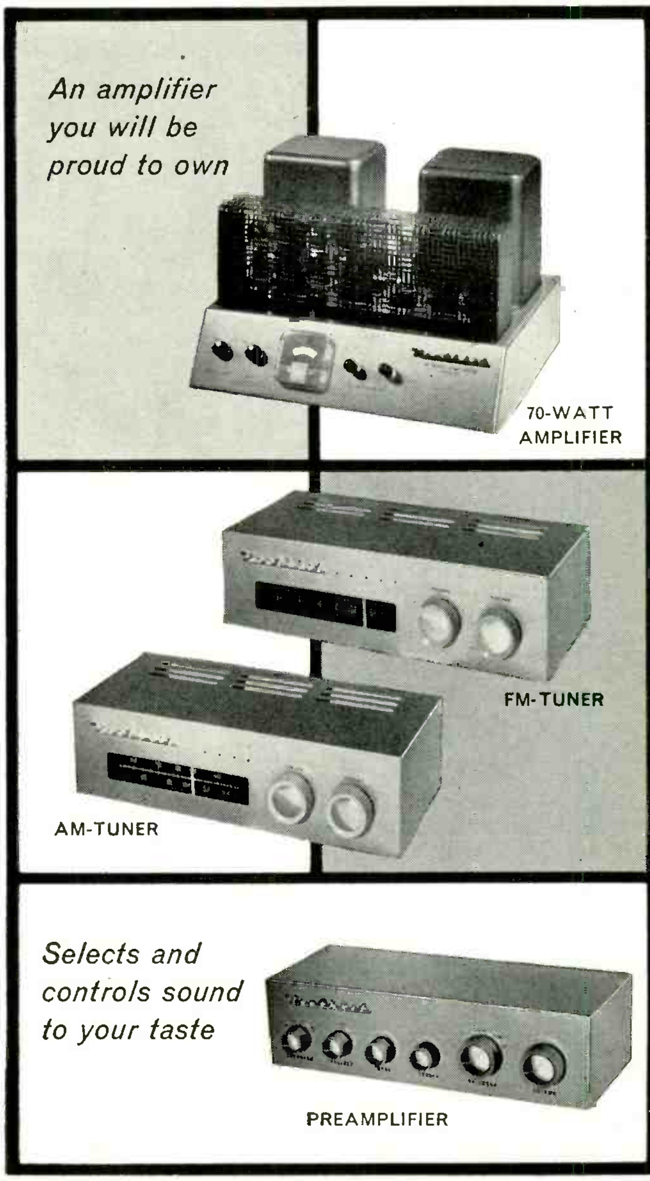
This AM tuner was designed especially for high fidelity applications. It incorporates a special detector using crystal diodes, and the IF circuits feature broad band-width, to insure low signal distortion. Audio response is ±1 db from 20 cps to 9 kc, with 5 db of preemphasis at 10 kc to compensate for station rolloff. Sensitivity and selectivity are excellent, and tuner covers complete broadcast band from 550 to 1600 kc. Quiet performance is assured by 6 db signal-to-noise ratio at 2.5 UV. Prealigned RF and IF coils eliminate the need for special alignment equipment. Incorporates AVC, two outputs, two antenna inputs, and built-in power supply. Edge-lighted glass slide-rule dial for easy tuning. Your "best buy" in an AM tuner. Shpg. Wt. 8 lbs.

MODEL BC-1A $25.95 *(with cabinet)*

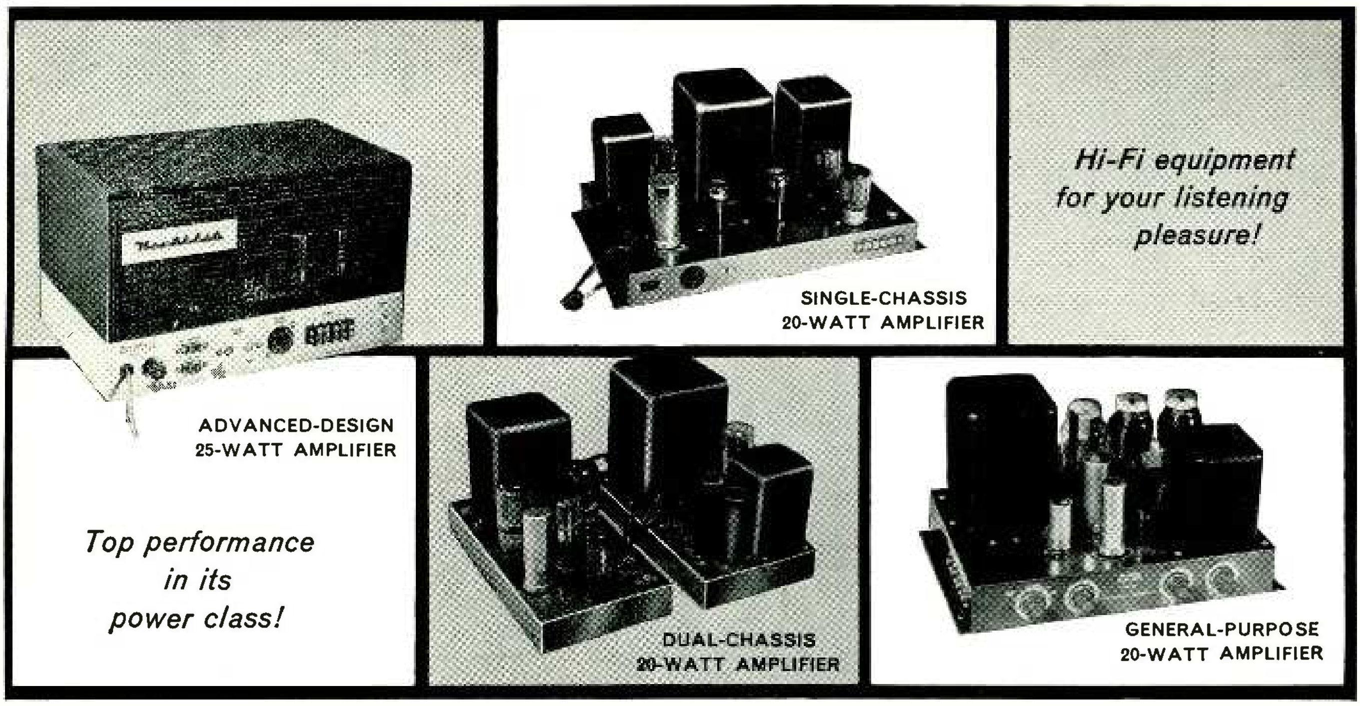
HEATHKIT MASTER CONTROL PREAMPLIFIER KIT

Designed for use with any of the Williamson-type amplifiers, the WA-P2 has five switch-selected inputs, each having its own level control to eliminate blasting or fading while switching through the various inputs, plus a tape recorder output. A hum control allows setting for minimum hum level. Frequency response is within ±1½ db from 15 to 35,000 cps. Equalization provided for LP, RIAA, AES, and early 78's. Separate bass and treble controls. Low impedance cathode follower output circuit. All components were specially selected for their high quality. Includes many features which will eventually be desired. Shpg. Wt. 7 lbs.

MODEL WA-P2 $19.75 *(with cabinet)*



HEATH COMPANY *A Subsidiary of Daystrom, Inc.* **BENTON HARBOR 20, MICH.**



HEATHKIT ADVANCED-DESIGN 25-WATT HIGH FIDELITY AMPLIFIER KIT

Designed especially to satisfy critical audio requirements, the W-5M incorporates the extra features needed to compliment the finest in program sources and speaker systems. Faithful sound reproduction is assured with a frequency response of ±1 db from 5 to 160,000 cps at 1 watt, and harmonic distortion is less than 1% at 25 watts, with IM distortion less than 1% at 20 watts. Hum and noise are a full 99 db below rated output, assuring quiet, hum-free operation. Output taps are 4, 8 and 16 ohms. Exclusive Heathkit features include the "tweeter saver", and the "bas-bal" balancing circuit, requiring only a voltmeter for indication. Years of reliable service are guaranteed through the use of conservatively rated, high quality components. KT66 tubes and Peerless output transformer are typical. Shipped express only. Shpg. Wt. 31 lbs.

MODEL W-5: Consists of W-5M kit above plus model WA-P2 preamplifier. Express only. Shpg. Wt. 38 lbs. $79.50

MODEL W-5M **\$59.75**

HEATHKIT SINGLE-CHASSIS 20-WATT HIGH FIDELITY AMPLIFIER KIT

The model W4-AM Williamson-type amplifier will amaze you with its outstanding performance. A true Williamson circuit, featuring extended frequency response, low distortion, and low hum levels, this amplifier can provide you with many hours of listening enjoyment with only a minimum investment compared to other units on the market. 5881 tubes and a special Chicago-standard output transformer are employed to give you full fidelity at minimum cost. Frequency response extending from 10 cps to 100 kc within ±1 db at 1 watt assures you of full coverage of the audio range, and clean clear sound amplification takes place in circuits that hold harmonic distortion at 1.5% and IM distortion below 2.7% at full 20 watt output. Hum and noise are 95 db below full output. Taps on the output transformer are at 4, 8 or 16 ohms. Shipped express only. Shpg. Wt. 28 lbs.

MODEL W-4A: Consists of W-4AM kit above, plus model WA-P2 preamplifier. Express only. Shpg. Wt. 35 lbs. $59.50.

MODEL W4-AM **\$39.75**

HEATHKIT DUAL-CHASSIS 20-WATT HIGH FIDELITY AMPLIFIER KIT

The model W3-AM is a Williamson-type amplifier built on two separate chassis. The power supply is on one chassis, and the amplifier stages are on the other chassis. Using two separate chassis provides additional flexibility in installation. Features include the famous acrosound model TO-300 "ultralinear" output transformer and 5881 tubes for broad frequency response, low distortion, and low hum level. The result is exceptionally fine overall tone quality. Frequency response is ±1 db from 6 cps to 150 kc at 1 watt. Harmonic distortion is less than 1% and IM distortion is less than 1.3% at 20 watts. Hum and noise are 88 db below 20 watts. Designed to match the speaker system of your choice, with taps for 4, 8 or 16 ohms impedance. A very popular high fidelity unit employing top quality components throughout. Shipped express only. Shpg. Wt. 29 lbs.

MODEL W-3A: Consists of W-3AM kit above plus model WA-P2 preamplifier. Express only. Shpg. Wt. 37 lbs. $69.50

MODEL W-3AM **\$49.75**

Heathkits...

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bring you the lasting satisfaction of personal accomplishment

HEATHKIT GENERAL-PURPOSE 20-WATT HIGH FIDELITY AMPLIFIER KIT

The model A-9C will provide you with high quality sound at low cost. Features a built-in preamplifier with four separate inputs, and individual volume, bass and treble controls. Frequency response covers 20 to 20,000 cps within ±1 db. Total harmonic distortion is less than 1% at 3 db below rated output. Push-pull 6L6 tubes are used, with output transformer tapped at 4, 8, 16 and 500 ohms. A true hi-fi unit using high-quality components throughout, including heavy-duty "potted" transformers. Shpg. Wt. 23 lbs.

MODEL A-9C **\$35.50**

HEATHKIT "BASIC RANGE" HI-FI SPEAKER SYSTEM KIT

The extremely popular Heathkit model SS-1 Speaker System provides amazing high fidelity performance for its size. Features two high-quality Jensen speakers, an 8″ mid-range woofer and compression-type tweeter with flared horn. Covers from 50 to 12,000 CPS within ±5 db, in a special-design ducted-port, bass reflex enclosure. Impedance is 16 ohms. Cabinet measures 11½″ H x 23″ W x 11¾″ D. Constructed of veneer-surfaced plywood, ½″ thick, suitable for light or dark finish. All wood parts are precut and predrilled for easy, quick assembly. Shpg. Wt. 30 lbs.

MODEL SS-1

$39.95

HEATHKIT "RANGE EXTENDING" HI-FI SPEAKER SYSTEM KIT

Extends the range of the SS-1 to ±5 db from 35 to 16,000 CPS. Uses 15″ woofer and super-tweeter both by Jensen. Kit includes crossover circuit. Impedance is 16 ohms and power rating is 35 watts. Measures 29″ H x 23″ W x 17½″ D. Constructed of veneer-surfaced plywood ¾″ thick. Easy to build! Shpg. Wt. 80 lbs.

MODEL SS-1B

$99.95

HEATHKIT "LEGATO" HIGH FIDELITY SPEAKER SYSTEM KIT

The quality of the Legato, in terms of the engineering that went into the initial design, and in terms of the materials used in its construction, is matched in only the most expensive speaker systems available today. The listening experience it provides approaches the ultimate in esthetic satisfaction. Two 15″ theater-type Altec Lansing speakers cover 25 to 500 CPS, and an Altec Lansing high-frequency driver with sectoral horn covers 500 to 20,000 CPS. A precise amount of phase shift in the crossover network brings the high frequency channel into phase with the low frequency channel to eliminate peaks or valleys at the crossover point, by equalizing the acoustical centers of the speakers. The enclosure is a modified infinite baffle type, especially designed for these speakers. Cabinet is constructed of veneer-surfaced plywood, ¾″ thick, precut and predrilled for easy assembly. Frequency response 25 to 20,000 CPS. Power rating, 50 watts program material. Impedance is 16 ohms. Cabinet dimensions 41″ L x 22¼″ D x 34″ H.

Choice of two beautiful cabinets. Model HH-1-C in imported white birch for light finishes, and HH-1-CM in African mahogany for dark finishes. Shpg. Wt. 195 lbs.

MODEL HH-1-C
MODEL HH-1-CM

$325.00 EACH

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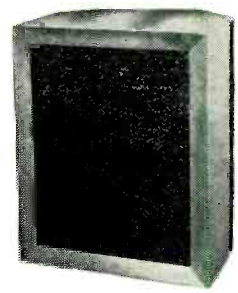
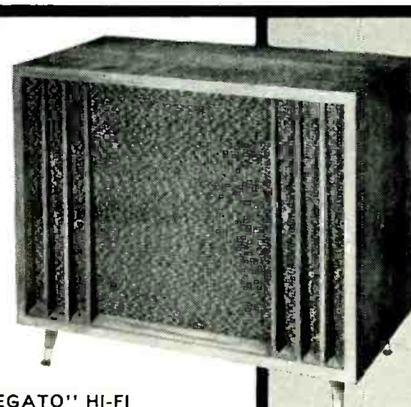
let you save up to ½ or more on all types of electronic equipment.

"BASIC RANGE" HI-FI SPEAKER SYSTEM



"RANGE EXTENDING" HI-FI SPEAKER SYSTEM

Superlative sound reproduction through the speaker system of your choice



"LEGATO" HI-FI SPEAKER SYSTEM

HEATHKIT SINE-SQUARE GENERATOR

The new AG-10 provides high quality, sine and square waves over a wide range, for countless applications. Some of these are; radio and TV repair work, checking scope performance, as a variable trigger source for telemetering and pulse work, and checking audio, video and hi-fi amplifier response. Frequency response is ±1.5 db from 20 CPS to 1 MC on both sine and square waves, with less than .25% sine wave distortion, 20 to 20,000 CPS. Sine wave output impedance 600 ohms, square wave output impedance 50 ohms, (except on 10v ranges). Square wave rise time less than .15 usec. Five-position band switch—continuously variable tuning—shielded oscillator circuit—separate step and variable output attenuators in ranges of 10, 1, and .1 volts for both sine and square wave, with extra range of .01 volt on sine wave. Both sine and square wave can be used at the same time without affecting either wave form. Power supply uses silicon-diode rectifiers. Shpg. Wt. 12 lbs.

MODEL AG-10

$49.95

HEATHKIT AUDIO ANALYZER KIT

The AA-1 is actually three instruments in one compact package. It combines the functions of an AC VTVM, an audio wattmeter, and an intermodulation analyzer. Input and output terminals are combined, and high and low frequency oscillators are built in. VTVM ranges are 0-.01, .03, .1, .3, 1, 3, 10, 30, 100 and 300 volts (RMS). Wattmeter ranges are .15 mw, 1.5 mw, 15 mw, 150 mw, 1.5 w, 15 w and 150 w. IM scales are 1%, 3%, 10%, 30% and 100%. Provides internal load resistors of 4, 8, 16 or 600 ohms. A tremendous dollar value. Shpg. Wt. 13 lbs.

MODEL AA-1

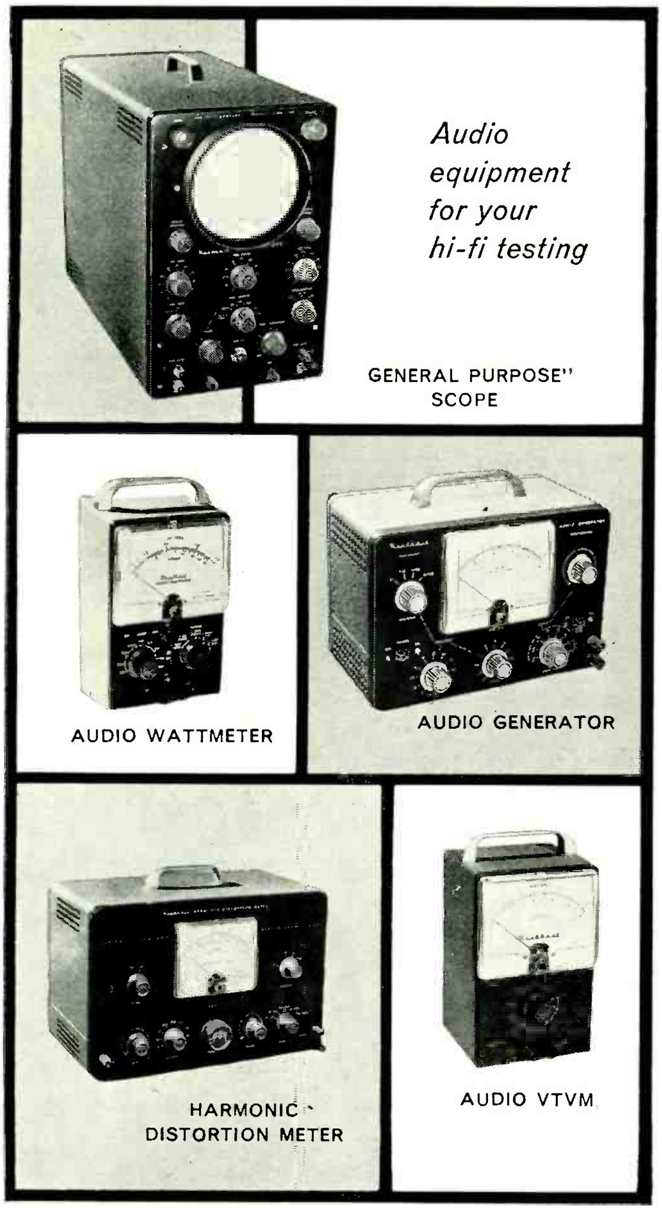
$49.95

SINE-SQUARE GENERATOR

AUDIO ANALYZER

Sine and square waves for countless applications.

HEATH COMPANY *A Subsidiary of Daystrom, Inc.* **BENTON HARBOR 20, MICH.**



HEATHKIT "GENERAL PURPOSE" 5" OSCILLOSCOPE KIT

The model OM-2 Oscilloscope is especially popular with part-time service technicians, students, and high fidelity enthusiasts. It features good vertical frequency response ±3 db from 4 cps to over 1.2 mc. A full five-inch crt. and sweep generator operation from 20 cps to over 150 kc. Stability is excellent and calibrated grid screen allows precise signal observation. Extra features include external or internal sweep and sync, 1-volt peak-to-peak calibrating reference, 3-position step-attenuated input, adjustable spot shape control, push-pull horizontal and vertical amplifiers, and modern etched-metal circuits. Easy to build and a pleasure to use. Ideal for use with other audio equipment for checking amplifiers. Shpg. Wt. 21 lbs.

MODEL OM-2
$42.50

HEATHKIT AUDIO WATTMETER KIT

The AW-1 Audio Wattmeter can be used in any application where audio power output is to be measured. Non-inductive LOAD resistors are built in for 4, 8, 16 or 600 ohms impedance. Five power ranges cover 0-5 mw, 50 mw, 500 mw, 5 w, and 50 w full scale. Five switch-selected db ranges cover −10 db to +30 db. All indications are read directly on a large 4½" 200 microampere meter. Frequency response is ±1 db from 10 cps to 250 kc. Precision type multiplier resistors used for high accuracy, and crystal diode bridge for wide-range frequency response. This meter is used in many recording studios and broadcast stations as a monitor as well as servicing. A fine meter to help supply the answers to your audio operating or power output problems. Shpg. Wt. 6 lbs.

MODEL AW-1
$29.50

HEATHKIT AUDIO SIGNAL GENERATOR KIT

The model AG-9A is "made to order" for high fidelity applications, and provides quick and accurate selection of low-distortion signals throughout the audio range. Three rotary switches select two significant figures and a multiplier to determine audio frequency. Incorporates step-type and a continuously variable output attenuator. Output indicated on large 4½" panel meter, calibrated in volts and db. Attenuator system operates in 10 db steps, corresponding to meter calibration, in ranges of 0-.003, .01, .03, .1, .3, 1,3 and 10 volts RMS. "Load" switch permits use of built-in 600-ohm load, or external load of different impedance. Output and frequency indicators accurate to within ±5%. Distortion less than .1 of 1% between 20 and 20,000 cps. Total range is 10 cps to 100 kc. Shpg. Wt. 8 lbs.

MODEL AG-9A
$34.50

HEATHKIT HARMONIC DISTORTION METER KIT

All sounds consist of dominant tones plus harmonics (overtones). These harmonics enrich the quality and brightness of the music. However, additional harmonics which originate in the audio equipment, represent distortion. Used with an audio signal generator, the HD-1 will accurately measure this harmonic distortion at any or all frequencies between 20 and 20,000 cps. Distortion is read directly on the panel meter in ranges of 0-1, 3, 10, 30 and 100% full scale. Voltage ranges of 0-1, 3, 10 and 30 volts are provided for the initial reference settings. Signal-to-noise ratio measurements are also permitted through the use of a separate meter scale calibrated in db. High quality components insure years of outstanding performance. Full instructions are provided. Shpg. Wt. 13 lbs.

MODEL HD-1
$49.50

Heathkits...

By DAYSTROM

are well known for their high quality and reliability.

HEATHKIT AUDIO VTVM KIT

This new and improved AC Vacuum Tube Voltmeter is designed especially for audio measurements and low-level AC measurements in power supply filters, etc. Employs an entirely new circuit featuring a cascode amplifier with cathode-follower isolation between the input and the amplifier, and between the output stage and the preceding stages. It emphasizes stability, broad frequency response, and sensitivity. Frequency response is essentially flat from 10 cps to 200 kc. Input impedance is 1 megohm at 1000 cps. AC (RMS) voltage ranges are 0-.01, .03, .1, .3, 1, 3, 10, 30, 100 and 300 volts. Db ranges cover −52 db to +52 db. Features large 4½" 200 microampere meter, with increased damping in meter circuit for stability in low frequency tests. 1% precision resistors employed for maximum accuracy. Stable, reliable performance in all applications. Shpg. Wt. 5 lbs.

MODEL AV-3
$29.95

HEATHKIT COLOR BAR AND DOT GENERATOR

The CD-1 combines the two basic color service instruments, a Color Bar Generator and White Dot Generator in one versatile portable unit, which has crystal-controlled accuracy and stability (no external sync lead required). Produces white-dots, cross hatch, horizontal and vertical bars, 10 vertical color bars, and a new shading bar pattern for screen and background adjustments. Variable RF output on any channel from 2 to 6. Positive or negative video output, variable from 0 to 10 volts peak-to-peak. Crystal controlled sound carrier with off-on switch. Voltage regulated power supply using long-life silicon rectifiers. Gain knowledge of a new and profitable field by constructing this kit. Shpg. Wt. 12 lbs.

MODEL CD-1

$59.95

Heathkits...

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are guaranteed to meet or exceed advertised specifications

HEATHKIT TV ALIGNMENT GENERATOR KIT

This fine TV alignment generator offers stability and flexibility difficult to obtain even in instruments costing several times this low Heathkit price. It covers 3.6 mc to 220 mc in four bands. Sweep deviation is controllable from 0 to 42 mc. The all-electronic sweep circuit insures stability. Crystal marker and variable marker oscillators are built in. Crystal (included with kit) provides output at 4.5 mc and multiples thereof. Variable marker provides output from 19 to 60 mc on fundamentals and from 57 to 180 mc on harmonics. Effective two-way blanking to eliminate return trace. Phasing control. Kit is complete, including three output cables. Shpg. Wt. 16 lbs.

MODEL TS-4A

$49.50

HEATHKIT "EXTRA DUTY" 5" OSCILLOSCOPE KIT

This fine oscilloscope compares favorably to other scopes costing twice its price. It contains the extra performance so necessary for monochrome and color-TV servicing. Features push-pull horizontal and vertical output amplifiers, a 5UPI CRT, built in peak-to-peak calibration source, a fully compensated 3-position step-type input attenuator, retrace blanking, phasing control, and provision for Z-axis modulation. Vertical amplifier frequency response is within +1.5 and −5 db from 3 CPS to 5 MC. Response at 3.58 MC down only 2.2 db. Sensitivity is 0.025 volts RMS/inch at 1 kc. Sweep generator covers 20 CPS to 500 kc in five steps, five times the usual sweep obtained in other scopes through the use of the patented Heath sweep circuit. Etched-metal circuit boards reduce assembly time and minimize errors in assembly, and more importantly, permit a level of circuit stability never before achieved in an oscilloscope of this type. Shpg. Wt. 21 lbs.

MODEL O-11

$69.50

HEATHKIT ELECTRONIC SWITCH KIT

A valuable accessory for any oscilloscope owner. It allows simultaneous oscilloscope observation of two signals by producing both signals, alternately, at its output. Four switching rates. Provides gain for input signals. Frequency response ±1 db, 0 to 100 kc. A sync output is provided to control and stabilize scope sweep. Ideal for observing input and output of amplifiers simultaneously. Shpg. Wt. 8 lbs.

MODEL S-3

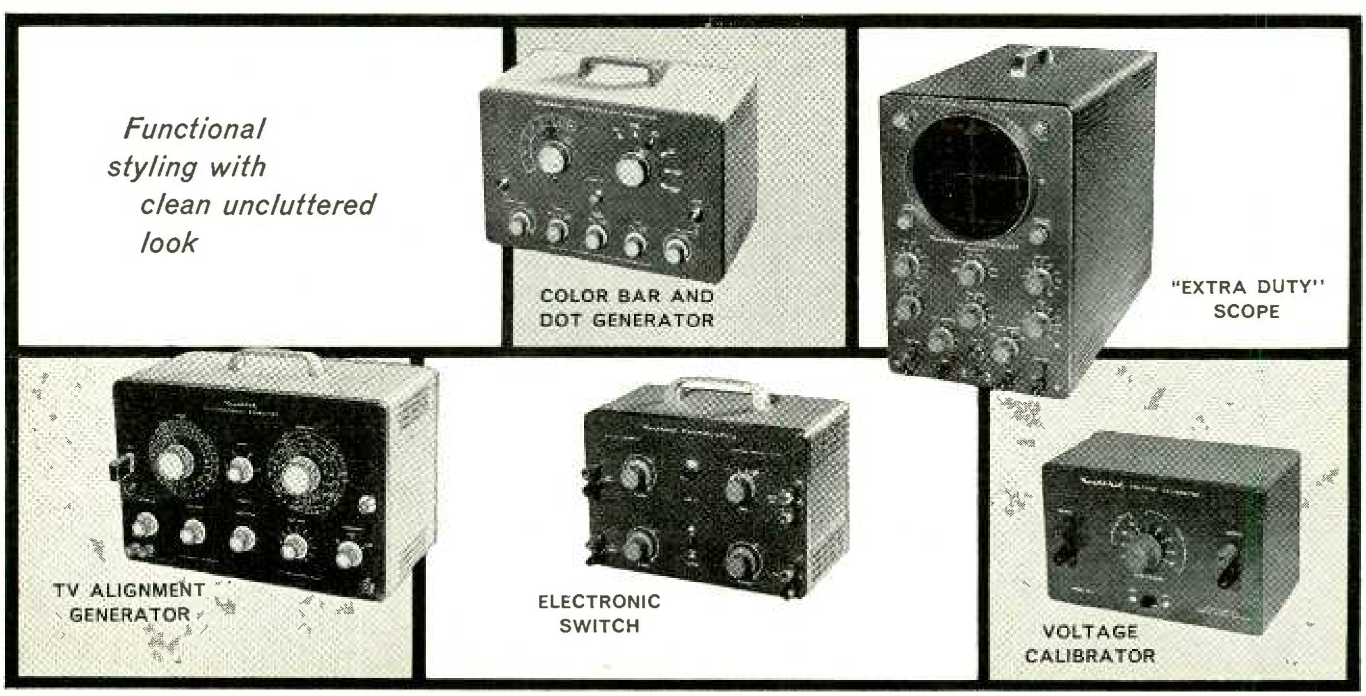
$21.95

HEATHKIT VOLTAGE CALIBRATOR KIT

This unit is an excellent companion for your oscilloscope. Used as a source of calibrating voltage, it produces near-perfect square wave signals of known amplitude. Precision 1% attenuator resistors insure accurate output amplitude, and multivibrator circuit guarantees good sharp square waves. Output frequency is approximately 1000 CPS. Fixed outputs selected by panel switches are; .03, 0.1, 0.3, 1.0, 3.0, 10, 30 and 100 volts peak-to-peak. Allows measurment of unknown signal amplitude by comparing it to the known output of the VC-3 on oscilloscope. Shpg. Wt. 4 lbs.

MODEL VC-3

$12.50



HEATH COMPANY *A Subsidiary of Daystrom, Inc.* **BENTON HARBOR 20, MICH.**

HEATHKIT TUBE CHECKER KIT

Eliminate guesswork, and save time in servicing or experimenting. The TC-2 tests tubes for shorted elements, open elements, filament continuity, and operating quality on the basis of total emission. It tests all tube types encountered in radio and TV service work. Sockets are provided for 4, 5, 6 and 7-pin, octal, and loctal tubes, 7 and 9 pin miniature tubes, 5 pin hytron miniatures, and pilot lamps. Tube condition indicated on 4½" meter with multi-color "good-bad" scale. Illuminated roll chart with all test data built in. Switch selection of 14 different filament voltages from .75 to 117 volts. Color-coded cable harness allows neat professional wiring and simplifies construction. Very easy to build, even for a beginner. Shpg. Wt. 12 lbs.

MODEL TC-2

$29.50

HEATHKIT HANDITESTER KIT

The small size and rugged construction of this tester makes it perfect for any portable application. The combination function-range switch simplifies operations. Measures AC or DC voltage at 0-10, 30, 300, 1000 and 5000 volts. Direct current ranges are 0-10 ma and 0-100 ma. Ohmmeter ranges are 0-3000 (30 ohm center scale) and 0-300,000 (3000 ohm center scale). Very popular with home experimenters, electricians, and appliance repairmen. Slips easily into your tool box, glove compartment, coat pocket, or desk drawer. Shpg. Wt. 3 lbs.

MODEL M-1

$17.95

HEATHKIT PICTURE TUBE CHECKER KIT

The CC-1 can be taken with you on service calls so that you can clearly demonstrate the quality of a customer's picture tube in his own home. Tubes can be tested without removing them from the receiver or cartons if desired. Checks cathode emission, beam current, shorted elements, and leakage between elements in electromagnetic picture tube types. Self-contained power supply, and large 4½" meter. CRT condition indicated on "good-bad" scale. Relative condition of tubes fluorescent coating is shown in "shadowgraph" test. Permanent test cable with CRT socket and anode connector. No tubes to burn out, designed to last a lifetime. Luggage-type portable case. Shpg. Wt. 10 lbs.

MODEL CC-1

$24.95

HEATHKIT ETCHED-CIRCUIT VTVM KIT

This multi-purpose VTVM is the world's largest selling instrument of its type—and is especially popular in laboratories, service shops, home workshops and schools. It employs a large 4½" panel meter, precision 1% resistors, etched metal circuit board, and many other "extras" to insure top quality and top performance. It's easy to build, and you may rely on its accuracy and dependability. The V7-A will measure AC (RMS) and DC voltages in ranges of 0-1.5, 5, 15, 50, 150, 500 and 1500. It measures peak-to-peak AC voltage in ranges of 0-4, 14, 40, 140, 400, 1400 and 4000. Resistance ranges provide multiplying factors of X 1, X 10, X 100, X 1000, X 10k, X 100k, and X 1 megohm. Center-scale resistance readings are 10, 100, 1000, 10k, 100k, 1 megohm and 10 megohms. A db scale is also provided. The precision and quality of this VTVM cannot be duplicated at this price. Shpg. Wt. 7 lbs.

MODEL V7-A

$24.50

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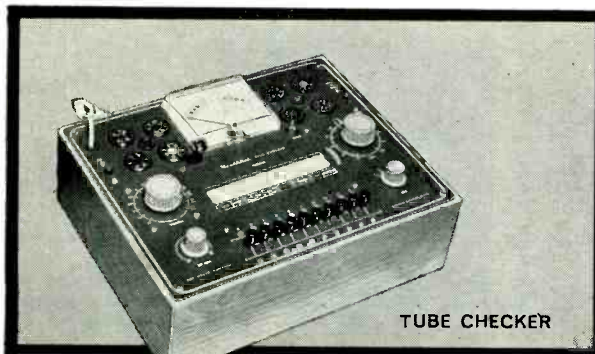
let you fill your exact needs from a wide variety of instruments

HEATHKIT 20,000 OHMS/VOLT VOM KIT

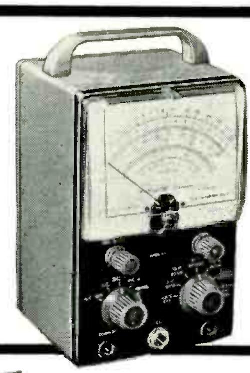
This fine instrument provides a total of 25 meter ranges on its two-color scale. It employes a 50 ua 4½" meter, and features 1% precision multiplier resistors. Requires no external power. Ideal for portable applications. Sensitivity is 20,000 ohms-per-volt DC and 5000 ohms-per-volt AC. Measuring ranges are 0-1.5, 5, 50, 150, 500, 1500 and 5000 volts, AC and DC. Measures direct current in ranges of 0-150 ua, 15 ma, 150 ma, 500 ma and 15 a. Resistance multipliers are X 1, X 100 and X 10,000, with center-scale readings of 15, 1500 and 150,000 ohms. Covers −10 db to +65 db. Easy to build and fun to use. Attractive bakelite case with plastic carrying handle. Shpg. Wt. 6 lbs.

MODEL MM-1

$29.95

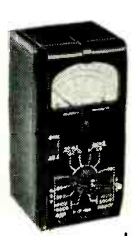


TUBE CHECKER



High quality test gear you will be proud to own

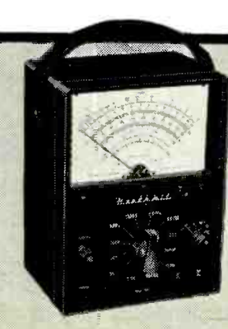
ETCHED CIRCUIT VTVM



Priced low to fit your budget

HANDITESTER

PICTURE TUBE CHECKER



20,000 OHMS/VOLT VOM

HEATHKIT RF SIGNAL GENERATOR KIT

Even a beginner can build this prealigned signal generator, designed especially for use in service work. Produces RF signals from 160 kc to 110 mc on fundamentals in five bands. Covers 110 mc to 220 mc on calibrated harmonics. Low impedance RF output in excess of 100,000 microvolts, is controllable with a step-type and continuously variable attenuator. Selection of unmodulated RF, modulated RF, or audio at 400 CPS. Ideal for fast and easy alignment of radio receivers, and finds application in FM and TV work as well. Thousands of these units are in use in service shops all over the country. Easy to build and a real time saver, even for the part-time service technician or hobbyist. Shpg. Wt. 8 lbs.

MODEL SG-8

$19.50

HEATHKIT LABORATORY RF GENERATOR KIT

Tackle all kinds of laboratory alignment jobs with confidence by employing the LG-1. It features voltage-regulated B+, double shielding of oscillator circuits, copper-plated chassis, variable modulation level, metered output, and many other "extras" for critical alignment work. Generates RF signals from 100 kc to 30 mc on fundamentals in five bands. Meter reads RF output in microvolts or modulation level in percentage. RF output available up to 100,000 microvolts, controlled by a fixed-step and a variable attenuator. Provision for external modulation where necessary. Buy and use this high-quality RF signal generator that may be depended upon for stability and accuracy. Shpg. Wt. 16 lbs.

MODEL LG-1

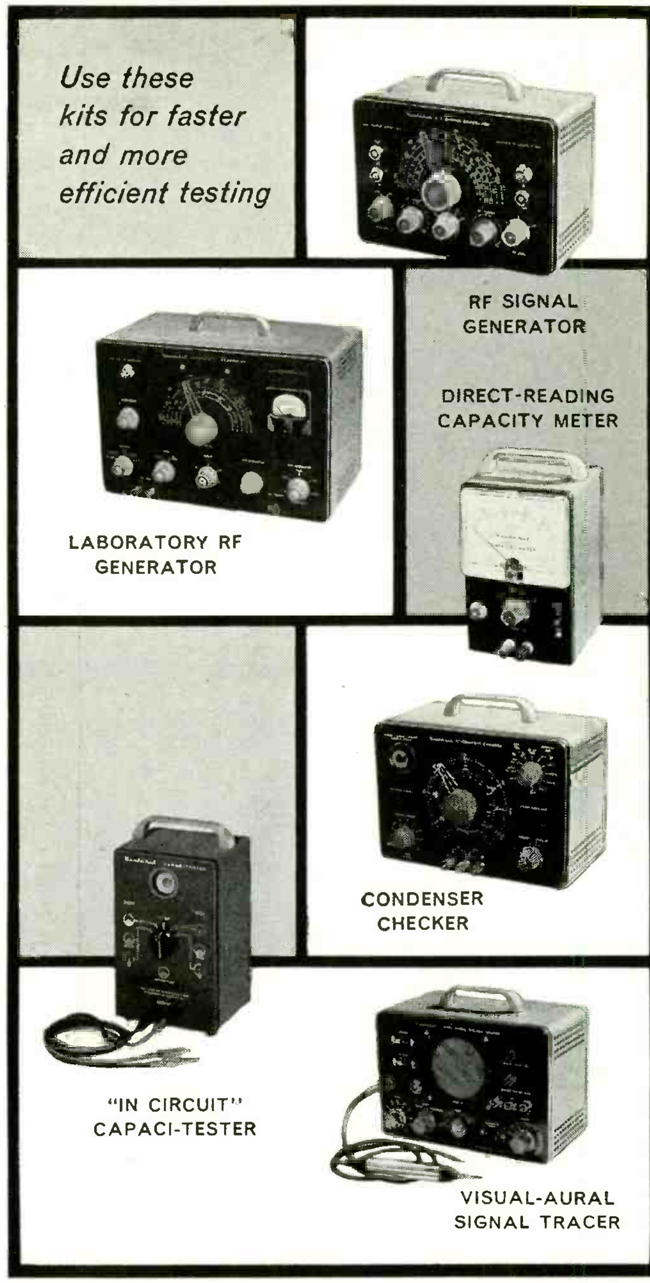
$48.95

HEATHKIT DIRECT-READING CAPACITY METER KIT

Here's a fast, simple capacity meter. A capacitor to be checked is merely connected to the terminals, the proper range selected, and the value read directly on the large 4½" panel meter calibrated in mmf and mfd. Ranges are 0 to 100 mmf, 1,000 mmf, .01 mfd, .1 mfd full scale. Not affected by hand capacity. Shpg. Wt. 7 lbs.

MODEL CM-1

$29.50



Heathkits...

By DAYSTROM

are educational as well as functional

HEATHKIT "IN-CIRCUIT" CAPACI-TESTER KIT

With the CT-1 it is no longer necessary to disconnect one capacitor lead to check the part, you can check most capacitors for "open" or "short" right in the circuit. Fast and easy—to save your valuable time in the service shop or lab. Detects open capacitors from about 50 mmf up, so long as the capacitor is not shunted by excessively low resistance value. Will detect shorted capacitors up to 20 mfd (not shunted by less than 10 ohms). (Does not detect leakage.) Employs 60 cycles and 19 megacycle test frequencies. Electron beam "eye" tube used as indicator. Compact, easy-to-build, and inexpensive. Test leads included. Shpg. Wt. 5 lbs.

MODEL CT-1

$7.95

HEATHKIT CONDENSER CHECKER KIT

This handy instrument uses an electron beam "eye" tube as an indicator to measure capacity in ranges of .00001 to .005 mfd, .5 mfd, 50 mfd and 1000 mfd. Also measures resistance from 100 ohms to 5 megohms in two ranges. Checks paper, mica, ceramic and electrolytic capacitors. Selection of five polarizing voltages. Shpg. Wt. 7 lbs.

MODEL C-3

$19.50

HEATHKIT VISUAL-AURAL SIGNAL TRACER KIT

Although designed originally for radio receiver work, the T-3 finds application in FM and TV servicing as well. Features high-gain channel with demodulator probe, and low-gain channel with audio probe. Traces signals in all sections of radio receivers and in many sections of FM and TV receivers. Built-in speaker and electron beam eye tube indicate relative gain, etc. Also features built-in noise locator circuit. Provision for patching speaker and/or output transformer to external set. Shpg. Wt. 9 lbs.

MODEL T-3

$23.50

HEATH COMPANY *A Subsidiary of Daystrom, Inc.* **BENTON HARBOR 20, MICH.**

HEATHKIT IMPEDANCE BRIDGE KIT

The model IB-2A employs a Wheatstone Bridge, a Capacity Comparison Bridge, a Maxwell Bridge, and a Hay Bridge in one compact package. Measures resistance from 0.1 ohm to 10 megohms, capacitance from 100 mmf to 100 mfd, inductance from 0.1 mh to 100 h, dissipation factor (D) from 0.002 to 1, and storage factor (Q) from 0.1 to 1000. A 100-0-100 ua meter provides for null indications. The decade resistors employed are of 1% tolerance for maximum accuracy. Completely self-contained. Has built in power supply, 1000-cycle generator, and vacuum-tube detector. Special two-section CRL dial insures convenient operation. Instruction manual has entirely new schematic that clarifies circuit functions in various switch positions. A true laboratory instrument, that will provide you with many years of fine performance. Shpg. Wt. 12 lbs.

MODEL IB-2A **$59.50**

HEATHKIT "LOW RIPPLE" BATTERY ELIMINATOR KIT

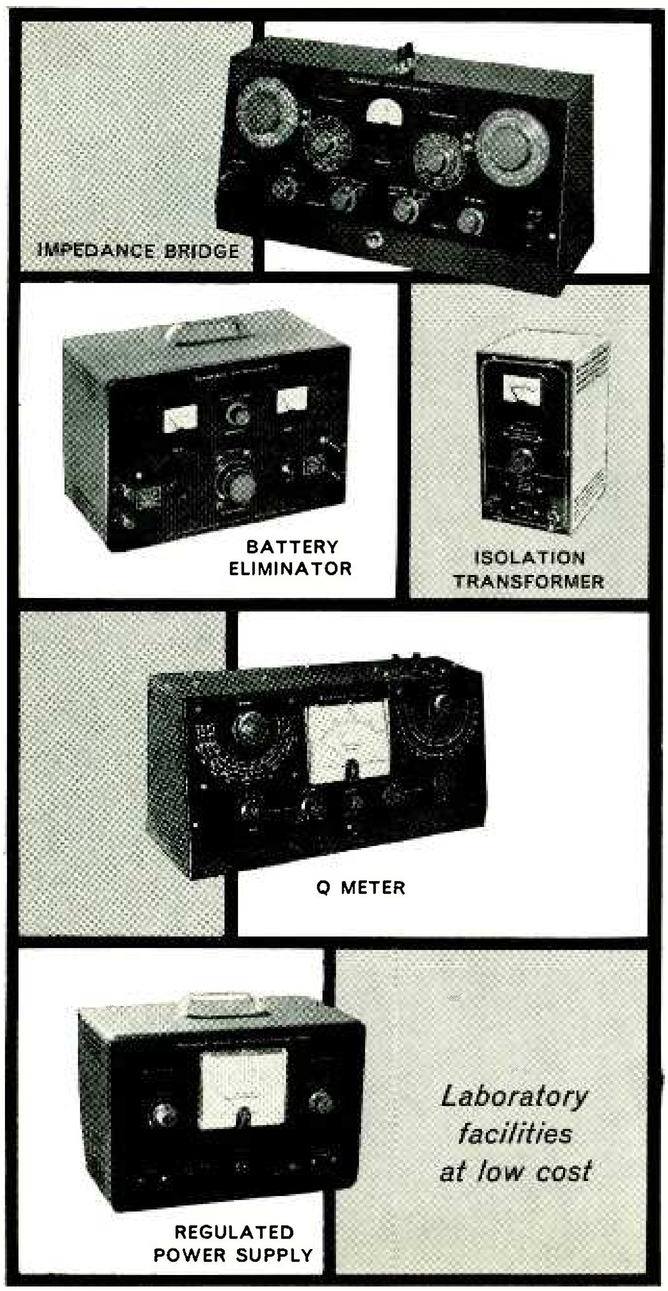
This modern battery eliminator incorporates an extra low-ripple filter circuit so that it can be used to power all the newest transistor-type circuits requiring 0 to 12 volts DC, and the new "hybrid" automobile radios using both transistors and vacuum tubes. Its DC output, at either 6 or 12 volts, contains less than .3% AC ripple. Separate output terminals are provided for low-ripple or normal filtering. Supplies up to 15 amps on 6 volt range or up to 7 amps on 12 volt range. Output is variable from 0 to 8 or 0 to 16 volts. Two meters constantly monitor output voltage and current. Will also double as a battery charger. Shpg. Wt. 23 lbs.

MODEL BE-5 **$39.95**

HEATHKIT ISOLATION TRANSFORMER KIT

The model IT-1 is one of the handiest units for the service shop, home workshop or laboratory. Provides complete isolation from the power line. AC-DC sets may be plugged directly into the IT-1 without the chassis becoming "hot". Output voltage is variable from 90 volts to 130 volts allowing checks of equipment under adverse conditions such as low line voltage. Rated for 100 volt amperes continuously or 200 volt amperes intermittently. Panel meter monitors output voltage. Shpg. Wt. 9 lbs.

MODEL IT-1 **$16.50**



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are designed with high-quality, name-brand components to insure long service life

HEATHKIT "Q" METER KIT

At this price the laboratory facilities of a Q Meter may be had by the average service technician or home experimenter. The Q Meter permits measurement of inductance from 1 microhenry to 10 milihenry, "Q" on a scale calibrated up to 250 full scale, with multipliers of 1 or 2, and capacitance from 40 mmf to 450 mmf ± 3 mmf. Built in oscillator permits testing components from 150 kc to 18 mc. Large 4½" panel meter is featured. Very handy for checking peaking coils, chokes, etc. Use to determine values of unknown condensers, both variable and fixed, compile data for coil winding purposes, or measure RF resistance. Also checks distributed capacity and Q of coils. No special equipment is required for calibration. A special test coil is furnished, along with easy-to-follow instructions. Shpg. Wt. 14 lbs.

MODEL QM-1 **$44.50**

HEATHKIT REGULATED POWER SUPPLY KIT

Here is a power supply that will provide DC plate voltage and AC filament voltage for all kinds of experimental circuits. The DC supply is regulated for stability, and yet the amount of DC output voltage available from the power supply can be controlled manually from 0 up to 500 volts. At 450 volts DC output, the power supply will provide up to 10 ma of current, and provide progressively higher current as the output voltage is lowered. Current rating is 130 ma at 200 volts output. In addition to furnishing B+ the power supply also provides 6.3 volts AC at up to 4 amperes for filaments. Both the B+ output and the filament output are isolated from ground. Ideal unit for use in laboratory, home workshop, ham shack, or service shop. A large 4½" meter on the front panel reads output voltage or output current, selectable with a panel switch. Shpg. Wt. 17 lbs.

MODEL PS-3 **$35.50**

HEATHKIT ELECTRONIC IGNITION ANALYZER KIT

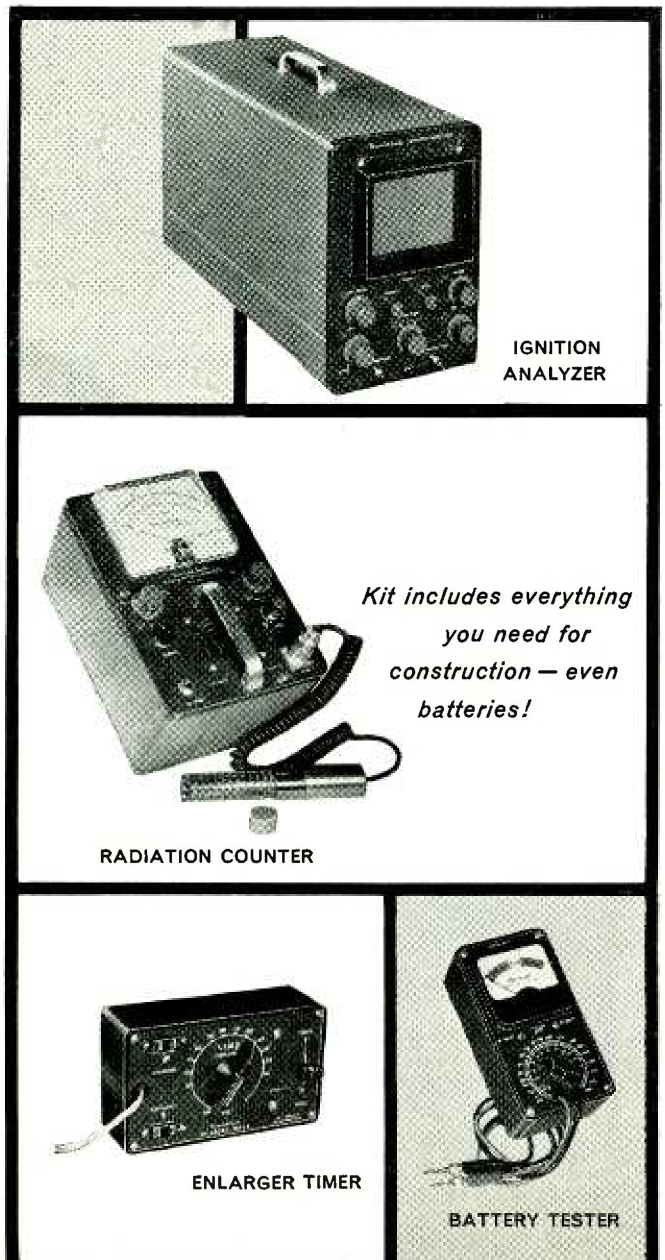
Previous electronic experience is not necessary to build this fine ignition analyzer. The construction manual supplied has complete step-by-step instructions plus large pictorial diagrams showing the exact placement and value of each component. All parts are clearly marked so that they are easily identified. The IA-1 is an ideal tool for engine mechanics, tune-up men, and auto hobbyists, since it traces the dynamic action of voltage in an ignition system on a cathode-ray tube screen. The wave form produced is affected by the condition of the coil, condenser, points, plugs, and ignition wiring, so it can be analyzed, and used as a "sign-post" to ignition system performance. This analyzer will detect inequality of spark intensity, a poor spark plug, defective plug wiring, breaker-point bounce, an open condenser, and allow setting of dwell-time percentage for the points. An important feature of this instrument is its ability to check dynamic performance, with the engine in operation (400 to 5000 RPM). It will show the complete engine cycle, or only one complete cylinder. Can be used on all types of internal combustion engines where breaker-points are accessible. Use it on automobiles, boats, aircraft engines, etc. Shpg. Wt. 18 lbs.

MODEL IA-1
$59.95

HEATHKIT PROFESSIONAL RADIATION COUNTER KIT

This Heathkit professional-type radiation counter is simple to build successfully, even if you have never built a kit before. Complete step-by-step instructions are combined with giant-size pictorial diagrams for easy assembly. By "building it yourself" you can have a modern-design, professional radiation counter priced far below comparable units. Provides high sensitivity with ranges from 0-100, 600, 6000 and 60,000 counts-per-minute, and 0-.02, .1, 1 and 10 miliroentgens-per-hour. Employs 900-volt bismuth tube in beta/gamma sensitive probe. Probe and 8-foot expandable cable included in kit price, as is a radiation sample for calibration. Use it in medical laboratories, or as a prospecting tool, and for civil defense to detect radioactive fallout, or other unknown radiation levels. Features a selectable time constant. Meter calibrated in CPM or mR/hour in addition to "beep" or "click" from panel-mounted speaker. Prebuilt "packaged" high voltage power supply with reserve capacity above 900 volt level at which it is regulated. Merely changing regulator tube type would allow use of scintillation probe if desired. Employs five tubes (plus a transistor) to insure stable and reliable operation. Kit price includes batteries. Shpg. Wt. 8 lbs.

MODEL RC-1
$79.95



Heathkits...

By DAYSTROM

are supplied with comprehensive instructions that eliminate costly mistakes and save valuable time

HEATHKIT ENLARGER TIMER KIT

The ET-1 is an easy-to-build electronic device to be used by amateur or professional photographers in timing enlarger operations. The calibrated dial on the timer covers 0 to 1 minute, calibrated in 5-second gradations. The continuously variable control allows setting of the "on" cycle of your enlarger, which is plugged into a receptacle on the front panel of the ET-1. A "safe light" can also be plugged in so that it is automatically turned "on" when the enlarger is turned "off." Handles up to 350 watts with built-in relay. All-electronic timing cycle insures maximum accuracy. Timer does not have to be reset after each cycle, merely flip lever switch to print, to repeat time cycle. A control is provided for initial calibration. Housed in a compact plastic case that will resist attack of photographic chemicals. A fine addition to any dark room. Shpg. Wt. 3 lbs.

MODEL ET-1
$11.50

HEATHKIT BATTERY TESTER KIT

The BT-1 is a special battery testing device that actually "loads" the battery under test (draws current from it) while it is being tested. Weak batteries often test "good" with an ordinary voltmeter but the built-in load resistance of the BT-1 automatically draws enough current from the battery to reveal its true condition. Simple to operate with "good-weak-replace" scale. Tests all kinds of dry cell batteries within ranges of 0-15 volts and 0-180 volts. Slide switch provides for either 10 ma or 100 ma load, depending on whether you're testing an A or B battery. Not only determines when battery is completely exhausted, but makes it possible to anticipate failure by noting weak condition. Ideal for testing dry cell hearing aid, flashlight, portable radio, and model airplane batteries. Test batteries in a way your customers can understand and stimulate battery sales. Shpg. Wt. 2 lbs.

MODEL BT-1
$8.50

HEATHKIT CRYSTAL RADIO KIT

The Heathkit model CR-1 crystal radio is similar to the "crystal sets" of the early radio days except that it has been improved by the use of sealed germanium diodes and efficient "high-Q" coils. The sealed diodes eliminate the critical "cats whisker" adjustment, and the ferrite coils are much more efficient for greater signal strength. Housed in a compact plastic box, the CR-1 uses two tuned circuits, each with a variable tuning capacitor, to select the local station. It covers the broadcast band from 540 to 1600 kc. Requires no external power whatsoever. This receiver could prove valuable to emergency reception of civil defense signals should there be a power failure. The low kit price even includes headphones. Complete step-by-step instructions and large pictorial diagrams are supplied for easy assembly. The instruction manual also provides the builder with the basic fundamentals of signal reception so that he understands how the crystal receiver functions. An interesting and valuable "do-it-yourself" project for all ages. Shpg. Wt. 3 lbs.

MODEL CR-1
$7.95

Heathkits...

By DAYSTROM

are easy and fun to build,
and they let you learn
by "doing-it-yourself"

HEATHKIT TRANSISTOR PORTABLE RADIO KIT

Heath engineers set out to develop a "universal" AM radio, suitable for use anywhere. Their objective was a portable that would be as much "at home" inside as it is outside, and would feature top quality components for high performance and long service life. The model XR-1 is the result of these efforts. Six name-brand (Texas Instrument) transistors were selected for extra good sensitivity and selectivity. A 4" by 6" PM speaker with heavy magnet was chosen to insure fine tone quality. The power supply was designed to use six standard size "D" flashlight cells because they are readily available, inexpensive, and because they afford extremely long battery life (between 500 and 1000 hours). Costs you no more to operate from batteries than what you pay for operating a small table-model radio from the power line. An unbreakable molded plastic was selected for cabinet material because of its durability and striking beauty. Circuit is compact and efficient, yet components are not excessively crowded. Transformers are prealigned so it is ready for service as soon as construction is completed. Has built in rod-type antenna for reception in all locations. Cabinet dimensions are 9" L x 8" H x 3¾" D. Comes in holiday gray, with gold-anodized metal speaker grille. Compare this portable, feature by feature, to all others on the market, and you'll appreciate what a tremendous dollar value it represents! Shpg. Wt. 4 lbs.

MODEL XR-1
$34.95
(Less batteries)
(With cabinet)

HEATHKIT BROADCAST BAND RADIO KIT

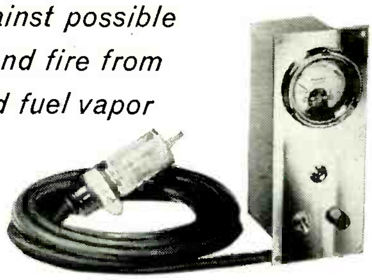
This table-model broadcast radio is fun to build, and is a fine little receiver for your home. It covers the standard broadcast band from 550 to 1600 kc with good sensitivity and selectivity. The 5½" PM speaker provides surprisingly good tone quality. High-gain IF transformers, miniature tubes, and a rod-type built in antenna, assure good reception in all locations. The power supply is transformer operated, as opposed to many of the economy "AC-DC" types. It's easy to build from the step-by-step instructions, and the construction manual includes information on operational theory, for educational purposes. Your success is assured by completely detailed information which also explains resistor and capacitor color codes, soldering techniques, use of tools, etc. A signal generator is recommended for final alignment. Shpg. Wt. 10 lbs.

Cabinet: Fabric covered cabinet with aluminum panel as shown. Shpg. Wt. 5 lbs. Part no. 91-9A. $4.95.

MODEL BR-2
$18.95
(Less cabinet)

HEATH COMPANY *A Subsidiary of Daystrom, Inc.* **BENTON HARBOR 20, MICH.**

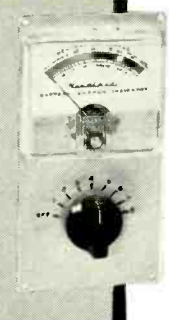
protects against possible explosion and fire from undetected fuel vapor



FUEL VAPOR DETECTOR

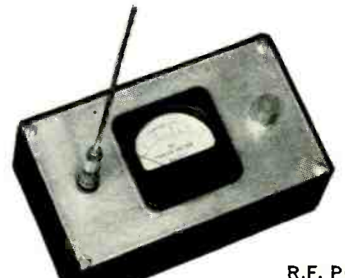
detects electrolysis currents which cause deterioration of underwater metal fittings on your boat

ELECTROLYSIS DETECTOR



indicates condition and charge of batteries for safe cruising

BATTERY CHARGE INDICATOR



R.F. POWER METER

HEATHKIT FUEL VAPOR DETECTOR KIT

Protect your boat and its passengers against fire or explosion from undetected fuel vapor by building and using one of these fine units. The Heathkit Fuel Vapor Detector indicates the presence of fumes on a three-color "safe-dangerous" meter scale and immediately shows if it is safe to start the engine. A pilot light on the front panel shows when the detector is operating, and it can be left on continuously, or just used intermittently. A panel control enables initial calibration of the detector when installed. Features a hermetically-sealed meter with chrome bezel, and a chrome-plated brass panel. It is very simple to build and install, even by one not having previous experience. Models FD-1-6 (6 volts DC) and FD-1-12 (12 volts DC) operate from your boat batteries. The kit is complete in every detail, even to the inclusion of a spare detector unit. Shpg. Wt. 4 lbs.

6 volt MODEL FD-1-6
12 volt MODEL FD-1-12
$35.95 EACH

HEATHKIT BATTERY CHARGE INDICATOR KIT

The Heathkit model CI-1 Marine Battery Charge Indicator has been designed especially for the boat owner, although it has found use in service stations, power stations, and radio stations where banks of batteries are kept in reserve for emergency power. It is intended to replace the hydrometer method of checking storage batteries, and to eliminate the necessity for working with acid in small, below-decks enclosures. Now it is possible to check as few as one, or as many as eight storage batteries, merely by turning the switch and watching the meter. A glance at the meter tells you instantly whether your batteries are sufficiently charged for safe cruising. Dimensions are 2-7/8" W x 5-11/16" H x 2" D. Operates on either 6 or 12 volt systems using lead-acid batteries, regardless of size. Simple installation can be accomplished by the boat owner in fifteen minutes. Shpg. Wt. 3 lbs.

MODEL CI-1
$16.95

HEATHKIT ELECTROLYSIS DETECTOR KIT

The Heathkit model ED-1 Electrolysis Detector indicates the extent of electrolysis currents between the boat's common ground and underwater fittings, except on boats having metal hulls. These currents, undetected, could cause gradual corrosion and deterioration of the propeller or other metal fittings below the water line. It is particularly helpful when installing electrical equipment of any kind, or to determine proper polarity when power is obtained from a shore supply. Easy-to-build, the model ED-1 consists of a hermetically-sealed, waterproof meter, special sensing plate, and sufficient wire to install, including the necessary hardware. Mounts on instrument panel where it can be easily seen. Requires no power for operation, and gives instant warning to guard your boat for a lifetime. Shpg. Wt. 2 lbs.

MODEL ED-1
$9.95

HEATHKIT RF POWER METER KIT

The Heathkit RF Power Meter Kit is designed to sample the RF field in the vicinity of your transmitter, whether it be marine, mobile, or fixed. Output meter is merely placed in some location close to the transmitter, to pick up RF radiation from the antenna. Requires no batteries, electricity, nor direct connection to the transmitter. It provides you with a continuing indication of transmitter operation. You can easily detect if power is dropping off by comparing present meter readings with past ones. Operates with any transmitter having output frequencies between 100 kc and 250 mc, regardless of power. Sensitivity is 0.3 volts RMS full scale, and a special control on the panel allows for further adjustment of the sensitivity. Meter is a 200 ua unit, mounted on a chrome-plated brass panel. The entire PM-1 measures only 3¾" W x 6¼" L x 2" D. An easy way to put your mind at ease concerning transmitter operation. Shpg. Wt. 2 lbs.

MODEL PM-1
$14.95

Heathkits...

By DAYSTROM

now offer you completely modern marine equipment with outstanding design features

HEATHKIT TRANSISTOR RADIO DIRECTION FINDER KIT

The Heathkit Transistor Radio Direction Finder model DF-1 is a self-contained, self-powered, 6-transistor super heterodyne broadcast radio receiver incorporating a directional loop antenna, indicating meter, and integral speaker. It is designed to serve primarily as an aid to navigation when out of sight of familiar landmarks. It can be used not only aboard yachts, fishing craft, tugs, and other vessels which navigate either out of sight of land or at night, but also for the hunter, hiker, camper, fisherman, aviator, etc. It is powered by a 9-volt battery. (A spare battery is also included with the kit). The frequency range covers the broadcast band from 540 to 1600 kc and will double as a portable radio. A directional high-Q ferrite antenna is incorporated which is rotated from the front panel to obtain a fix on a station and a 1 ma meter serves as the null and tuning indicator. The controls consist of: tuning, volume and power (on-off), sensitivity, heading indicator (compass rose) and bearing indicator (antenna index). Overall dimensions are 7½" W x 5⅞" H x 5⅜" D. Supplied with slip-in-place mounting brackets, which allow easy removal from ship bulkheads or other similar places. Shpg. Wt. 5 lbs.

MODEL DF-1

$54.95

TRANSISTOR
RADIO DIRECTION FINDER

Heathkits...

By DAYSTROM

are sold only by direct mail, passing middleman profits on to you

Pioneer in "do-it-yourself" electronics

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The Heath Company maintains a technical consultation service, should you experience some sort of difficulty in construction or operation. Although only a very small percentage of our customers ever have occasion to use this service (usually only beginners in electronics) it is still reassuring to know that technical help is available when needed. A service department is also available, should you wish a complete factory check of operation and alignment or repair. After you build your first Heathkit you'll realize how easy it is.

Free Catalog

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AUDIO—HIGH FIDELITY

(*Continued from page* 61)

counterbalanced by a weight in the rear portion of the hollowed-out wooden arm. See Fig. 2 for a detailed view of the base, pivot assembly and counterweight.

The Weathers arm uses viscous damping on both vertical and horizontal pivots. Fig. 2 clearly shows the vertical pivot which has two washers (appearing to be nylon or Teflon) between the rotating cylinder attached to the arm and the U-bracket attached to the horizontal pivot. The space between these washers and the rotating cylinder is filled with a silicone grease which provides viscous damping in the vertical plane. Enough damping is used so that the arm's descent is always gentle, even if it is dropped in handling.

The horizontal pivot employs a cylinder of the same plastic material used in the vertical pivot. It is surrounded by the damping grease and provides a viscous drag when the arm is moved laterally. Extended use of this arm has shown that there is no appreciable tendency for the grease to leak out or lose its damping properties.

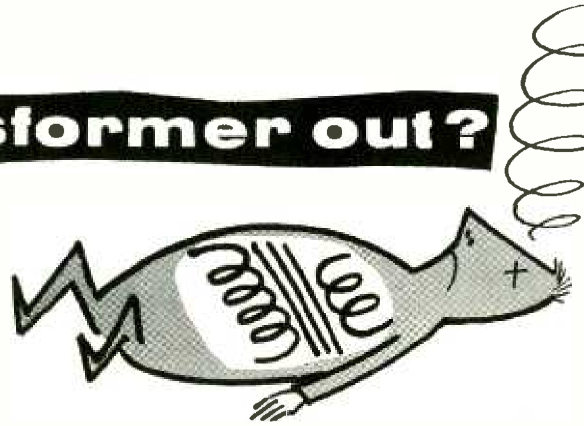
The stylus force of the Weathers arm is set at the factory by adjusting the counterweight visible in Fig. 2. Since this arm is used only with the Weathers pickup, there is no need to adjust the tracking force from its normal setting of 3 grams.

Although the Weathers arm is not balanced laterally, it has little tendency to jump grooves and is stable even when considerably off level. This is due to the stabilizing and damping properties of the viscous material in the pivot bearings.

The only height adjustment on the Weathers arm is a rubber ring of the same diameter as the base and about ½ inch thick. If the turntable is unusually high, the ring may be installed under the arm base as a shim. Since the Weathers pickup is not unduly critical as to the angle the arm makes with the record surface, this rather crude method of height adjustment is adequate.

In the final article of this series, I will describe several arms of unconventional design, representing different approaches to the problem of reducing tracking-angle error. TO BE CONTINUED

Is the Output Transformer out?



Merits of transformerless amplifiers are compared to those of conventional types. Distortion, power and circuitry are discussed

By HERBERT RAVENSWOOD

THERE seem to be two reasons for wanting to dispense with output transformers—they *cause* distortion and they are the principal obstacles to reducing distortion *due to other causes*. Both reasons are open to discussion.

To get a little perspective on the problem, let's examine the amounts of distortion involved and where they come from. The contention that the output transformer causes distortion is somewhat out of date. Modern high-quality output transformers *may* run into saturation at the low-frequency end of their response. But—provided the saturation region is not encroached upon—maximum distortion caused by the transformer at the lowest operating frequency falls between 2 and 5%. Very often it is considerably less. By using operating conditions that produce a high damping factor, the *effective* distortion produced by the output transformer can be reduced far below this.

But, anyway, this distortion figure (2–5%) is for a frequency between 20 and 60 cycles. At middle frequencies (600 to 1,000 cycles), distortion introduced by the transformer, *before feedback is employed to reduce it*, is down to less than 1/10 that figure. So the maximum basic distortion a transformer is likely to produce ranges from 0.25 to 0.5% over the greater part of the audio spectrum. Compared to this, output tubes have distortion figures, over the whole of the audio range, between 2 and 5% at maximum output.

Thus it is evident that the output tubes are a greater source of distortion than the output transformer. This brings us to the second objection to output transformers—they restrict the measures that can be taken to reduce distortion. This is true.

An output transformer introduces two extra stability criteria (or should it be *in*stability criteria?) for feedback at the high-frequency end and seriously complicates design attempts to increase feedback to reduce distortion due to output tubes. Overall feedback around an amplifier using an output transformer can seldom exceed 20 db. A few types raise the feedback to 26 db, while some employ no more than about 14 db. This means the reduction in distortion permitted in an amplifier with an output transformer is between 5 to 1 and 20 to 1. A distortion figure of 5% can be reduced to between 0.25 and 1%.

By contrast, some of the OTL's (*O*utput *T*ransformer*L*ess amplifiers) use as much as 40-db feedback, which reduces distortion by a factor of 100 to 1. These are the facts; unfortunately this is not all there is to it. To get a true assessment of the relative merit of different circuits, we must consider several factors besides how much distortion the tubes give and how much feedback we can use to reduce it.

Another basic factor is cost. While some hi-fi addicts may be fortunate enough to pursue quality regardless of cost, economy has to be considered by most of us.

Notch distortion

Where the need is to produce a higher power output economically, tubes must be operated more efficiently. First we step from triode to pentode and finally to class-B push-pull. These steps toward better tube utilization introduce further complications into transformer design. A good, fat, output transformer that would perform very well with simple class-A push-pull operation might be pushed into service for class-B triode operation and still give passable performance. But when we use pentodes (or beam tetrodes) in class-B push-pull, or even class-AB push-pull, we run into such things as the well known notch distortion.

This should not be confused with crossover distortion, caused by overbiasing the output tubes. It sometimes occurs when maximum output is slightly exceeded, due to grid current on the positive excursion biasing the tubes further back and causing a short period during which both tubes are cut off. Waveforms of notch and crossover distortion are shown in Fig. 1.

Notch distortion is due to a reactance effect in the output transformer. Due to the high-impedance source on the primary—pentode plate resistance is many times the optimum load resistance—the combination of leakage inductance with primary capacitance causes a sort of resonance notch to occur in the transition from the plate current flowing in one tube to that in the other tube (Fig. 2). This effect characteristically becomes more noticeable as the test frequency is raised. Notch distortion does not usually show up below 1,000 cycles but becomes more excessive starting at about 3,000 cycles.

The discovery of notch distortion—and blaming it on the output transformer—has added more urgency to the call for eliminating output transformers and switching to OTL's. A variety of such circuits have appeared and it is pertinent to consider their relative merits in a little more detail.

Immediately upon trying to dispense with the output transformer, we are handed the problem of using a speaker that directly provides the necessary

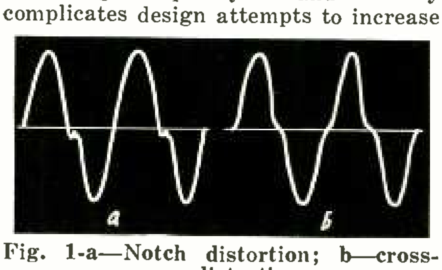


Fig. 1-a—Notch distortion; b—crossover distortion.

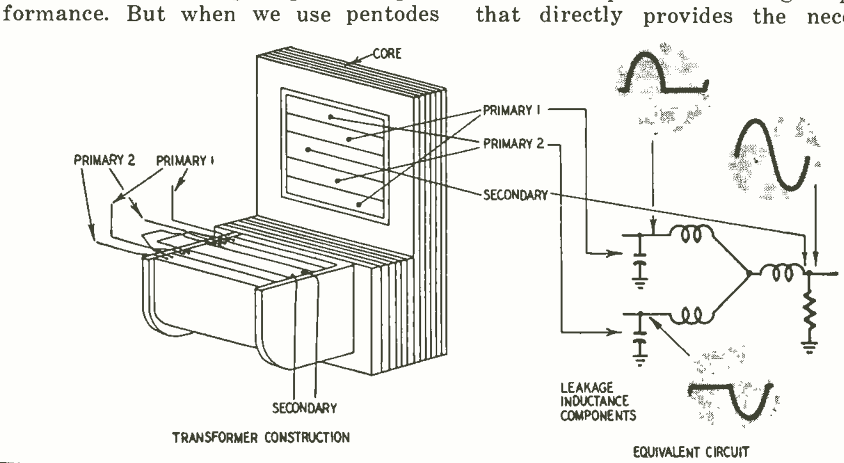
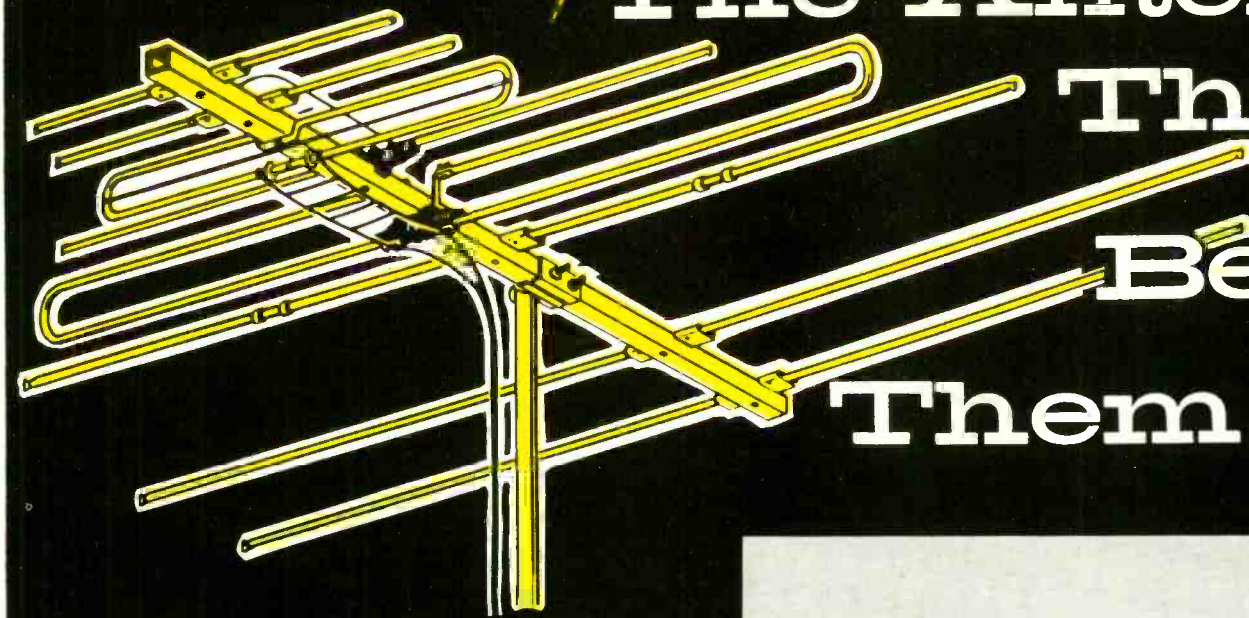


Fig. 2—The components in an output transformer responsible for notch distortion in class-B pentode operation.

G-C-TELCO

GOLDEN INVADER

The Antenna That Beats Them All!



TRY TELCO'S NEW GOLDEN INVADER, the powerful antenna for VHF fringe areas and UHF primary areas. Extensive tests prove its uni-plane design can pull in stations from as far as 200 miles away. Ghosts and co-channel interference are eliminated. The GOLDEN INVADER, for color or black-and-white TV, comes pre-assembled with the new Snap-Lock construction that makes it easier to handle, easier to install. Available in single bay (illustrated), two-bay or four-bay models.

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- BEAUTIFUL GOLD ANODIZING
- NEW SNAP-LOCK DESIGN
- RECEPTION UP TO 200 MILES AWAY

No. A-8121 Single Bay.......List $29.95
A-8122 Two-Bay................59.95

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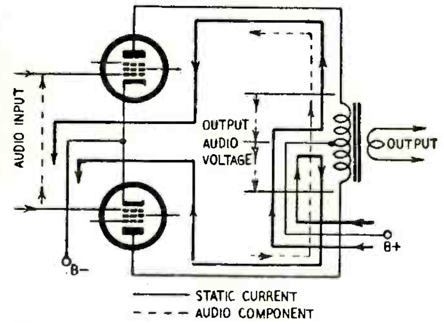

Fig. 3—In the conventional push-pull output circuit, the B-supply feed to the tubes is in parallel (solid lines with arrows) while the audio current and voltage are in series (dashed lines).

load impedance for the output tubes. It is relatively easy to wind speaker voice coils with impedances of 1 to 16 or even 40 to 50 ohms but complications arise if we try to exceed 400 to 600 ohms. The wire gauge becomes extremely fine, causing difficulties in assembly.

The alternative is to find some way to reduce the load needed for the output tubes. Push-pull operation using a transformer provides parallel feed from the supply circuit to the plate (Fig. 3) but operates the two tubes effectively in series. That is, the windings of the transformer primary are basically in series rather than in parallel—from the viewpoint of audio signal—because the two audio voltages are additive.

The so-called single-ended push-pull arrangement of operating tubes (Fig. 4) reverses this combination. Plate supply for the tubes is in series, but the audio signal action of the tubes may be regarded as in parallel. Suppose we use a couple of tubes that require a plate-to-plate load (in normal push-pull operation) of 8,000 ohms. Using the same tubes in single-ended push-pull reduces the required load to 2,000 ohms, which is a 4-to-1 improvement. If we use tubes with a plate-to-plate load requirement of 3,200 ohms, the single-ended push-pull arrangement reduces the required load to 800 ohms.

This is getting much nearer to what we really need. In the Philips amplifier (NG5200), two UL84's are used in both positions. In normal push-pull they have a plate-to-plate nominal load of 3,500 ohms. So this arrangement reduces the optimum load to 430 ohms—a considerable improvement. As two UL84's operated in push-pull are rated to supply 15 watts in class AB, we should expect the four-tube single-ended push-pull arrangement to deliver better than 25 watts into a speaker load of about 400 ohms. Actually this circuit has to be kept practically class A. So the Philips amplifier is rated to give only 12 watts for the four tubes.

This assumes we work the tubes as pentodes, so the supply circuit must be arranged so each tube works effectively as a pentode. Such a circuit, used by the Philips arrangement, is shown in Fig. 5. This circuit can be used with as much as 36-db feedback and Philips says that distortion is reduced to about 0.1%.

Working backward, if feedback is reducing distortion by a factor of 62 (36 db) and finishes up at 0.1%, the distortion provided by the output tubes must be about 6.2%.

The tube manual lists push-pull tubes of this type as delivering the same output with 3.5% distortion, so even operating the tubes into their correct plate load, the single-ended push-pull method of operation tends to cause about twice as much distortion as the normal push-pull method before feedback is applied.

Unequal drive

At this point another fact should be linked in because it is closely related to the distortion-producing properties of the single-ended push-pull output circuit. Output tube grids require very unequal drive for single-ended push-pull. Assume that the voltage across each tube in quiescent condition is 200 (using a 400-volt supply) and that the

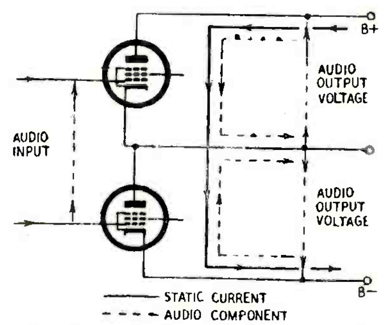

Fig. 4—In a single-ended push-pull circuit, B supply feeds tubes in series (solid line with arrow). Audio is handled in parallel (dashed line).

alternating voltage at maximum output is 150 (peak), which requires an output grid swing of 20 volts peak. On the lower tube the required grid swing is 20 volts each way, while on the upper tube it is 20 volts for the grid, plus a 150-volt plate–cathode swing at the output. So we require a phase-splitting arrangement that delivers 20 volts to the lower grid and 170 to the upper grid. This is not all. . .

We have considered ideal conditions where the output load is a pure resistance, so the voltage for a given grid swing comes out accurately according to calculations. Assume we use a speaker load. (Is this unusual in a hi-fi system?) Then the output voltage will not be the same as that with a resistance load, but will differ in two ways. There will be a degree of phase shift in the drive to the two grids due to the reactance load and the voltages will be different. Suppose we continue to drive the upper tube with 170 and the lower tube with 20 volts on its grid. Now, when the output voltage is, say, 200 volts, at a phase angle considerably different from that on the grid of the upper tube, we may end up with the upper tube getting a total swing of 100 volts or more. Yet the lower tube is still getting the same 20 volts.

The lower tube will continue delivering its proportion of the power, relatively undistorted, while the upper tube will run into all kinds of distortion. Of course, the presence of overall feedback in bucket loads will cut down the input and minimize this distortion. The actual effect of loading on this type circuit depends on whether the output tubes are triodes, as in the Stephens amplifier and basic Peterson-Sinclair circuit (Fig. 6) (or pentodes operated as triodes) or whether they are pentodes, as in the modified Peterson-Sinclair circuit, as used in the National Horizon amplifier (Fig. 7).

With triode tubes, the difference in voltage output due to different loadings is not so large, but with pentodes the voltage change is almost in direct proportion to the load impedance and consequently the difference can be serious. A number of circuits, such as the Futterman (Fig. 8) and the Coulter (Fig. 9), use feedback arrangements to compensate the drives to the two tubes. Now, each one continues to deliver a corresponding proportion of the total load.

Some single-ended circuits

The Futterman circuit can be understood by regarding the drive stage as the normal split-load phase inverter—equal halves—which feeds each output stage with a signal from plate to grid instead of the more normal cathode to grid. In the Coulter circuit the upper tube is fed directly while an inverter is used for the lower tube. The inverter has two inputs, one at the grid, adjusted for balance with normal output loading, and one in the cathode to compensate for different loading effects.

The Stephens circuit is quoted as having 0.4% distortion with 40-db feedback. This sounds very good until we realize the implication that without the feedback distortion would be 40%. If

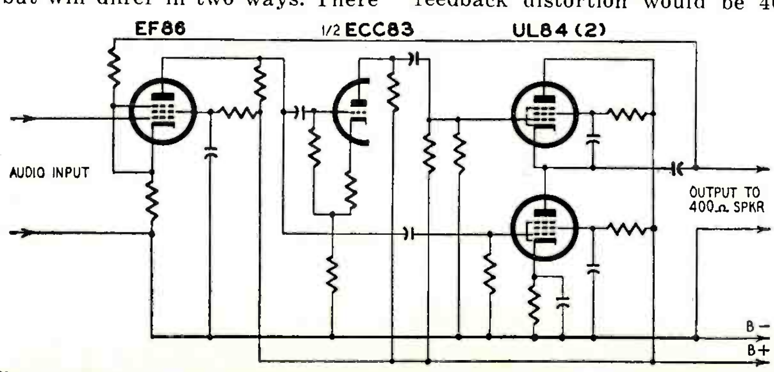

Fig. 5—Basic circuit of Philips NG5200, single-ended push-pull amplifier.

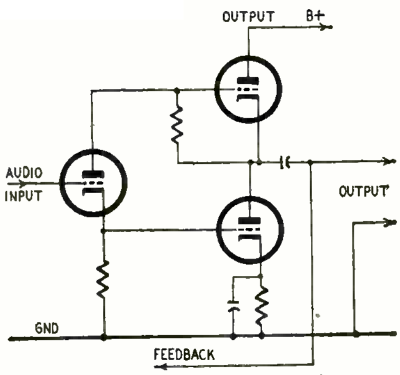

Fig. 6—Basic Peterson-Sinclair circuit using triodes.

the 40% was basically second and third harmonics, this means that the 0.4% contains a very large proportion of fourth, sixth and ninth harmonics, which makes the story a very different one. To put in some figures: If the amplifier, without feedback, gives 26.5% second and 26.5% third, with 40-db feedback, it will produce 0.265% second, 0.265% third, .07% fourth, 0.1% sixth and .07% ninth, which adds up (rms method) to 0.4% total.

Notice that some of the so-called single-ended push-pull circuits, although basically using an arrangement that does not *need* an output transformer, do use one. The National Horizon-20 does use an output transformer. Several other of these circuits also do, as a matter of convenience rather than necessity. This means the design of the output transformer is not so critical. It can be regarded as just a speaker-matching transformer rather than an amplifier output transformer because the push-pull action is not dependent on it.

How does this peculiarity of single-ended push-pull circuit compare with the more normal variety of push-pull? Doesn't the difference in loading upset the grid drive on normal push-pull circuits too? This certainly happens, but the eccentricity of the single-ended variety is that changing the load value unbalances the load distribution between the output tubes.

Modified adaptations of the Peterson-Sinclair circuit, such as the Futterman or Coulter, attempt to rectify this deficiency by using feedback. Such compensation is usually only a partial measure and cannot completely achieve full correction over a wide range of different impedances. Consequently, the distortion obtained under practical conditions is still considerably larger than with the corresponding push-pull arrangement.

With push-pull operation the modification due to incorrect loading is *symmetrical* between the two tubes. Therefore, the tendency is not for one tube to provide all the output while the other one provides all the distortion. With a normal pentode type output using over-all negative feedback, a higher-than-correct value of load impedance results in increased voltage feedback, which cuts down grid drive, so the output voltage is very little more than it would be into the correct load. True, the distortion does rise slightly since the tube is not operated under quite such linear conditions. But neither of the tubes operates into a saturation region and causes excessive distortion, which is what can easily happen with the single-ended push-pull arrangement.

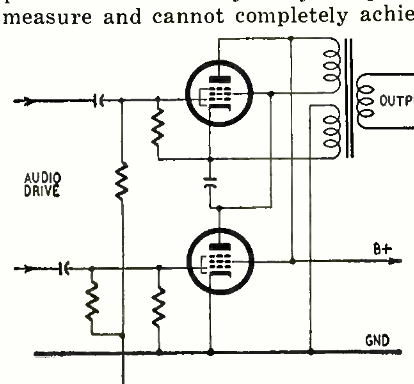

Fig. 7—An adaptation of Peterson-Sinclair circuit for pentodes, as used in National Horizon amplifier.

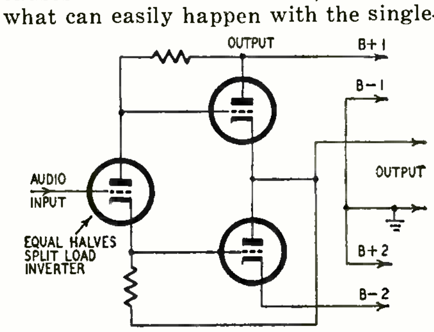

Fig. 8—Futterman circuit for equalizing the drive to output tubes requires two high-voltage supplies.

All this trouble to get rid of an output transformer seems to be due to the desire to use a large amount of feedback to minimize distortion, which we can more easily avoid by using a circuit that does not distort too readily in the first place.

Class-AB or class -B pentode operation produces notch distortion. Working the tubes as triodes avoids notch distortion, but drops the efficiency-power output for given tubes way down. Using an intermediate condition, like Ultra-Linear, has its problems, because it involves extremely tight coupling arrangements between each plate and the corresponding screen. Otherwise we get a much-amplified version of the notch-distortion problem, with little parasitic oscillations appearing at all kinds of odd points on the waveform. This means that Ultra-Linear operation requires extremely careful attention to the output transformer design.

Unity-coupled circuit

Another form of operation that takes full advantage of the pentode method of working with tubes is the unity-coupled circuit (Fig. 10). It puts half the load on each tube in its cathode circuit and the other half in the plate circuit. The tubes can be operated in class B and still maintain good output, provided coupling between the cathode and the screen section of the winding is extremely tight. Each tube then operates truly as a pentode and so full degeneration due to cathode coupling is achieved.

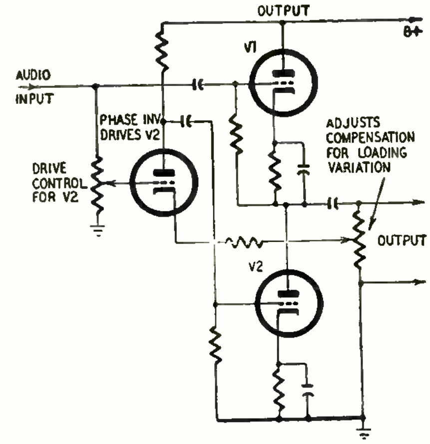

Fig. 9—Coulter circuit for separately adjusting basic drive to output tubes and then compensating for variation in loading.

This eliminates the notch distortion of class-B-operated pentodes because the relative impedance of the respective windings in the tube circuit is divided by four and the cathode's degeneration reduces the effective source resistance presented by the tube to a fraction of the load resistance. Consequently, any tendency to produce notch distortion is reduced to a small fraction of triode-coupled output circuits, which never produce notches unless a very poor transformer is used. This circuit uses the output tubes as pentodes to make maximum power available.

The McIntosh method of achieving the necessary tightness of coupling consists of bifilar winding of the transformer's primaries. There is only one disadvantage to this and that is the increased cost of the transformer. McIntosh's solution is to make the transformers under the same roof as the amplifiers and in an integrated production line. As the company makes only bifilar-wound output transformers, they have the facilities for doing so at a lower cost than a regular transformer manufacturer could. They also eliminate the middle handling cost that occurs in most other types of transformer output amplifiers. Although this method of producing a transformer is normally not an economic proposition, their particular application produces a unit that is competitive with many other am-

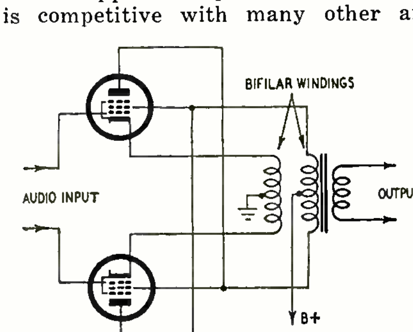

Fig. 10—Basic output circuit of unity-coupled amplifier requires special bifilar-wound output transformer.

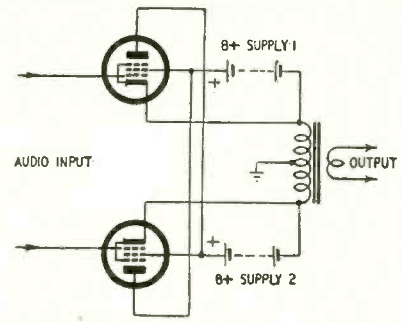

Fig. 11—Basic circuit of the Circlotron amplifier requires two floating high-voltage supplies.

plifiers and performs better than most.

Another circuit that achieves the same mode of operation in the tubes is the Circlotron (Fig. 11). It avoids a special output transformer by cross-connecting plates and screens, and coupling each screen to its own cathode through two separate B supplies. This adds the complication that components of the power supply circuit.

Still a third arrangement using the same tube operating conditions is the twin-coupled circuit described in the November, 1957, issue. This uses two output transformers of very low cost compared to that normally required for comparable quality, and relies on good capacitance coupling between cathode and screen for most of the frequency range. A side advantage is the provision of a pickoff point for feedback (push-pull) at low dc voltage, so no blocking capacitors are needed.

That is most of the story on OTL *vs* transformer outputs. *Maybe* the OTL, with special tube types, has an edge costwise (which is not the usual reason for the choice) but a good transformer output, of which we have several, still holds the lead for quality. But the last chapter has not yet been written. Transistors are slowly but surely creeping into the picture. Here too we meet the no-transformer advocates. Transistors are a natural for matching voice coil impedances without transformers. But a lot more work must be done, in developing both transistors and circuits, before such a clear picture emerges as we now have with tubes. END

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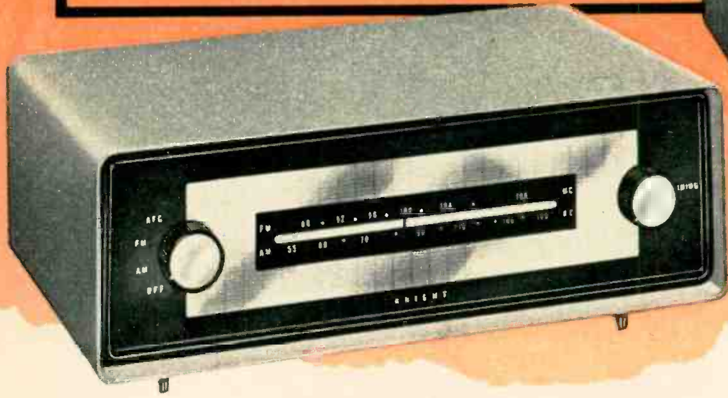

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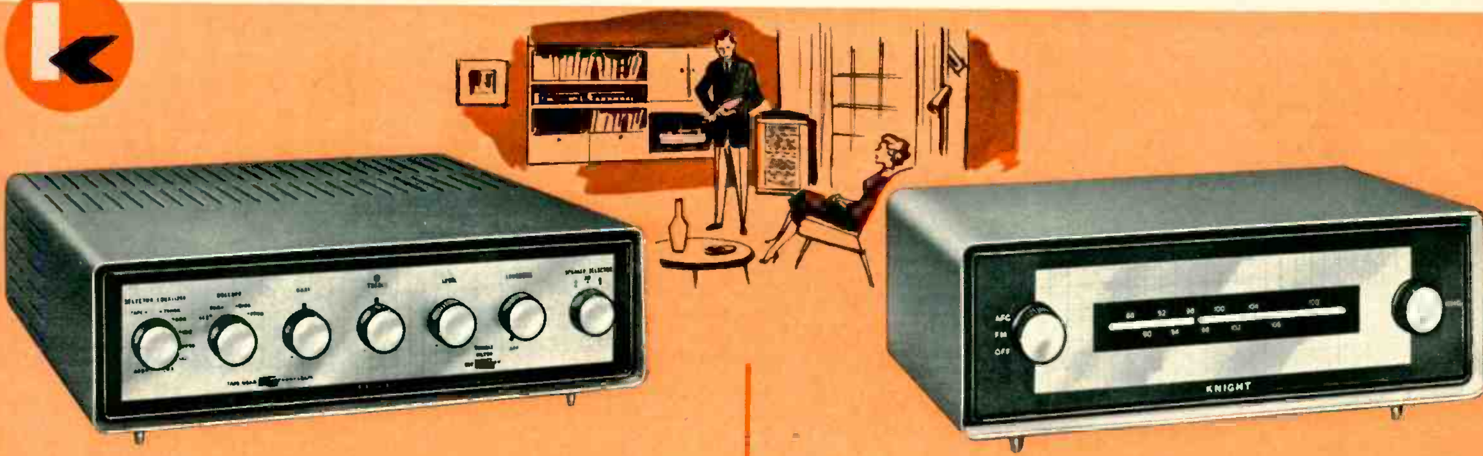

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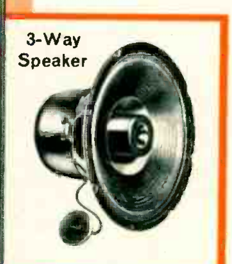

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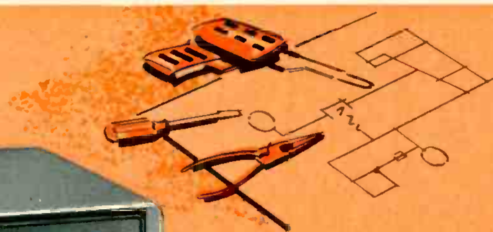

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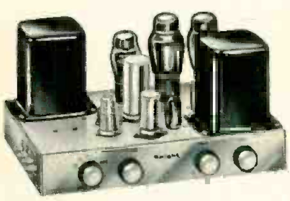
Here's superb Hi-Fi performance at less than half the cost of a comparable commercially-assembled unit. Williamson-type linear-deluxe circuit delivers over 25 watts of virtually undistorted reproduction. Ideal for use with the KNIGHT-KIT preamp at left. Includes printed circuit board for simplified, error-free assembly. Remarkable hi-fi response, ± 0.5 db, 10-120,000 cps at 20 watts. Harmonic distortion, 0.15% at 30 watts; IM, 0.4% at 20 watts. Hum level, 85 db below 25 watts output. Output impedances, 4, 8 and 16 ohms; output tubes, 2-5881. Includes balance control for precise matching of the output tubes; variable damping control for maximum performance with any speaker system—prevents low-frequency distortion from overdamping or underdamping. Very attractive black and chrome styling, 6¼ x 14 x 9″. An outstanding engineering achievement in a basic hi-fi amplifier, delivering performance equal to the finest commercially assembled units. Includes all parts and tubes; with step-by-step instructions, ready for easy assembly. Shpg wt., 25 lbs.

Model Y-755. 25-Watt Amplifier Kit. Net only **$44.50**
Y-759. Metal Cover for above; black finish. 5 lbs. Net **$4.25**



knight-kit 20-Watt Hi-Fi Amplifier Kit

Y-750
$35.75
$3.57 down

True hi-fi for less! Complete with full set of controls and built-in preamplifier. Response, ± 1 db, 20-20,000 cps; distortion 1% at 20 watts. Inputs for magnetic phono, microphone, crystal phono or recorder, and tuner. Compensation positions for 78 and LP records. Separate bass and treble controls. Output impedances, 4, 8, 16 and 500 ohms. Chrome-plated chassis. 7 x 13 x 8¾″. Ready for easy assembly. Shpg. wt., 20 lbs.

Model Y-750. Net only . . **$35.75**
Y-758. Metal Cover **$4.15**

knight-kit 2-Way Hi-Fi Speaker System Kit

Model Y-789
$49.95
Only $4.99 down

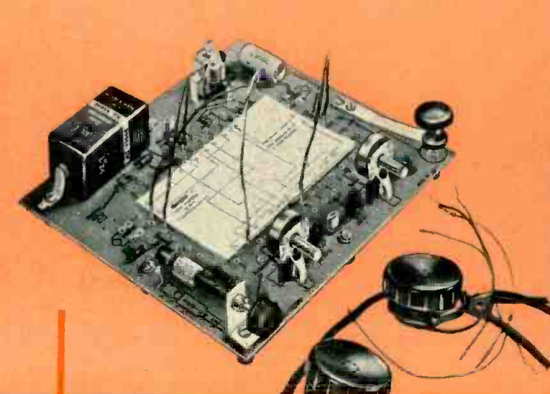
- Easy to Assemble—Pre-Finished Enclosure
- High Fidelity Response, 45 to 14,000 cps
- 12″ Woofer and Horn-Type Tweeter
- A Wonderful Money-Saving Speaker Value

BIG SAVINGS—assemble your own quality KNIGHT-KIT 2-way speaker system—it's quick and easy! The cabinet is *pre-finished* in full-grained, high luster blonde or mahogany—you just assemble 7 pieces, mount the speaker components and enjoy rich, thrilling hi-fi sound—at incomparably low cost. Special Jensen-engineered baffle features "ducted port" construction to bring out the full beauty of bass notes, perfectly matching the Jensen woofer and compression tweeter; genuine L-pad control is rear-mounted to permit adjustment of tweeter for best tonal balance. Impedance, 16 ohms. The assembled unit delivers a frequency response of 45 to 14,000 cps. Enclosure measures 26 x 19 x 14″. Beautifully styled to blend in any room. Kit includes Jensen 12″ woofer, Jensen compression-type tweeter, prefinished wood parts (with grille cloth installed), acoustic material, glue, hardware and step-by-step instructions. Absolutely no furniture finishing required. *Specify blonde or mahogany finish when ordering.* Shpg. wt., 33 lbs.

Model Y-789. 2-Way Speaker System Kit.
Net only **$49.95**

knight-kit HI-FI IS AVAILABLE ON EASY TERMS TO FIT YOUR BUDGET

Fascinating ALLIED **knight-kits** FOR EXPERIMENTERS AND HOBBYISTS



knight-kit 2-Transistor Pocket Radio Receiver Kit

Model Y-262 $14.65

- Loud, Clear Local Reception
- Newest Printed Circuit Board
- Built-In Loop Antenna
- Complete Kit—Nothing Else To Buy

It's fun to build this pocket-size two-transistor radio—and you'll enjoy its crystal-clear local broadcast-band reception wherever you go! Fits in your pocket, or with its button-down flap, can be worn from your belt. Completely self-contained with built-in ferrite loopstick antenna—no external antenna needed. Extremely efficient reflex type 2-transistor circuit actually does the work of 3 transistors! Printed circuit board reduces building time to about one hour. Has air-dielectric variable capacitor for easy, accurate station tuning. Operates for months and months on long-life alkaline battery supplied. Sensitive miniature earpiece provides crystal-clear tone. Handsome tan carrying case, plastic-impregnated, is styled to resemble leather; only 4x3¾x1¾". Kit includes all parts, transistors, earpiece, battery and case. Shpg. wt., 1½ lbs.

Model Y-262. Net only $14.65

knight-kit "Trans-Midge" Transistor Receiver Kit

Model Y-767 $2.45

Tiny, cigarette-pack-size one-transistor radio kit—fascinating to build—so low-priced. This novel miniature receiver will provide endless listening pleasure the moment assembly is completed. Covers the local AM broadcast band with exceptional sensitivity and selectivity. Special features include: Efficient, slug-tuned coil for excellent station separation; external knob for easy station tuning; low-drain transistor operating for months from single penlight cell supplied; hinged-back, red plastic case. Kit includes all parts, transistor, battery, compact case and easy-to-follow instructions for quick assembly. (External antenna and headphones required.) Shpg. wt., 8 oz.

Model Y-767. Net only $2.45
J-149. 4000 Ohm Headphones. 1 lb. .. $2.15
C-100. Antenna Kit. 1½ lbs. $1.03

knight-kit 10-Circuit Transistor Lab Kit

Model Y-299 $15.75

Sensational experimenters' transistor kit—an electronic marvel! Perfect for experimenter, student or hobbyist. Assemble basic parts once, then complete project after project (10 in all), by simply plugging leads into proper jacks on printed circuit board—no wiring changes needed. You learn how transistors operate by "plugging in" to make any one of the following circuits; AM radio for strong headphone reception; 2-stage audio amplifier; wireless broadcaster; code practice oscillator; electronic timer; electronic switch; electronic flasher; photoelectronic relay; voice-operated relay; capacity-operated relay. Includes all parts, 2 transistors, battery, headphones, circuit leads, relay, photocell, special guide cards for each project, explanation of each circuit. 3 lbs.

Model Y-299. Net only $15.75

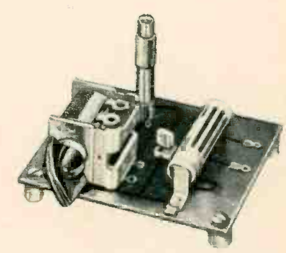
knight-kit 5-Transistor Superhet Personal Portable Radio Kit

Model Y-766 $29.95

- Styled to Equal the Finest
- Push-Pull Audio Drives 3½" Speaker
- Printed Circuit for Easy Building
- 200 Hour Battery Playing Life

Beautiful, easy-to-build transistorized personal portable with every ultra-modern design feature: 5 Texas Instrument Co. transistors; latest printed circuit chassis for easy, error-free assembly; bigger-than-average 3½" speaker; class B push-pull audio output; built-in high-gain ferrite loopstick antenna; plus phone jack output for private listening. Provides sensitive reception of the AM broadcast band with exceptional tone quality. Ultra-smart high-impact ivory plastic case has handsome gold trim with ebony accents; includes pull-out handle; only 7½x3⅜x1¾". With all parts, transistors, 9 volt transistor radio battery, carrying case and instructions anyone can easily follow. Shpg. wt., 2 lbs.

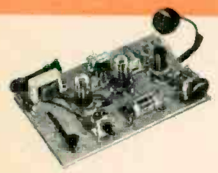
Model Y-766. Net only $29.95



1-Transistor Radio Kit

$3.95 Offers excellent AM local broadcast headphone reception. Printed circuit board for easy assembly. Operates from single penlight cell for months. Complete with all parts, transistor and penlight cell. (Antenna and headphones required.) Shpg. wt., 1 lb.

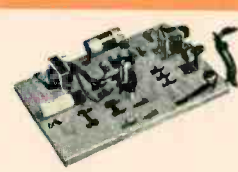
Model Y-765. Net only $3.95



"10-In-One" Electronic Lab Kit

$12.65 Famous experimenters' kit. Builds any of 10 fascinating projects, including broadcast receiver, wireless phono oscillator, code practice oscillator, signal tracer, relays, etc. Shpg. wt., 5 lbs.

Model Y-265. Net only $12.65



"6-In-One" Electronic Lab Kit

$8.45 A favorite with beginners. After basic wiring is completed, you make circuit changes without soldering. Builds any of six favorite projects, including radio, wireless broadcaster, etc. Shpg. wt., 3 lbs.

Model Y-770. Net only $8.45

Crystal Set Hobby Kit

$2.15 Entertaining, educational. Delivers clear headphone reception of local broadcast stations. With all parts, ready for easy assembly. (Antenna and headphones required.) Shpg. wt., 1 lb.

Model Y-261. Net only $2.15

Wireless Broadcaster Kit

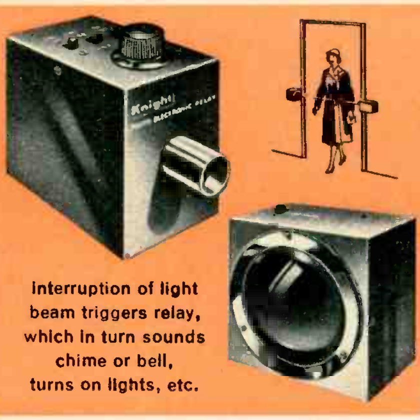
$9.50 Play music or make announcements through your radio set—no connection to set required! Loads of fun—easy to build. Works up to 50 feet from set. Shpg. wt., 3 lbs.

Model Y-705. Net only $9.50

ORDER FROM ALLIED RADIO 100 N. WESTERN AVE. • CHICAGO 80, ILL

FUN TO BUILD . . . INSTRUCTIVE . . . LATEST CIRCUITS FOR TOP PERFORMANCE

WIDEST CHOICE OF QUALITY HOBBYIST KITS



Interruption of light beam triggers relay, which in turn sounds chime or bell, turns on lights, etc.

knight-kit Photoelectronic Relay Kit

Model Y-702

$13^{50}

Advanced-design, ultra-sensitive photoelectronic relay—build it yourself and save! Dozens of uses: for automatic control of lights, door announcer, burglar alarm, counting devices, etc. Provides dependable operation up to 250 feet with white light, up to 125 feet with "unseen" light (red filter) from Light Source Kit listed below. Selectable operation, with "trip" for burglar alarm to provide continuous ringing of alarm; and "auto" if relay is to operate each time beam is broken (for chimes, counting devices, turning on lights at darkness). Has SPST relay operated from thyratron; 6.3 v. terminals provide power for accessories. For 105-120 v. 50-60 cy. AC use. 6 lbs.

Model Y-702. Relay Kit. Net only . . **$13.50**

Model Y-703. Light Source Kit. With bulb and red filter. Shpg. wt., 3½ lbs. Net . **$6.75**

knight-kit "Ocean Hopper" All-Wave Radio Kit

Model Y-740

$11^{95}

This top-performing regenerative receiver puts a world of listening pleasure at your finger-tips. Tuning range (using coils listed below) is virtually world-wide; covers 155 kc to 35 mc. including every type of radio transmission: AM broadcast, marine, aircraft, distress channels, direction-finding, Amateur, frequency standard, foreign broadcast, and police. With bandspread tuning. For use with headphones or 3-4 ohm PM speaker. Kit is supplied with standard broadcast band coil and all tubes and parts. (Less extra coils, headphones, speaker and cabinet.) Shpg. wt., 5 lbs.

Model Y-740. Net only **$11.95**

Y-746. Cabinet for above. 1½ lbs. Net **$2.90**

Extra coils available: Long Wave Coil (155-470 kc), Net 79c. Short Wave (1.65—4.1 mc; 2.9—7.3 mc; 7—17.5 mc and 15.5—35 mc). Each 65c.

knight-kit "Space-Spanner" Bandswitching World-Wide Radio Kit

Model Y-243

$15^{95}

- Broadcast or Short Wave Reception
- Sensitive Regenerative Circuit
- Convenient Bandspread Tuning
- Built-In Loudspeaker

Imagine the thrill of hearing overseas broadcasts on a precision receiver you've built yourself—and then, at the flip of a switch, being able to tune to your favorite local broadcast station! Bandswitch selects exciting short wave, including foreign broadcasts, amateur calls, aircraft, police and marine radio on the 6.5 to 17 mc range, as well as standard 540-1700 kc broadcasts. Features highly sensitive regenerative circuit. Includes built-in 4" PM speaker and beam-power tube for strong volume and clear tone. Headphone connectors are available for private listening; switch cuts out speaker. Controls: Bandspread, Main Tuning, Antenna Trimmer, Bandswitch, Regeneration, Volume. 7x10x6". Easy to build from step-by-step instruction manual. For 110-120 v., 50-60 cy. AC or DC. (Less cabinet.) Shpg. wt., 5 lbs.

Model Y-243. Net only **$15.95**

Y-247. Cabinet for above. Shpg. wt. 2 lbs. Net . **$2.90**

"Ranger II" Superhet Receiver Kit

$17^{25}

Popular Broadcast band receiver built and enjoyed by thousands. Features built-in antenna, automatic volume control, ball-bearing tuning condenser, PM dynamic speaker. Handsome plastic cabinet. Easy to assemble. AC or DC operation. Shpg. wt., 8 lbs.

Model Y-735. Net only **$17.25**

knight-kit 2-Way Intercom System Kit

Model Y-295

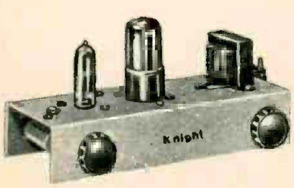
$14^{75}

- Low Cost—Easy to Assemble
- High Gain—Clear Tone
- Handsome Metal Cabinets
- Includes 50-Foot Cable

Easy to build at lowest cost—ideal for home, office, shop or school. Consists of Master unit and Remote unit. Remote unit may be left "open" for answering calls from a distance, for "baby sitting", etc. Remote also may be set for "private" operation—cannot be "listened-in" on, but it can be called and can originate calls. Master unit includes high-gain 2-stage amplifier, combination volume control and on-off switch, plus pilot light. Each unit has 4" PM dynamic speaker. System responds to even a whisper. Handsome Antique white cabinets, each 4¾x6½x4⅜". With all parts, tubes and 50-ft. cable (up to 200-ft. may be added). For 110-120 v., AC or DC. 8 lbs.

Model Y-295. Master and one Remote. Net only . . **$14.75**

Y-296. Extra Remote Station Kit. 3 lbs. **$3.75**



Phono Amplifier Kit

$9^{45}

Build it yourself—and save! Ideal for use in a portable phonograph—just add record player and 3-4 ohm speaker. 1½ watts output. Inverse feedback circuit. Easy to assemble. Shpg. wt., 3 lbs.

Model Y-790. Net only **$9.45**

Electronic Photoflash Kit

$28^{50}

Ideal for color or black and white photography. 1/700th-of-a-second flash; 50 watt/second output. Synchronizes with any camera with X or O shutter. (Less battery.) Shpg. wt., 4 lbs.

Model Y-244. Net only **$28.50**

Code Practice Oscillator Kit

$3^{95}

Ideal for beginners learning the code. Transistorized circuit. Operates for months from single penlight cell supplied. Clear, crisp 500 cycle tone. Jacks for headphones; screw terminals for key. 1 lb.

Model Y-239. Net only **$3.95**

Phono Oscillator Kit

$5^{85}

"Broadcasts" recorded music through any standard radio set up to 50 feet away. No direct connection to set required. Easy to build—fun to use. Shpg. wt., 2 lbs.

Model Y-760. Net only **$5.85**

FINEST ELECTRONIC EQUIPMENT IN EASY-TO-BUILD MONEY-SAVING KIT FORM

Better By Far — ALLIED knight-kit QUALITY TEST INSTRUMENTS

knight-kit Low-Cost Tube Tester Kit

Model Y-143
$29.75

- With 16 Filament Voltages
- 600 Latest Tube Types Listed
- Easy-to-Read 4½" Meter
- Tests Series-String TV Tubes

Expertly designed for complete, up-to-date coverage of tube types. Tests *series-string TV tubes;* tests 4, 5, 6 and 7 pin large, regular and miniature types, octals, loctals, 9-pin miniatures and pilot lamps. Tests for open, short, leakage, heater continuity and performance (by amount of cathode emission). Big 4½" square meter has clear "GOOD-?-REPLACE" scale. With line-voltage indicator and line-adjust control. Choice of 16 filament voltages from 0.63 to 117 volts to check virtually all receiving tubes; blank socket for future type tubes. Universal-type selector switches permit selection of any combination of pin connections. Single-unit, pre-assembled 10-lever function switch simplifies and speeds assembly. Up-to-date illuminated roll chart lists over 600 tube types. Counter model case, 5 x 14 x 10". Easy to build. 14 lbs.

Model Y-143. Net only **$29.75**
Y-142. Portable Case model. 15 lbs. Net **$34.75**
Y-141. Picture Tube Adapter. 1 lb. Net ...... **$ 4.25**

knight-kit RF Signal Generator Kit

Model Y-145
$19.75

Build this wide-range, extremely stable RF signal generator—save two-thirds the cost of a comparable wired instrument! Large, semi-circular dial is clearly calibrated; range is covered in 5 separate bands for close accuracy in setting individual frequencies. Ideal for aligning RF and IF stages in radio and TV sets and for troubleshooting audio equipment. Delivers output on fundamentals from 160 kc all the way out to 112 mc; useful harmonics to 224 mc. Has built-in 400-cycle sine-wave audio oscillator for modulating RF; audio is also available externally. Features high-stability Colpitts circuit. Convenient jack for external modulation. Maximum audio output 10 volts; RF output over 0.1 volt on all ranges. Step and continuous-type attenuator controls. Supplied with precision-wound coils that require no adjustment. 7 x 10 x 5". Shpg. wt., 11 lbs.

Model Y-145. Net only **$19.75**

knight-kit 1000 Ohms/Volt VOM Kit

Model Y-128
$16.95

Exceptional accuracy and versatility at amazing low cost. Ideal for service shop, lab or Amateur use. Large 4½", 400 microamp meter with separate scales for AC and DC voltage and current, decibels and resistance. *Uses 1% precision resistors;* has 3-position function switch and 12-position range switch. *38 ranges* include: AC, DC and output volts, 0-1-5-10-50-500-5000 (1000 ohms/volt sensitivity); Resistance, 0-1000-100,000 ohms and 0-1 meg (center scale readings of 60, 150 and 1500 ohms); Current, AC or DC, 0-1-10-100 ma and 0-1 amp; Decibels, −20 to +69 in 6 ranges. Precision resistors are used as shunts and multipliers to assure exceptional accuracy of measurements. With all parts, battery, test leads and black bakelite case with convenient carrying handle, 6¾ x 5¼ x 3¾". A great value in an easy-to-build quality instrument. Shpg. wt., 2½ lbs.

Model Y-128. Net only **$16.95**

knight-kit Vacuum Tube Voltmeter Kit

Model Y-125
$24.95

- 200 μa Movement, 4½" Meter
- Includes AC, Peak-to-Peak
- Balanced-Bridge, Push-Pull Circuit
- 1% Film-Type Resistors

Top buy in an extremely stable, highly accurate VTVM. Easy to assemble—entire chassis is printed circuit board. Perfect for radio-TV service work, lab and Amateur use. Features low-leakage type switches; 1% film-type precision resistors; balanced-bridge, push-pull circuit (switch to any range without readjusting zero set); zero center scale and direct-reading db scale; polarity reversing switch. Ranges: Input Resistance, 11 megs; DC and AC rms, 0-1.5-5-15-50-150-500-1500; AC Peak-to-Peak, 0-4-14-40-140-1400-4000; Response, 30 cycles to 3 mc; Ohms, 0-1000-10K-100K and 0-1-10-100-1000 megs; db, −10 to +5. Includes all parts, tubes, battery, test leads and portable case, 7¾ x 5¼ x 4-5/16". Easy to assemble. Shpg. wt., 6 lbs.

Model Y-125. Net only **$24.95**
Y-126. Hi Voltage Probe; extends DC to 50,000 v. .... **$ 4.75**
Y-127. Hi-Frequency Probe; extends AC to 250 mc. .... **$ 3.45**

6V-12V Battery Eliminator Kit

$32.95

High current rating; continuously variable filtered output; delivers 15 amps at 6 volts, 10 amps at 12 volts. May be used as battery charger. Two meters provide simultaneous current and voltage readings. Shpg. wt., 18 lbs.

Model Y-129. Net only **$32.95**

Transistor Checker Kit

$8.50

Checks gain ratio of all types of transistors; checks germanium and silicon diodes; checks for continuity and shorts. A valuable instrument at very low cost. Easy to assemble. Shpg. wt., 2½ lbs.

Model Y-149. Net only **$8.50**

Flyback Checker Kit

$19.50

Checks condition of all types of horizontal output transformers and deflection yokes, as well as TV linearity and width coils. 4½" meter; widest range in its field. Shpg. wt., 6 lbs.

Model Y-118. Net only **$19.50**

Sweep Generator Kit

$43.75

Extreme linearity on a par with costly lab instruments; fundamentals to 250 mc; output flat within 1 db; electronic blanking. Easy, money-saving assembly. Shpg. wt., 16 lbs.

Model Y-123. Net only **$43.75**

Capacitor Checker Kit

$12.50

Tests capacitors while in the circuit! Has widest range—20 mmf to 2000 mfd. Exclusive circuit for cancelling lead capacity. "Magic Eye" indicator. Save 60% over factory-wired units. 5 lbs.

Model Y-119. Net only **$12.50**

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ADVANCED-DESIGN INSTRUMENTS FOR SERVICE, INDUSTRIAL AND RESEARCH USE IN EASIEST-TO-BUILD, MONEY-SAVING KIT FORM

knight-kit 20,000 Ohms/Volt VOM Kit

Model Y-140 29^{50}

Outstanding quality and performance at money-saving low price. Features 1% precision multipliers; 4½" meter accurate within 2% of full scale deflection; 50 microamp sensitivity for 20,000 ohms/volt input resistance on DC; front panel "Zero adjust"; single switch to select function and range. 32 ranges: AC, DC and output volts, 0-2.5-10-50-250-1000-5000; Resistance, 0-2000-200,000 ohms and 0-20 meg.; DC ma, 0-0.1-10-100; DC amps, 0-1-10; Decibels, −30 to +63 in six ranges. Moisture-resistant film-type resistors for extreme accuracy. Carefully engineered circuit design achieves high sensitivity and extremely versatile application. Kit includes all parts, battery, test leads and black bakelite case with highly legible white markings; size 6¾ x 5¼ x 3¾". Easy to assemble. Shpg. wt., 5 lbs.

Model Y-140. Net only **$29.50**

knight-kit High-Gain Signal Tracer Kit

Model Y-135 26^{50}

A remarkable value in an easy-to-build instrument which permits visual and aural signal tracing of RF, IF, video and audio circuits. Has *highest gain in its price class*. Traces signal from antenna to speaker. Reproduces signal at plate or grid connection of any stage. Identifies and isolates "dead" stages. Features: usable gain of *91,000;* "magic eye" with calibrated attenuators for signal presence indication and stage-by-stage gain measurements; built-in 4" PM speaker; combination 2-position probe, one for RF (6 mmf. input), the other for audio. Provides noise test; built-in watt-meter calibrated from 25 to *1000 watts;* provision for external scope or VTVM. Binding posts provide output transformer and speaker substitution test, plus external 280 volts B+. With all parts, tubes and probe. 7x10x5". 12 lbs.

Model Y-135. Net only **$26.50**

knight-kit 5" Wide-Band Oscilloscope Kit

Model Y-144 69^{00}

Only $6.90 down

- 5 mc Width for Color TV
- Horizontal Sweep to 600 kc
- 25 mv/inch Sensitivity
- Z-Axis Input
- Printed Circuit Construction

Equals or betters the performance of commercially wired scopes costing far more. Two printed circuit boards and laced wiring harness assure wiring accuracy and cut assembly time. Ideal for lab use, color TV servicing and high frequency applications. Wide sweep range—*15 to 600,000 cps.* Vertical response, ± 3 db, 5 cps to 5 mc; only 1 db down at 3.58 mc color burst. High vertical sensitivity of .025 rms v/inch. Input capacity, 20 mmf. Outstanding features: cathode follower inputs; 2nd anode provides 1400 volts high-intensity trace; push-pull amplifiers; positive and negative locking; frequency-compensated attenuator; Z-axis input; one volt P-P calibrating voltage; astigmatism control; retrace blanking circuit; DC positioning control. Includes CRT. 14½ x 9½ x 16". 40 lbs.

Model Y-144. Net only **$69.00**
Y-148. Demodulator Probe. Net .... **$ 3.45**
Y-147. Low Capacity Probe. 12 mmf. Net .... **$ 3.45**

Voltage Calibrator Kit

12^{75} Permits use of any scope as precision peak-to-peak AC voltmeter. Puts a true square-wave voltage on scope screen. Selects any voltage between .01 and 100 volts; feeds external signal direct to scope for instant comparison. Shpg. wt., 5 lbs.

Model Y-136. Net only **$12.75**

knight-kit 5" General-Purpose Scope Kit

Model Y-146 42^{00}

Only $4.20 down

- Phantastron Linear Sweep
- 25 mv/inch Sensitivity
- Printed Circuit Board
- Retrace Blanking Circuit

Feature for feature the world's best oscilloscope kit value. A stand-out in its class with all these fine features: *Printed Circuit* wiring board and laced harness for quick, error-free assembly. *Phantastron Sweep Circuit* for high linearity of sweep from 15 to 150,000 cps. *25 Millivolts Per Inch Sensitivity*—3 times that of similarly priced scope kits. *Calibration Voltage*—1 volt peak-to-peak square wave, fully regulated. *Vertical Amplifier*—frequency response ± 3 db, 3 cps to 1.5 mc (± 6 db to 2.5 mc). Includes: Directly coupled positioning controls; retrace blanking circuit; frequency-compensated vertical input attenuator; positive and negative internal sync; high 2nd-anode voltage for high-intensity trace; input capacity, 45 mmf. Kit includes CRT. 9½ x 13¾ x 17¾". 26 lbs.

Model Y-146. Net only **$42.00**

Resistance Substitution Box

5^{95} Easily determines resistor values required in a circuit. Makes available 36 standard 1-watt resistance values in 2 ranges between 15 ohms and 10 megohms, with 10% accuracy. Slide switch selects range; 18-position switch for value selection. Shpg. wt., 2 lbs.

Model Y-139. Net only .... **$ 5.95**

Capacitance Substitution Box

5^{95} Makes it easy to find capacitor values needed in a circuit. Provides 18 standard values from .0001 mfd to .22 mfd, ± 20%. All values are 600 volt, except .15 and .22, which are 400 volt. 18-position selector switch. Shpg. wt., 2 lbs.

Model Y-138. Net only .... **$ 5.95**

Audio Generator Kit

31^{50} Excellent design; range, 20 cps to 1 mc; less than .25% distortion; 600 ohm output. Ideal for hi-fi testing; offers the flat response of a lab standard. Shpg. wt., 16 lbs.

Model Y-137. Net only **$31.50**

R/C Tester Kit

19^{50} Measures capacitance and resistance. Balanced-bridge circuit; indicates power factor; tests capacitors at rated voltage. Large, easy-to-read dial and "magic eye." Shpg. wt., 10 lbs.

Model Y-124. Net only **$19.50**

EASY TERMS AVAILABLE

Take advantage of the most liberal Easy Pay plan in electronics. On Knight-Kit orders totaling $45 or more—just 10% down, small monthly payments thereafter. Low carrying charges—no "red tape."

knight-kits FOR THE RADIO AMATEUR

knight-kit All-Band Amateur Receiver Kit

Model Y-726
$104^{50}

Only $10.45 down

- Tunes 540 kc to 31 mc
- Built-In Q-Multiplier
- Constant Running HF Oscillator
- Worthy of the Advanced Ham Operator
- Printed Circuit Bandswitch
- Printed Circuit Board • 1.5 μv Sensitivity

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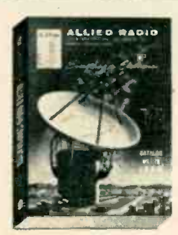

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Part I—How transistor sets differ from the familiar tube circuit; a detailed look at rf, mixer, oscillator and if stages

By JACK DARR

THE experienced technician will not run into many problems in servicing transistor auto radios, aside from the difficulties common in all auto-radio work. Of course, a bench power supply with good regulation and filtering, is a must. I use a pair of standard 6-volt storage batteries, with a small trickle charger and a switch to select either 6 or 12 volts for the set being serviced. This gives almost perfect voltage regulation. (Except for the times I forget to add water to the batteries!)

An ac-powered battery-eliminator supply can be used, *if* it has good regulation and a very low hum level. The voltage should be adjustable over a fairly wide range as there is a wide variation in the current demand, especially in signal-seeking tuner sets. On tube sets, the current used by the solenoid, tuner mechanism, etc., represents only a small part of the 10 amps or so drawn by the set. With the much-lower-drain transistor sets, if the voltage is set for the small drain, 2 amps or so, the added drain of the tuner may cause an excessive voltage drop unless the power supply has excellent regulation. Delco recommends setting the bench power supply to 16 volts when testing automatic tuner type sets to avoid binding of the solenoid or better still, floating a 12-volt battery across the line to improve regulation.

When bench-testing the hybrid sets using low-voltage tubes or sets using these tubes throughout, excessive hum in the power supply can cause trouble. Floating a battery across the power supply eliminates this difficulty by smoothing out variations in voltage.

All-transistor sets tend to be quite compact. Set designers have taken advantage of transistors to reduce the size of the cases. However, heat-radiating fins and power transistors take up some room, although the whole thing is still quite a bit smaller than a tube set. Many recent sets are removed from the front, coming out through the dash, rather than the old familiar down-and-back method. One precaution should be observed, however. Because there is a voltage on the case of the power transistor, the set should never be removed from the dash before disconnecting the power leads, or with the power on. If the transistor's case is shorted to ground during removal, the transistor may be damaged. Also, when replacing the set after servicing, be sure that the choke cable, speedometer shafts and other bare metal objects under the dash are cleared away from the transistor's case to prevent grounding it.

While the familiar vibrator buzz is gone, there are still a few indications that make for convenience in the car tests. Even in the hybrid sets, using transistors only in the output stages, there will be a slight thump in the speaker when the switch is turned on. These sets require the normal warmup time, 30–50 seconds, while all-transistor sets will begin to play almost immediately. Otherwise, diagnosis and testing in the car is exactly the same as with older sets.

Noise problems

The same assortment of noises that plagued the old sets will cause the same troubles in the newer ones. One additional headache may cause trouble. With tube sets using low-voltage tubes, a high level of generator ripple may be fed through into the audio input stage, causing noise in the speaker. This can be reduced or eliminated entirely by additional filtering in the supply circuits and by servicing the generator and voltage regulator. If the car's battery is not up to par, the increased internal resistance under heavy charging rates may cause an increase in the noise level. This would also be true with transistorized sets. So, if an unexplained noise persists, check the car's battery very carefully.

Tube testing in the low-voltage series may present a problem. Although I have not had the courage to try it, it is quite likely that potentials present in the average tube tester, especially the transconductance type, will prove far above the maximum allowable voltages for these new tubes. Therefore, tube testing should be limited to substitution, at least until a set of test settings has been developed. With the very close spacing between elements, necessary in these tubes to achieve the needed transconductance, flashovers may occur even in perfectly good tubes, under the high potentials used on short tests. It is probably possible to build up a plug-in adapter for any standard tube tester, which will reduce voltages for these tests.

Troubleshooting techniques

The technician encountering his first all-transistor auto radio will find that *basic* procedures differ little from those used in the past. The old reliable method of locating a defective stage by performance checks and analysis is still valid. He will find himself using a signal generator for stage-to-stage tests far more than he has been accustomed to! Some basic differences will feel very peculiar to him, after many years of servicing tube sets—voltage measurements, for example.

First, most important and most likely to be overlooked is the matter of battery supply polarity when hooking a set up on the bench. *THE BATTERY SUPPLY* MUST *HAVE THE SAME POLARITY AS THAT USED IN THE CAR!!* Failure to observe this will result in immediate damage to the transistors! The technician who has been doing two-way radio work or the old-timer who remembers the days of the synchronous vibrator will soon become accustomed to checking this point. The newer crop of technicians, who have never seen anything but interrupter type vibrators with rectifier tubes, may have to post warning notices over their benches (on the face of the battery eliminator is an effective spot)! This will avoid expensive transistor replacements!

Some of the old quick-checks used by

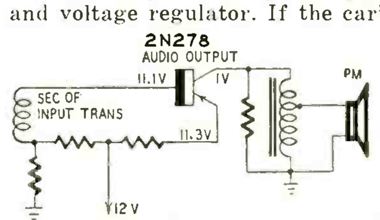

Fig. 1—Ground the transistor's base in this audio output stage and say goodbye to the transistor.

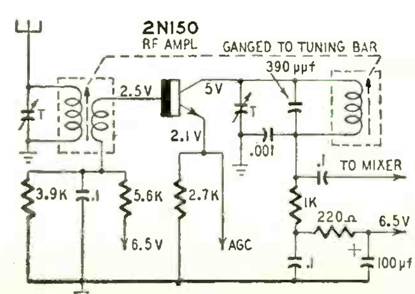

Fig. 2—Rf amplifier circuit found in Delco Brougham 7268085.

service technicians can lead to trouble in transistor sets. For instance, the practice of grounding the grid of a tube to produce a click in the speaker *cannot be used with transistors!* Delco issues a strong warning against this in their *Testing Tips.*

In the transistor output circuit of Fig. 1, a p-n-p 2N278 is used. With a negative battery-ground connection, the transistor has a normal forward bias of 0.2 volt (from emitter to cathode). If the base (the grid) is grounded, this bias is changed to 11.2 volts, and the transistor burns out in a matter of a few *microseconds!*

Therefore, when testing for signal continuity in a transistor circuit, touch the base with a fingertip or a small screwdriver, being very careful not to let the screwdriver short to ground, and listen for the pop. Taking voltage measurements using a vtvm will probably produce enough pop in the speaker to assure that the stage is working. Touching the audio amplifier (driver) stage's input will produce enough buzz or hum for a positive test, just as it would in a tube set. An audio signal generator, set at a fairly low output level (2 or 3 volts), with a small blocking capacitor in the input lead, will be very useful. Most shop signal generators have a 400-cycle af output; use this for making stage-to-stage tests, if necessary.

Another precaution, this one familiar to PA men and most hi-fi addicts, is the need for loading the transistor output at all times. The transistor is a very-low-impedance device—the impedance from collector to emitter is relatively low, especially as compared with the plate resistance of a vacuum tube. A large increase in this impedance, such as would result if the secondary of the output transformer were suddenly opened, causes collector voltage to rise to a very high level. If this happens and the voltage rise should exceed the collector's maximum rating, the transistor is instantly and severely damaged. So before turning on the radio, be sure that the speaker is connected. If it is left off and a signal passes through the set, the resultant burst of voltage may severely damage the output transistor. Conversely, if the speaker voice coil should open, as often happens in auto-radio work, look for a defective output transistor if the radio has been operated with the speaker open.

Voltage and current

Perhaps the strangest thing of all to the vacuum-tube technician will be the very peculiar voltage measurements found in transistor sets. Up till now, he has always found positive voltages on the plate or output element, negative voltages on the grid and positive voltages on the cathode. His high voltage has been running from 150 to 200, especially in auto-radio work. Now, he's in for a rude shock: he will find only 8 to 12 volts at what he is sure is the plate, the same voltage at the grid, and possibly no voltage at all at the cathode. In some circuits, he may be worse off. In the grounded-emitter circuit used for so many power output stages, he will be quite disconcerted to find only *1 volt* at the collector, which can be either positive or negative, 11.8 volts on the emitter, and 12 volts at the base! Until he can force himself to orient his thinking to the lower voltages and peculiar polarities found in transistor circuits, he's in for some trouble.

Seriously speaking, the technician who tries to go directly from tube circuits to transistors *will* find himself confused unless he has taken the time to prepare himself thoroughly for it. This is not difficult or expensive. Practically all major set manufacturers have made transistor and transistor-circuit data available through parts supply houses and other sources, mostly free, or for a very nominal sum. Delco, G-E, Motorola, Philco, RCA and many others have this material, and it can usually be had for the asking. Therefore, I will not attempt to cover in this limited space any basic transistor theory. It is available in so many other places that it should be unnecessary. I will try to give you some idea of the differences between tube and transistor circuits, and some of the things you can expect to find when the transistor sets begin to show up on your workbench.

Actually, there is no difference in the primary function of tube and transistor radio receivers! Each picks up an rf signal, amplifies it, converts it to af, then feeds it into a speaker. The common circuits are all there. They may be in slightly different forms, but the functions are present.

Parts values differ radically and very few parts, outside of resistors and capacitors, are interchangeable between tube and transistor sets. Resistors will be much smaller, because of the lower voltages, and capacitors will be much larger, at what seem to be ridiculous working voltages: 6, 12, 15, etc. Transformers are different because of the low impedances found in transistor circuits. Rf and if transformers are very much different, sometimes consisting of only a tapped coil of a few turns. Output transformers also differ; the autotransformer is found here, too.

Rf gains of up to 100 per stage are quite common in tube sets. Because of lower gain, at present at least, transistor sets are unable to achieve this efficiency, so more stages are used, especially in the radio's if strip—the Cadillac set has three if amplifiers, for example.

Oscillator circuits are conventional: with feedback from collector to base, coupling through a transformer. The mixer stage functions like a common tube circuit, the cathode-coupled type. The input rf signal is fed to the emitter, while the oscillator signal is fed to the base. The two signals combine inside the transistor in the normal manner. The 262-kc if output is selected by the action of the input if transformer, just as it is in tube type radios.

The rf stage, as used in Delco sets (see Fig. 2) uses a 2N150, connected in a common-emitter circuit. A matching transformer couples the high impedance of the antenna to the low input impedance of the 2N150, with a step-down in the transformer. The base is returned to the junction of the two resistors, which form a voltage divider across the 6.5-volt line. This places a 2.5-volt forward bias on the base. This positive voltage at the base attracts electrons from the emitter and causes collector current to flow. As the collector current and a small base current return through the emitter circuit, the 2,700-ohm resistor in the circuit causes a small voltage drop. In a tube circuit, this is the equivalent of self-bias, with the bias resistor in the cathode circuit. Although the emitter is positive with respect to ground, it is negative with respect to the base, a 0.4-volt forward bias being placed on the input diode. Agc bias voltage is also applied to the emitter, regulating the stage's gain.

In Fig. 3, a 2N149 transistor is shown connected in a tuned collector

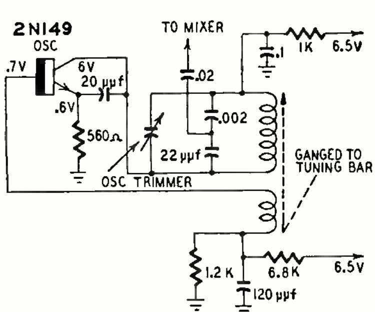

Fig. 3—Typical oscillator stage in transistor auto radios.

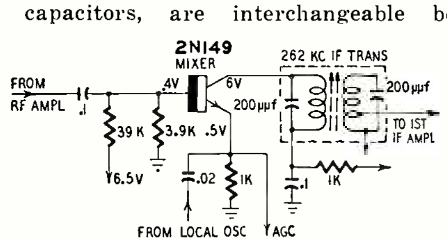

Fig. 4—Rf amplifier's output is fed to base and oscillator output to emitter of mixer stage.

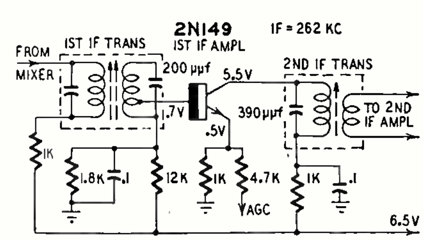

Fig. 5—A Delco if stage. Most transistor auto radios have three if amplifiers.

circuit. It uses a tickler winding for base feedback. Forward base-emitter driving current is picked up from the tap on the voltage-divider resistors, 6,800 and 1,200 ohms, across the 6.5-volt line. Tuning is set by the collector tank. This one has a slug-tuned coil. The 560-ohm self-bias resistor in the emitter circuit has a degenerative effect since the drop across it tends to cause the emitter to go positive on the conducting half of the cycle. This prevents excessive collector current flow and avoids tank-circuit loading for better stability.

Oscillator voltage is capacitance coupled to the mixer from a low-impedance point on a capacitance divider across the tank. This provides the proper impedance match for the input to the mixer stage's emitter, also a low impedance point.

The mixer (Fig. 4) is roughly equivalent to a triode mixer. The input or rf signal is fed to the base of the 2N149, and the oscillator signal is fed into the emitter. The by now familiar voltage-divider arrangement provides the necessary forward bias. The emitter circuit uses a 1,000-ohm resistor to stabilize collector current. Oscillator signal voltage, fed in at this point, will produce additional emitter voltage. This is an ac signal which drives the emitter into conduction on the positive swing, supplying a rectified emitter voltage which keeps the mixer operating near the class-B point for best non-linear detection characteristics. If the oscillator is not working, then the emitter voltage in the mixer stage will be less than the base voltage, an easy point to check.

Actual mixing of the signals takes place inside the transistor. The resultant if is selected by the tuned circuit of the primary of the first if transformer. It is then fed on through the if stages to the detector and audio section.

The if stages

It is not possible, as yet, to obtain a gain per stage from the transistor to equal that obtainable from tubes. Therefore, the designer of the transistor set uses one more transistor. Most transistor sets have a total of three if amplifiers, instead of the conventional one or two. Fig. 5 is a typical if stage. A 2N149 is used in a common-emitter circuit. Conventional-appearing if transformers are used. The major difference is the low-impedance windings to match the transistors. Agc, as in the mixer and rf stages, is applied to the emitter through a 4,700-ohm resistor. Three of these stages form the if strip.

Next month we will continue to tour the transistor auto radio. The detector, agc control, agc amplifier, audio preamp and audio output stages will be discussed. Methods of testing transistors, what to do while servicing in the car and how to cure auto noises will also be described. TO BE CONTINUED

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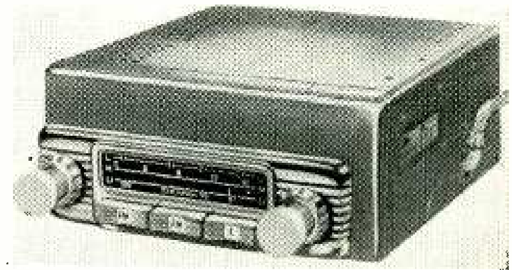
Rediscovery of FM Broadcasting

Once almost down and out, FM is on the upswing again



Blaupunkt *Kolon* 3-way auto radio has FM, AM and longwave bands.

By DAVID LACHENBRUCH

THIS year, for the first time since the very early 1950's, you'll see FM radios displayed by nearly all major manufacturers—and a greater assortment of imported and minor-brand FM sets than ever before.

This spring or summer, you're likely to see the first AM–FM automobile radios bearing the imprint of top U. S. car radio manufacturers.

Is it for real this time? Is FM going to catch on after 10 disappointing years?

It's still too early to tell. But this much is apparent—FM is experiencing a very definite boost in popularity which seems sure to accelerate in 1958.

It's a small increase, but it shows up at both the broadcasting and the receiving ends of the business. The downward trend in number of stations on the air and in production of receiving sets has halted for the first time since early 1950. If the signs of FM's health were plotted on a graph, 1956–57 would show up as the beginning of a small upward bump (see Fig. 1). The new signs of FM life bear close watching by everyone whose livelihood—or interest—is geared to radio.

A sick industry

Ask almost any broadcaster and he'll tell you that FM is still a very sick industry, a far cry from the virile newcomer who seemed destined to knock AM radio out of the spectrum after World War II—until television came along.

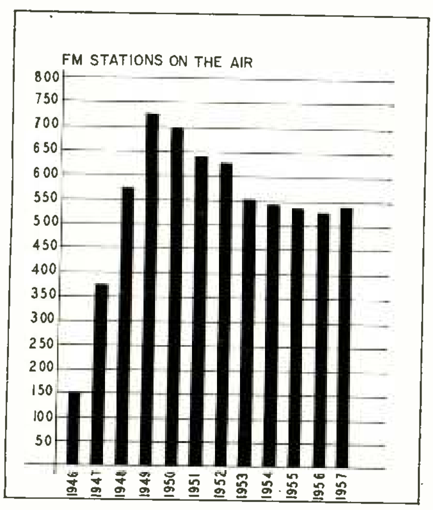
The number of FM stations on the air began tapering from its peak of 730 late in 1949, dwindling to 536 by early 1956. Then the casualties virtually stopped, and the number of operating stations even increased slightly to 544 by September, 1957.

Then, last summer, the FCC's normally quiet FM section was stunned by a comparative avalanche of applications for new stations. During a single 8-week period, the commission received a total of 24 applications—an average of 3 a week, compared with fewer than one a week in the same period the preceding year. Applications on file for new stations now total about 50.

For the first time in years, the FCC has more applications than available channels in some big cities—making it necessary to hold hearings among applicants for contested frequencies.

In the New York City area, where 16 FM stations are operating or authorized, there are 6 applications for the 2 vacant channels. In Los Angeles, where 17 are on the air with 1 more ready to start, 5 applicants are vying for 2 remaining channels. In Philadelphia, 7 are operating and there are 4 applicants for the 4 available assignments.

These cases are exceptions, of course. In most locations—even big cities like Chicago—FM channels are going begging. But these illustrations are indications of the broadcaster's current reappraisal of FM's possibilities.



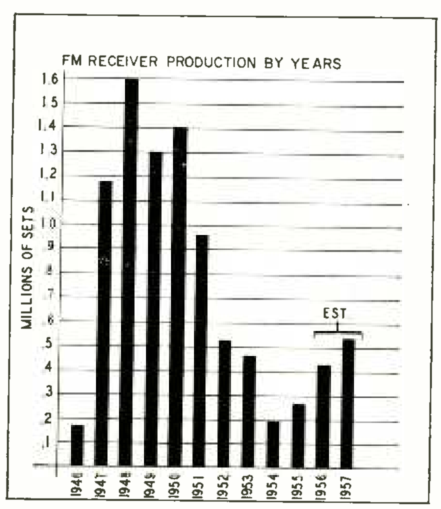


Fig. 1 (left)—FM stations on the air. Slight upturn began early in 1957 along with sharp increase in applications.

Fig. 2 (right)—FM receiver production by years, including TV sets with continuous tuners which tune FM band. Without such sets, FM set production would have dipped to about 878,000 in 1949, staying at about this level in 1950–51.

Independent programming

There were other signs of a renewed interest in FM in 1957. Westinghouse Broadcasting Co. ended the repeater status of its FM outlets in Pittsburgh, Pa., and Portland, Ore., programming them separately from their AM companions—with classical music exclusively. Westinghouse also applied for a new FM station in Boston to replace the one it took off the air 2 years ago, and ordered brand-new transmitting equipment for its Cleveland FM outlet. Both of these will also be independently programmed with serious music.

A few other large-network-affiliated outlets began programming their FM stations independently from AM—Washington's WMAL is an example. And NBC applied for a new FM station in Philadelphia as a companion for its AM and TV stations there, but currently has no plans for separate FM programs.

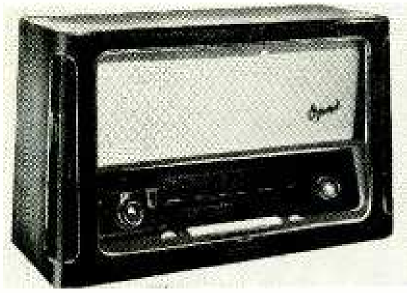
Many FM-only stations, and independently programmed FM's, report a definite increase in the amount of mail received from listeners—generally considered a reliable indication of a pickup in audience size.

During the long years of FM's post-1949 famine, one question frequently asked in the broadcasting industry has been: If FM is dead, why won't it lie down? Why did considerably more than half of the peak 730 stations stay on the air, when official FCC figures show only a handful of them making a profit from FM operations?

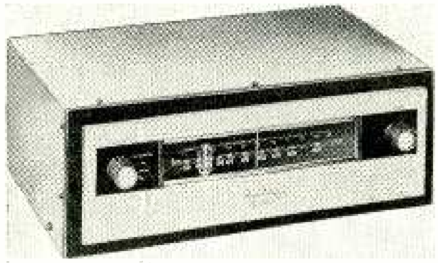
The National Association of Radio & Television Broadcasters, in a recent questionnaire to FM broadcasters, asked each one to give its own reason. The most recurrent answers were:

1. By duplicating AM programs on the FM transmitter, it costs virtually nothing to stay on the air.

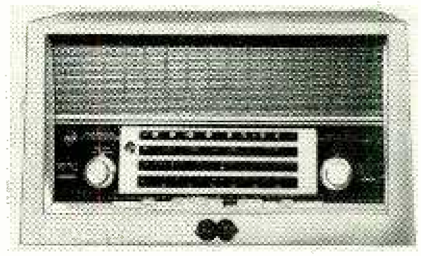
2. FM listeners are a loyal bunch,



Telefunken ***Opus*** covers FM, AM and shortwave bands.



Pilot's FM-530, FM tuner.



RCA International receiver, European made, has FM, AM, 2 shortwave bands.

and it would be poor public relations to turn the station off.

3. FM gives daytime-only AM stations an opportunity to provide some nighttime coverage.

4. Duplicating programs on FM extends the coverage of low-powered AM stations.

5. Local sports events, carried on FM only, have a big following.

6. The possibility of future developments in the FM band makes it worth while to keep a foot in the door.

It's impossible to estimate just how many FM dials are actually being twisted. About 8,000,000 sets have been produced since FM started up after the war, but how many have been scrapped or are standing idle, nobody knows.

There aren't even any current statistics on FM receiver production or sales. The industry's record keeper, Electronic Industries Association (formerly RETMA), stopped keeping track several years ago when manufacturers' interest in FM approached the vanishing point.

Before EIA (or RETMA as it was then) stopped counting, it estimated 1,175,000 sets were produced in 1947, peaking to a high point of 1,600,000 in 1948 (see Fig. 2). Then came the drop, with annual output dipping to a little over half a million by 1952. In subsequent years, production probably fell to about 200,000 annually, reaching this lowest ebb in 1954.

A turning point came in 1955. That year, it's estimated that production of sets and tuners increased to 275,000. The uptrend continued in 1956, with sales climbing well over 400,000, and an educated guess would put 1957 sales somewhere above half a million. Not a boom by any means—but a step up.

Hi fi and FM

What did it? All of the probable answers revolve around high fidelity and the education of the American ear.

Though audio aficienados had been hooking up components for best possible musical reproduction for years, their purchases of FM tuners (made by nearly 20 small manufacturers) never comprised a numerically important factor for nation-wide FM. But their enthusiasm was so contagious that by 1955 it had spread to some important manufacturers, who decided that hi fi might become a magic word for the mass market.

The time was ripe. Phonograph records had attained a quality far beyond the ability of the average phonograph to reproduce. The natural companion to hi-fi recordings was hi-fi radio—FM.

But in 1956, the first big year for packaged hi fi, most of the 500,000 units sold under the hi-fi label did not contain FM. The number doubled in 1956 and a greater proportion of them had FM tuners. In 1957, it's estimated that some 1,700,000 packaged hi-fi units were sold. It's improbable that anywhere near half of them had FM, but the proportion increased again.

Distributors in some cities now report that it's practically impossible to sell packaged hi-fi units without FM.

At least some of the credit for America's recently renewed interest in FM is due the Germans. In Germany, where FM has virtually replaced AM because of the crowded broadcast band, manufacturers with such jawbreaking names as Grundig, Telefunken and Blaupunkt began exporting their generally excellent FM–AM–SW sets to the U. S. The Germans are believed to have sold as many as 50,000 here in 1956 and perhaps 75,000 in 1957. American manufacturers sat up and took notice.

More American sets

During the long FM famine, only one major U. S. manufacturer—Zenith—continually produced FM receivers in quantity. Late in 1954, just before the FM upturn began, a small American manufacturer — Granco Products, Inc. —experimentally turned out a $30 FM-only set with a circuit based on the design of its uhf TV converter. This clicked, and Granco claims its sales of FM sets and tuners hit 100,000 in 1956, and even more in 1957.

Other American manufacturers have decided to try again. For their 1958 lines they have announced not only hi-fi sets which include FM tuners, but such items as FM–AM clock radios and table models. Among those now offering or preparing to offer FM sets are: Motorola (its first since 1952), Admiral (first since 1954), RCA (which will import a specially made set from Germany), G-E, Philco, Arvin, Columbia, Magnavox, Stromberg-Carlson and Olympic. British radio manufacturers are also hoping to crack the 1958 U. S. markets with their FM sets. At least one Japanese manufacturer plans to export FM tuners to this country.

Also from Germany, along with German-made automobiles, came FM auto radios. Again, U. S. manufacturers plan to follow suit. It's understood that both Motorola and Philco have FM car radios on the drawing boards for introduction this spring or summer.

Last summer, the FCC asked for the TV industry's comments on a proposal to facilitate highway FM reception with standard buggy-whip auto antennas by permitting FM stations to use vertical polarization in place of the traditional horizontal polarization. Commenting on this proposal, some FM stations pointed out that the FCC rules already permit circular or elliptical polarization which could produce the same effect without any changes in the rules. (However, no station is currently using circular or elliptical polarization). Other stations expressed the view that present transmissions can be picked up satisfactorily by conventional auto radio antennas, that if there is any reception problem at all, it will be in areas far distant from FM stations.

All of these signs point to a definite increase in public awareness of FM. But FM station operators have their eyes on another development which they hope will permit them to keep serving a small and loyal public audience, and make money too.

This is multiplexing (see "Multiplexing and You," RADIO-ELECTRONICS, October, 1957)—now permitted by the FCC on a regular basis. The commission has more than 50 applications by existing FM stations who want to begin this service, and a number of them have already started.

Stations plan many ingenious uses for the multiplexing technique. Among them are background music for stores, factories and offices; specialized programs beamed to schools; special home-study courses, etc.—all to be offered simultaneously with, and in addition to, regular FM broadcasts.

Equipment has already been developed for binaural radio using a single FM channel. Some day soon, multiplex FM receivers may well be a companion to binaural tape players in the home.

Which way FM? The signs of renewed activity in the 88–108-mc band are not of boom proportions. But there is more hope today than at any time since 1949 that this superior form of radio finally will take its well deserved place under the audio sun. END

FASTER RADIO REPAIRS

By JOHN B. LEDBETTER

IF you have deserted the field of radio servicing for TV, stop a moment and reconsider, even if you are "snowed under" with TV repairs. Radio servicing not only helps to pay your bills, it keeps you in closer contact with radio owners who in most cases will be prospects for TV receivers, antennas, converters and other accessories.

Since time is your most valuable asset, these notes have been selected to help you save it. Some troubles may sound routine, but they can result in quite a waste of time if you are not prepared for them.

1. Oscillation, usually appearing as birdies or squeals, evenly spaced throughout broadcast band.

a. *Radiation from second detector.* If the set is not ac–dc, pull out the oscillator or converter tube. If the oscillation stops, trouble is probably caused by radiation from the second detector back to the front end (usually through the loop antenna or poorly shielded rf or converter stage.) If the set is ac–dc, check the same possibilities by shorting the converter tuning capacitor with a small screwdriver. See that all leads from the second detector are as short as possible and are dressed away from if, rf and antenna leads. In some cases, a copper or aluminum sheet installed between the loop antenna and the set (grounded to the chassis) will cure radiation trouble and may improve performance. Also try increasing spacing between antenna and chassis by 1 inch or so.

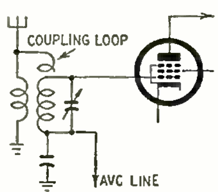


Fig. 1—Coupling loop circuit couples antenna to converter grid coil.

b. *Feedback from if strip.* If radiation in either of the above cases continues after the oscillator or converter has been disabled, the trouble is originating in the if section. Check all decoupling bypass capacitors in these stages. These sometimes open or become intermittent, and in some cases have changed value enough to produce resonance or feedback at the intermediate frequency. Check for gassy if tubes (instability and resultant oscillation from this cause is fairly common). Check each stage for correct alignment.

c. *Feedback from wiring.* Check ac (heater) leads and dress away from grid circuits keeping as close to the chassis as possible. Keep maximum separation between grid and plate circuits. Check cathode and screen bypass capacitors for opens, changed values or a cold-soldered joint.

d. *Capacitive coupling between tube elements.* If the set is designed to use metal tubes, see if they have been replaced with glass types. If designed for glass, use a GT instead of the G (these reduce microphonic tendencies and keep internal capacitances at a minimum). Keep all wiring as short as possible and be sure coupling capacitors are not crowding adjacent terminals on the tube socket. If a particular stage is critical even after these precautions, try a metal tube or check operating voltages for abnormal readings.

2. Oscillation or squeals from about 700 kc to lower end of band.

Image interference from stations on high end of band. This is the result of poor selectivity or low Q in antenna and rf tuned circuits. About the only remedy (outside of adding an rf stage) is to shift the intermediate frequency slightly so images of higher-frequency stations will not beat with the desired low-frequency stations. Adding a broad-tuning rf stage to most midget sets is impractical, but you may be surprised at how effective this will be on some of the older (and larger) receivers.

3. Oscillation occurring only at low end of band.

Sometimes caused by blocking or undesirable coupling from antenna or rf stage. Check alignment of receiver and realign at proper if frequency. Check for undesirable line-cord radiation by bypassing each side of the ac line to ground with a .05- to 0.1-μf molded capacitor.

4. Turntable hum.

Most common cause, especially in ac–dc receivers, is insufficient capacitance in the ac line-to-ground bypasses. Often .01 μf is used, and in some cases this is not enough. Replace with .05 or 0.1 μf.

5. Intermittent reception.

a. *Defective paper coupling capacitor in second detector, first audio or output stage.* Try replacing with .01- to .05-μf 600-volt molded units.

b. *Leaky coupling loop.* This wire loop is used in many small and old-model receivers to couple the rf and oscillator, or antenna and converter grid coil (Fig. 1). The insulation sometimes absorbs moisture and makes these wire loops a hard-to-locate source of low gain or intermittent trouble.

6. Noisy tuning capacitor.

a. *Collection of dirt, grease, etc. in bearings or on wiper contacts.* Clean with carbon tetrachloride. Apply a small amount of Lubriplate or similar noncorrosive lubricant.

b. *Flakes or dirt between tuning capacitor plates* This was a common fault in older sets which used plated capacitors. If the receiver uses a transformer power supply, remove the rectifier tube, unsolder the grid connection from the stator of the tuning capacitor and apply high-voltage ac from one of the rectifier plate pins to the stator with a test probe. Rotating the capacitor will burn out the flakes in short order. (In some receivers, it may be necessary to straighten the plates to prevent rubbing.)

7. Microphonic howl in home; OK at shop.

a. *Low line voltage at customer's home.* A tube which may operate satisfactorily in your shop can be microphonic in the customer's home under certain line-voltage conditions. (This is particularly true with three-way portables which use 1.4-volt tubes.) You can catch most of these offenders with an isolation transformer with a variable tap, or with a 115-volt bulb (20 to 60 watts) in series with the secondary (see Fig. 2). Low emission and drifting oscillator conditions will show up (along with a few other troubles) if the set is given a test run at reduced line voltages.

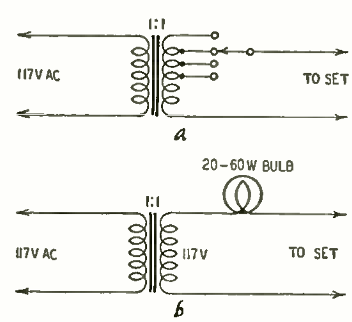


Fig. 2—Two methods of lowering line voltage; a–isolation transformer with variable secondary; b–110-volt lamp in series with secondary.

8. Sound comes on suddenly after set has warmed up; is sometimes accompanied by microphonics or "pinging" noise.

Defective oscillator or audio tube. 12SA7, 12SQ7 and similar types are frequent causes of this trouble.

If the above notes seem too simple in this complex business of servicing, remember—it is the *simple* things which trip you up! Nine times out of ten, you will remember your most difficult or time-consuming jobs as those which were caused by a simple or too-obvious defect. As the time-worn axiom states, we sometimes "can't see for lookin'." END

VANGUARD 108

Author using Vanguard 108 with his Hammarlund HQ-110 receiver.

Track the US satellites with this simple two-tube 108-mc converter, which also has other uses

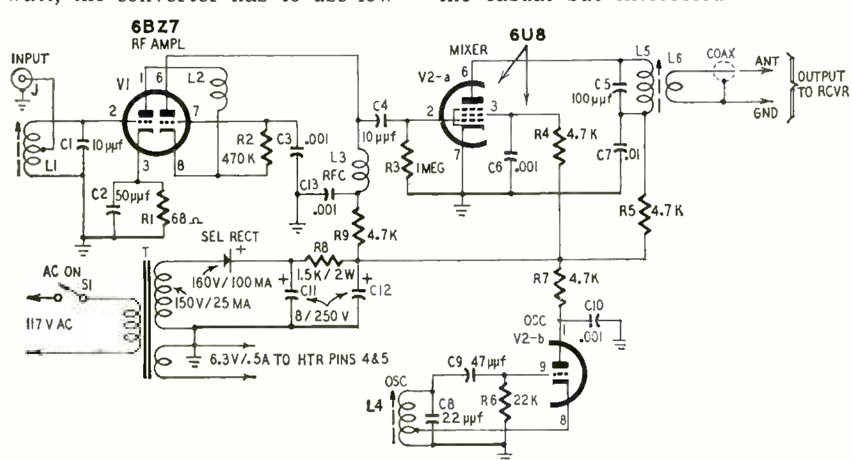
By RICHARD GRAHAM

TUNING in our own Vanguard satellite promises to be one of the thrills of this year. However, because the frequency of radio transmissions from the Vanguard is beyond the tuning range of most receivers, many will miss out on this event. But you won't miss out on this or the satellites to follow, if you build this Vanguard 108 converter.

Basically, the converter is a device that translates the 108-mc transmissions from the satellite to a frequency of 8 mc which can be heard on your shortwave receiver. The receiver will read frequency directly if you mentally add 100 to the reading on the dial. For example, 8 mc on the receiver dial corresponds to 108 mc and 7 mc to 107 mc.

Since the transmitted power output from the US satellite will not exceed 0.1 watt, the converter has to use low-noise high-gain circuitry which must be adjusted for peak efficiency for satisfactory results. The ability to receive the satellite satisfactorily depends almost entirely on the converter's gain and noise figure. The receiver, if it is of average quality, plays a relatively minor part. (At vhf frequencies, the receiver's ability to detect a signal is limited only by the noise generated in the antenna resistance and the front-end tubes.[1])

The Vanguard 108 combines reasonably high gain and low-noise circuitry at a reasonable cost. It uses standard TV tubes, which are inexpensive and readily available. Some improvement in the gain and noise figure could be obtained by using some very special and very expensive Western Electric types. This is fine for those actually engaged in satellite tracking, but for the casual but interested observer the economic difference[2] is worth the small sacrifice in performance.



R1—68 ohms
R2—470,000 ohms
R3—1 megohm
R4, 5, 7, 9—4,700 ohms
R6—22,000 ohms
R8—1,500 ohms, 2 watts
All resistors ½ watt, 10% unless noted
C1, 4—10 µµf
C2—50 µµf
C3, 6, 10, 13—.001 µf
C5—100 µµf
C7—.01 µf
C8—22 µµf
C9—47 µµf
C11, 12—8 µf, 250 volts, electrolytic
All capacitors 600-volt ceramics unless noted
J—coaxial connector
L1—4 turns No. 16 tinned wire, 1-wire diameter spacing tapped in center, wound on Cambridge-Thermionic type LS-3 form with white-coded core
L2—1¾ turns No. 16 tinned wire, ¼-inch diameter, air-wound, self-supporting
L3—Rf choke, Z-144 Ohmite
L4—3 turns No. 16 tinned wire, 1-wire diameter spacing tapped at 1 turn from ground end, wound on Cambridge-Thermionic LS-3 form with white-coded core
L5—18 turns No. 30 enameled wire, closewound on Cambridge-Thermionic LS-3 form with white-coded core
L6—2 turns hookup wire, wound over L5
RECT—selenium rectifier, 100 ma, 160 volts
S—spst toggle
T—power transformer: primary 117 volts; secondary 150 volts, 25 ma; 6.3 volts, 0.5 amp (Stancor P-8181 or equivalent)
V1—6BZ7
V2—6U8
Chassis, 5 x 3 x 2 inches
Miscellaneous hardware

Circuit of the Vanguard 108 converter.

Circuit description

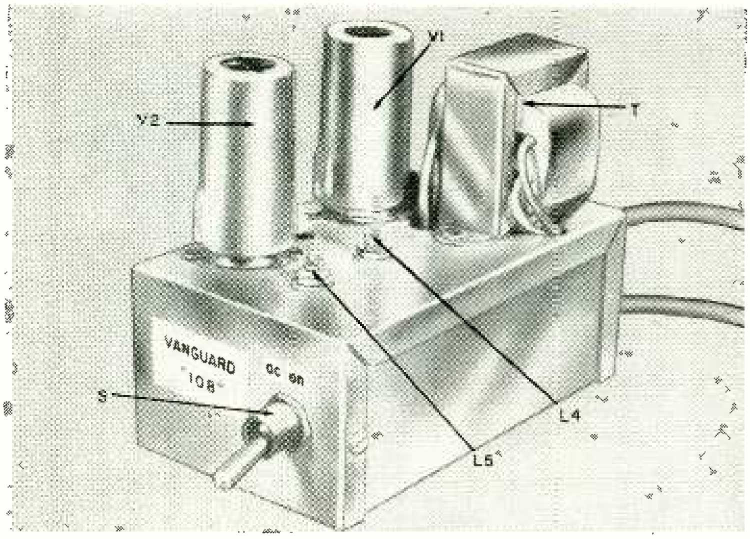
The Vanguard 108 has only two tubes and its circuitry (see schematic) resembles that of many TV and FM receiver front ends. The converter uses the popular cascode circuit for the rf amplifier. This is followed by a mixer oscillator using a dual-purpose pentode–triode.

The converter can be generally described as a broad-band fixed-tuned type. This means that all of the tuned circuits are "fixed" and do not require adjustment while the converter is in use. All necessary tuning is done with the receiver only. This is possible because the converter's tuned circuits are broad enough to permit tuning over ±2 mc around the center frequency of 108 mc without any significant change in performance.

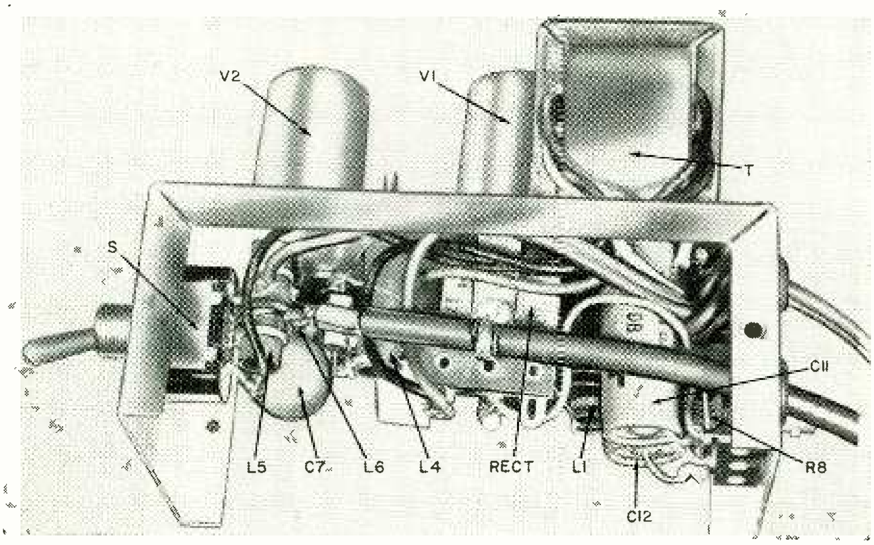
The signal from the antenna is applied to tapped coil L1. This is adjusted to resonate with capacitor C1 and the input capacitance of the tube to 108 mc. This drives the grid of the cascode rf amplifier. This stage uses a 6BZ7 dual triode which is the latest in a series of tubes designed specifically for this purpose. The cascode amplifier is noted for its low noise characteristic. It is equivalent to a single grounded-cathode triode with zero plate-to-grid capacitance, and with a mutual conductance and noise resistance equal to that of the first triode tube in the circuit.[3]

A glance at the circuit shows that effectively the two triodes of V1 are in series. The first triode functions as a grounded-cathode and the second as a grounded-grid amplifier. The cathode of the second triode is driven instead of its grid, which is placed at ac ground by bypass capacitor C3. The output of this second triode is untuned and is capacitance-coupled to the grid of the pentode half of the 6U8 which serves as the mixer.

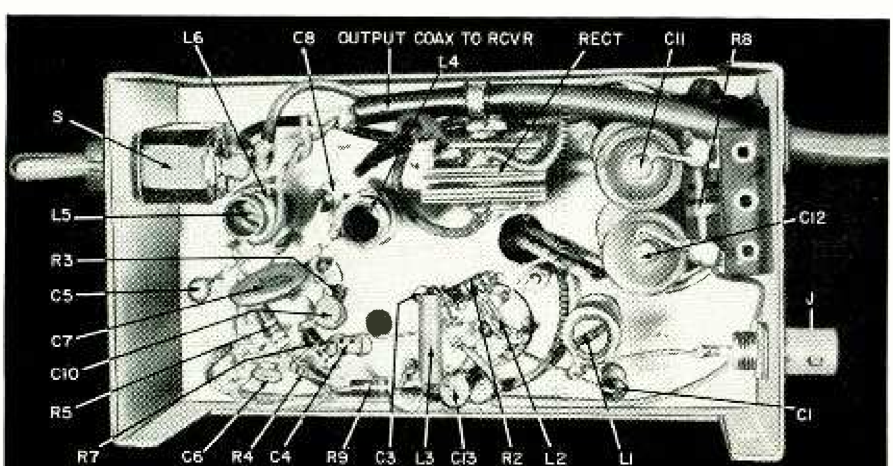
L2 acts as a neutralizing coil. In practice, this coil is not too critical and therefore needs no adjustment. However, the purist who wants the most from the converter and who has a way



Closeup of the finished unit.



Underchassis view of the converter.



Another look inside the unit. Short leads are used on all components.

to measure noise figure,[4] can adjust it for a minimum noise figure.

The triode half of V2 is an oscillator of the Hartley variety. It is adjusted by L4 to operate at a fixed frequency of 100 mc. The oscillator signal is coupled to the pentode mixer by stray capacitances in the tube and wiring. The oscillator operates 8 mc lower than the incoming signal rather than 8 mc higher, because in this way the receiver reads an exact 100 mc below the actual incoming signal.

The difference frequency of 8 mc in the plate circuit of the mixer is selected by the tuned circuit consisting of the adjustable inductor L5 and fixed capacitor C5. A link (L6) wound over coil L5 provides a low-impedance output for coupling to the receiver's antenna terminals. To insure stability, the plate and screen circuit of each stage is decoupled with a 4,700-ohm resistor and a bypass capacitor.

The power supply uses a Stancor P-8181 power transformer which is intended for TV booster service. This supplies the 150 volts necessary for proper operation of the cascode amplifier. It also allows the use of the more economical resistance type of power supply filter. Otherwise the circuit is a conventional selenium halfwave transformer-fed power supply.

Construction hints

The Vanguard 108 is built into a 5 x 3 x 2-inch Minibox which acts as a shielded chassis. This avoids any possible interference with FM sets in the immediate vicinity. The general layout of the components can be seen in the photographs. I strongly suggest, unless you are fairly familiar with vhf circuitry, that the layout shown be used.

As can be seen in the photographs, lead length in rf circuits, particularly those performing rf bypass functions, is practically nonexistent. Short leads to a good ground connection go a long way toward preventing oscillation and birdies.

The rf output should be coupled to the receiver's antenna terminals with a short length of coax. Neither type or length of the cable is particularly critical. I used a piece of RG 59/U, 20-inches long. Keep the unshielded connection at the receiver end of this cable as short as possible. Sensitive receivers do not need much of an antenna to pick up objectionable signals directly at 8 mc. These might mask the desired converted signal at 108 mc.

.If your receiver picks up signals in the vicinity of 6 to 10 mc with the antenna terminals shorted, it is a sign that the receiver needs additional shielding or power-line filtering is needed where the line comes into the receiver chassis.

Alignment

Alignment of the Vanguard 108 is quite simple and straightforward. It requires a source of 108 mc, which can be in the form of a signal generator or a grid-dip meter. After the unit has been completed and visually checked, it is ready for alignment. The first step is to set up the Vanguard 108 with the receiver antenna, just as it will be used in practice.

Set the receiver to 8.0 mc. It is this frequency that will correspond to a received frequency of 108 mc with the Vanguard 108. Turn the converter on and set the grid-dip meter to 108 mc. If a signal generator is used, connect a small antenna (12 inches or so) to the generator's output terminal. Now adjust oscillator coil L4 until a carrier is heard. It can be identified as the grid-dip meter or signal generator simply by turning off the instrument being used. Next, adjust output coil L5 for maximum signal from the receiver by watching the receiver's S-meter or an output meter across the speaker voice-coil terminals. Now adjust coil L1 for maximum signal. The type of antenna and transmission line may make a slight modification of input coil L1 necessary. If it does not peak up, squeeze or spread the turns, as necessary, until it is in range of the tuning slug of L1.

At this point, check the oscillator frequency to insure that it is *below* the incoming signal. As stated earlier, adjust the oscillator to 100 mc. Then it is necessary only to add 100 mc to the receiver frequency reading to obtain the true received frequency. As you recall, from superhetrodyne theory, the chosen 8-mc if frequency can be obtained when the oscillator frequency is at either 100 (108 mc minus the if) or at 116 (108 mc plus the if). However, it is only when the oscillator is at 100 mc that the frequency is read by adding 100 mc.

This can be checked by adjusting the frequency of the signal generator or grid-dip meter slightly upward, say to 110 mc. Now tune the receiver to approximately 10 mc. The carrier from the generator should be picked up if the oscillator is on the correct frequency. If it isn't heard, tune to 6 mc. The carrier should now be heard, which will indicate that the converter's local oscillator is on the wrong frequency and L4 should be readjusted to a lower frequency. Once again, due to wiring differences, some spreading or squeezing of the turns may be necessary to get the inductance of the coil within the proper range.

Of course the accuracy of the equipment used to align the Vanguard 108 will determine the frequency accuracy of the converter receiver system. One way of checking the accuracy of the system and perhaps make the final touchup on the Vanguard 108 local oscillator is by using local FM stations around the high end of the FM band. For example, if a local FM station is at 106.5 mc, the receiver connected to the Vanguard 108 converter should pick up this signal at 6.5 mc. The signal will appear quite broad. However, the center or carrier frequency will be the point where the least audio garble is heard.

Another method, available to those not so fortunate as to have a convenient FM station on the high end of the FM band, is simply to use an FM tuner of known calibration accuracy to check the oscillator's frequency.

It's worth making sure that the oscillator frequency is precisely set at 100 mc since this will help to insure that, when the satellite goes up, you won't miss it by having to fool around with converter adjustments. As we all know, the thing travels fast and won't be heard long enough or often enough to permit much adjustment.

The antenna used should come under careful consideration. With a transmitter power of 0.1 watt, the signal will inevitably be very weak and receiving equipment must be in top operating condition. A good antenna, one that is directive and hence has high gain, and is rotatable will give the signal a welcome boost. Even a rotatable TV antenna has something to offer in this respect.

One aspect of building this converter should be not overlooked. Vhf is a busy world these days. Once the thrill of satellite hunting has subsided, the unit can always be converted to a host of other uses, either by simple realignment or by adding or taking turns from the coils. Removing one turn from L1 and L4, plus squeezing, will bring the 144-mc ham band within your tuning range. Similarly, police, fire, taxi, aircraft and other community and industrial services abound, requiring only minor modification to bring them within your tuning range. END

REFERENCES

[1] A good discussion of circuit and tube noise can be found in *Electronic and Radio Engineering*, 4th edition, by E. F. Terman, pages 434-442.

[2] The ultimate in performance can be had with a converter design described in "A Low-Noise 108/144-Mc Converter," by Mason P. Southworth, *QST*, November, 1956.

[3] The design characteristics of the cascode amplifier is described in *Radiotron Designer's Handbook*, pages 914 and 533–534.

[4] A discussion on noise generators can be found in "Noise Generators—Their Uses And Limitations," *QST*, July, 1953.

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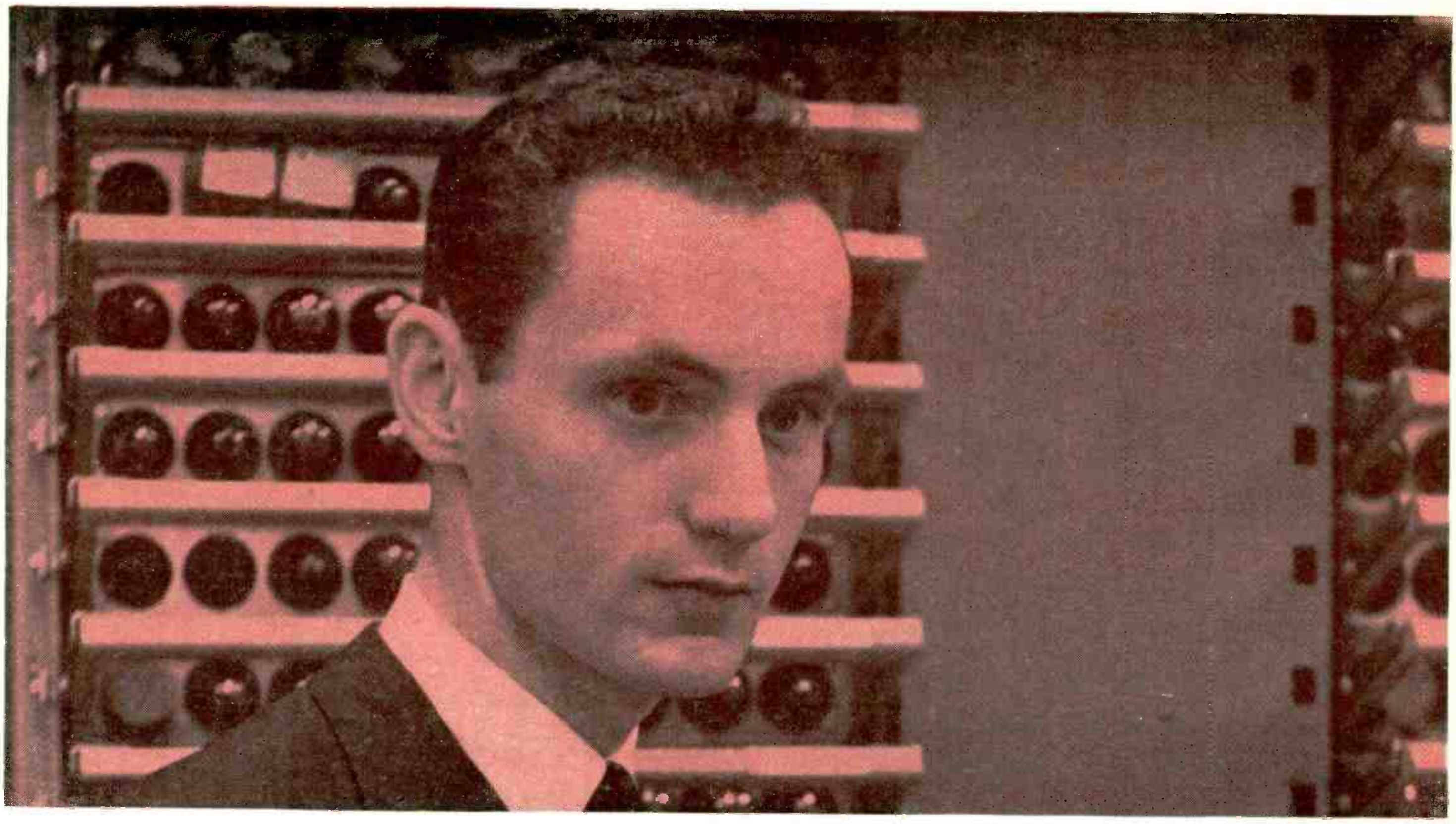

HOW FAR CAN YOU GO IN ELECTRONICS WITHOUT A DEGREE?

LESS THAN TWO YEARS AGO, 20-YEAR-OLD TIM WICKHAM HAD ASKED HIMSELF THIS QUESTION. Today, firmly established as a Computer Units Field Engineer with IBM, Tim knows some of the answers. His story of how he assumed important engineering responsibilities on one of our country's biggest electronics projects makes encouraging reading for every technician who feels himself handicapped by lack of a formal degree.

"I always wanted to be an electronics engineer," Tim says, "ever since I first tinkered with hi-fi in my high school days. But my formal education ended when I entered the Marines in 1953. In spite of the excellent radar training I received in the Service, I still had doubts as to how far I could go in my chosen field without a degree."

HEARS ABOUT IBM—AND SAGE

A few months prior to his discharge, Tim began to look into the opportunities for a civilian career. He heard about IBM, learned that IBM was willing to invest thousands of dollars training the right men to assume engineering responsibilities in the Project SAGE program. "Could I do it?" Tim asked himself. To be brief, Tim could—and did. Two months later Tim reported to Kingston, N. Y., to begin training as an IBM Computer Units Field Engineer.

SAGE—PROJECT OF NATIONAL SIGNIFICANCE

SAGE—for which Tim was trained—means Semi-Automatic Ground Environment. It is part of America's radar warning system—a chain of defense that will ultimately ring our country's perimeter. At the heart of this system are giant electronic computers, built for the project by IBM. These computers receive data from Texas towers, picket ships, reconnaissance planes, ground observers—analyze the data for action by the Strategic Air Command and other defense units. "These computers are the largest in the world," Tim points out. "Each contains 58,500 vacuum tubes plus 170,000 diodes."

BECOMES FIELD ENGINEER

"My five months' training at Kingston were a revelation," Tim remembers. "Here were top-notch courses in advanced electronics, taught by instructors who really knew their business—and had a personal interest in your progress. We had classroom lectures in which we learned about basic computers, logic, programming, general machine operation—how everything worked together. Instead of a lab, we worked in actual test areas, along with the regular test area personnel. Incidentally, IBM went out of its way to make our stay at Kingston pleasant. They helped us with housing accommodations and we received a living allowance over and above salary during our training period."

INSTALLS WORLD'S LARGEST COMPUTER

His training completed, Tim was assigned to the Project SAGE site at Newburgh, N. Y. "The giant computer was ready for installation," Tim recalls, "but before it could be moved into its new building, 300 miles of cable had to be laid. Then we made interconnections and brought in the power. Next came the testing phase—a long procedure, as you may imagine for a computer of this size. Then we set up the auxiliary equipment. Finally, when everything was ready, the Air Force ran its acceptance tests—a stiff trial with no if's, and's or but's permitted. I'm happy to say we got an unqualified OK.

"My present work," continues Tim, "is in the Tape Section of the computer. I'm responsible for the maintenance of the Central Computer Tape System which includes eight tape drives (a means of storing information) and two tape adapter frames which adapt information for admittance into the Central Computer. A Computer Units Field Engineer like myself works about three months in each of the computer's three sections, giving him a chance to learn the whole computer."

A NEW ENGINEERING DIMENSION

"IBM has proved to me," Tim says, "that a degree is not the only measure of a man's ability, or the only indication of what he can do when given the opportunity. Around me at the site I see a lot of men who were once considered 'just technicians'—men who have had a new engineering dimension added to their careers—all because IBM will spend time and money to train technicians for engineering responsibilities. I know this better than ever, now that I'm on the job. I'm on the Education Committee at the Newburgh site and I see what IBM will do to train men. My job on the committee is to find out what the men want. Then, IBM supplies courses, instructors, classrooms—everything that's needed."

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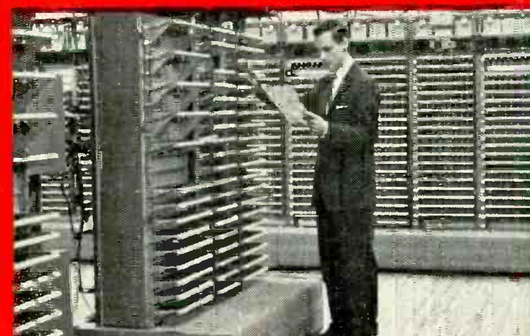
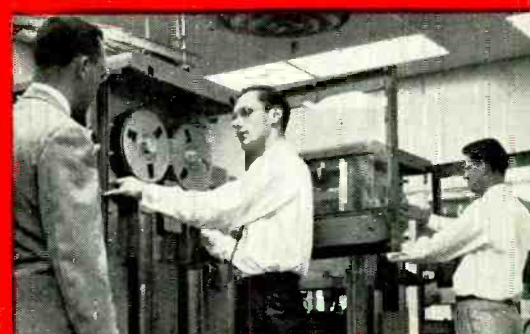
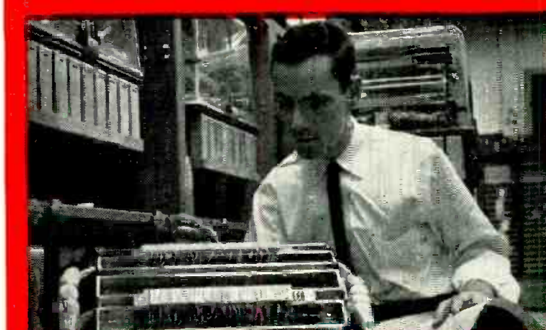
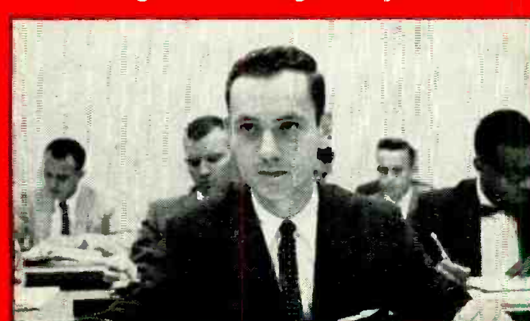
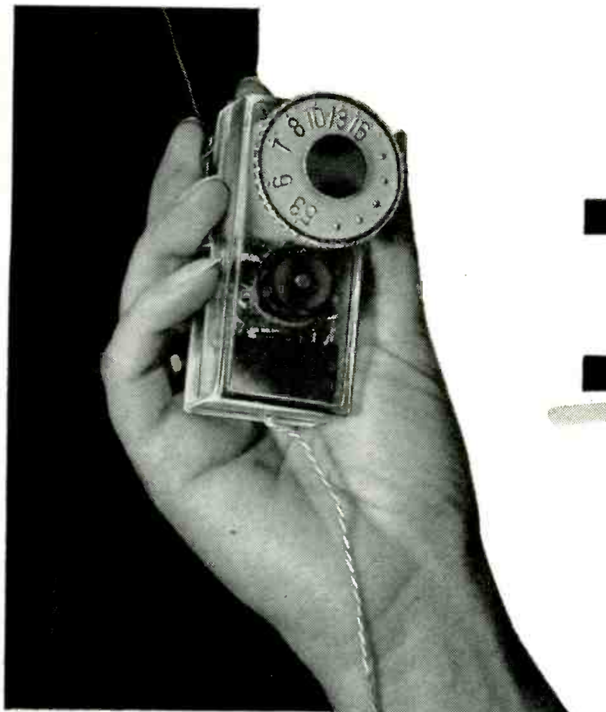
Checking panel wiring of Simplex console


Trouble-shooting a computer frame


Discussing a problem in computer magnetic tapes


Working on SAGE magnetic input drums


Classroom lecture in computer logic



The finished unit fits into a neat plastic case.

Small enough to nestle in the palm of your hand, it has 4 stages of audio amplification

TINY-TRAN POCKET RADIO

By FORREST H. FRANTZ, SR.

BEEN yearning for a really portable radio? One that will fit in your pocket and pick up stations without immobilizing you? A radio that's selective enough to separate strong local stations? Don't look any further; the Tiny Tran will fill the bill!

The Tiny-Tran doesn't shackle you to an antenna or ground. You don't have to hold a lead and let your body serve as an antenna either. Here's an example of Tiny-Tran's performance: I live 15 miles from the nearest radio stations (in Dallas and Fort Worth); Tiny-Tran in my shirt pocket picks up eight stations without any external antenna and I can listen comfortably while walking.

I've wanted a radio as small as this for a long time. I've tried to miniaturize transistor audio amplifiers, use regenerative transistor detectors and, on occasion, I've even resorted to "odd ball" body-mounted antenna schemes. The results, though they seemed good at the time, are rather dismal, now that I've used Tiny-Tran.

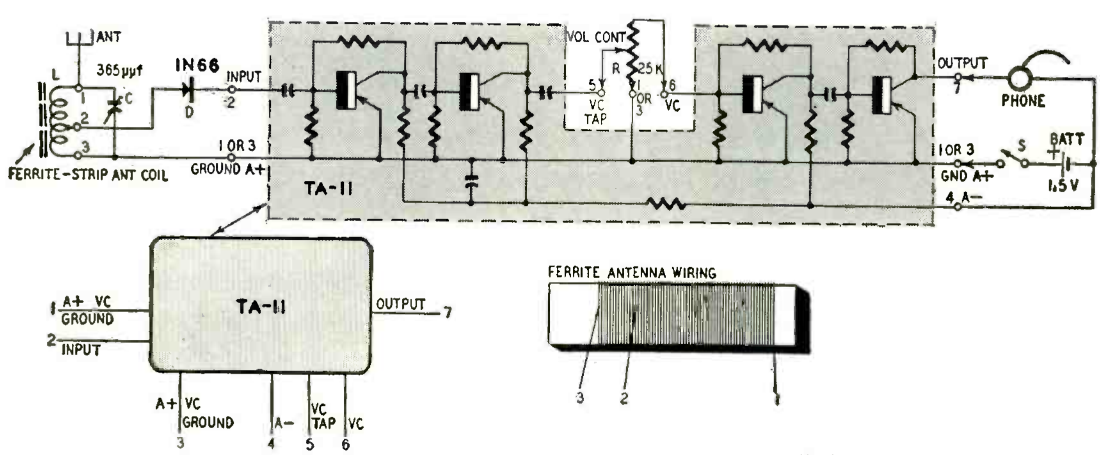
The experimenter bent on extreme miniaturization for pocket radio operation has, until recently, faced almost insurmountable odds. Although transistors are small and other components have been miniaturized, he has still been hampered by resistor dimensions and space requirements for making electrical (non-short-circuiting!) connections.

Two recent developments have changed the picture. These are manufacturing as well as engineering breakthroughs:

1. The packaged, printed-circuit, four-stage transistor amplifier manufactured by Centralab and designated the TA-11. Dimensions: 1.175 x 0.665 x 0.25 inch!

2. The miniature flat ferrite-strip antennas such as the Miller 2004. Q: 500 at 790 kc! Dimensions: 2⅞ x ¾ x ⅛ inch, when removed from its masonite mounting board!

Tiny-Tran's small size (2⅞ x 1-3/16 x 1 inch) and excellent performance are possible because of these components. The TA-11 subminiature transistor amplifier is expensive—about $35—but (to me at least) the compactness that it affords and the simplicity it lends to the Tiny-Tran more than compensate



R—pot, 25,000 ohms, subminiature, with spst switch (Centralab B16-217 or equivalent)
C—365 μμf, miniature variable (Lafayette MS-274 or equivalent)
S—spst switch on R
D—1N66 diode
L—ferrite antenna (Miller 2004 or equivalent)
Packaged transistor amplifier, Centralab TA-11
BATT—1.5-volt penlight cell (Eveready 912 or equivalent)
Knobs
Plastic case, 2-7/8 x 1-3/16 x 1 inch (Lafayette MS-157 or equivalent)
Earphone, impedance 8,000 ohms, dc resistance 2,000 ohms (Lafayette MS-260 or equivalent)
Miscellaneous hardware

Circuit of Tiny-Tran receiver.

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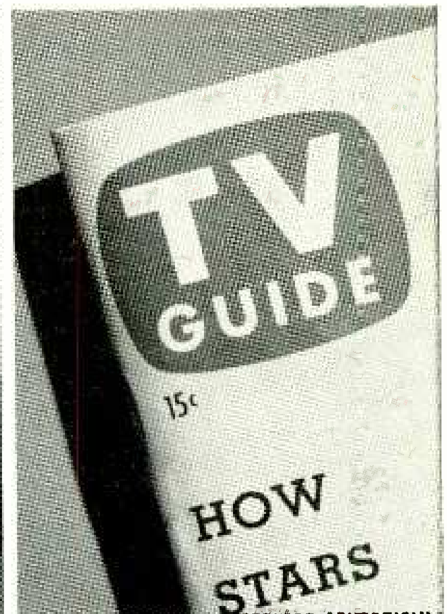

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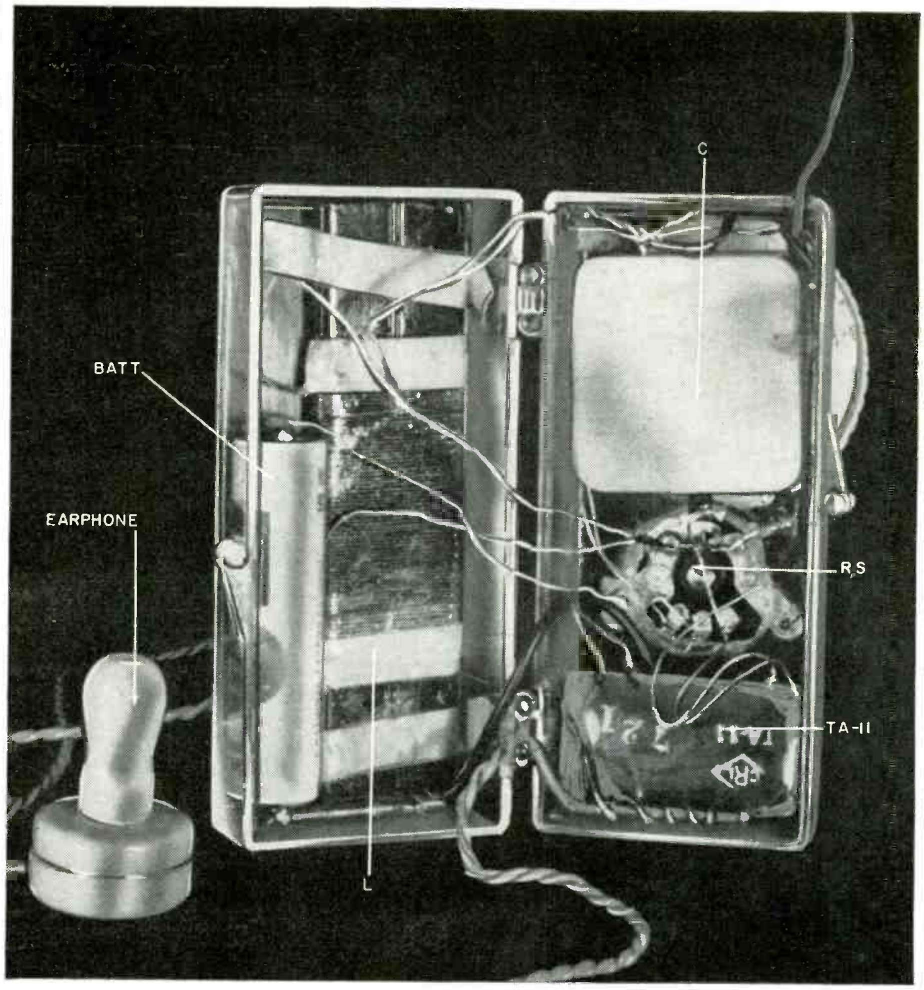

Opening the case shows parts placement.

for the expenditure. Other miniature parts are also essential, but these have been available for some time.

The circuit

The circuit of the Tiny-Tran is straightforward (see diagram). The high-Q antenna provides adequate selectivity in a diode detector circuit. The extreme sensitivity of this high-Q circuit also accounts for the radio's good station pickup characteristics.

The rectified signal at the output of the detector is not strong enough for direct headphone operation without an external antenna. To eliminate the need for an antenna, considerable audio amplification is required. The TA-11 furnishes this amplification. Its gain is better than 73 db. That's a voltage gain of approximately 4,500!

Volume is controlled by a miniature volume control between the second and third transistor amplifier stage. A spst switch on the volume control turns the set on and off. The energy source controlled by this switch is a penlight cell.

Several of the amplifier's characteristics are of particular interest. Current drain ranges from 3.6 to 4.4 ma, input and output design impedances are 1,000 ohms and power output is 1 mw maximum with 15% distortion. At 0.36 mw, distortion is only 2%. Frequency response is within 5 db from 250 to 20,000 cycles. Not hi fi, but certainly listenable.

Now build it

It won't take very long to make your Tiny-Tran. The first time I worked with the TA-11 amplifier, I breadboarded the basic circuit in less than 10 minutes. After I forced myself to stop playing with this simple setup that produced such intriguing results, I undertook the more tedious task of packaging the circuit. Even this can be done in less than 30 minutes. Here's a suggested procedure:

1. Drill the plastic case. Make starter holes with a small drill for the volume control and tuning capacitor shafts. Then ream the holes out to size. This precaution prevents cracking the case. My reamer wasn't large enough to make the volume-control hole, but I managed to melt the hole to size with a soldering gun. The small holes for fastening the tuning capacitor and the volume control are drilled directly. Notches at the top of the case (for the antenna) and at the bottom (for the headphone lead) are melted out with a soldering gun.

2. Mount the components as shown in the photos.

Remove the antenna coil from its Masonite mounting strip. This is done

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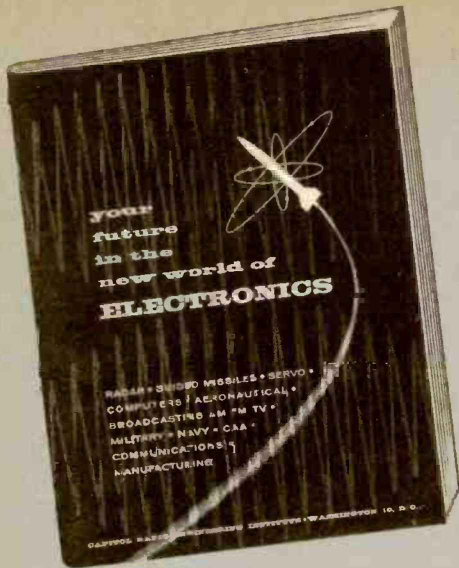

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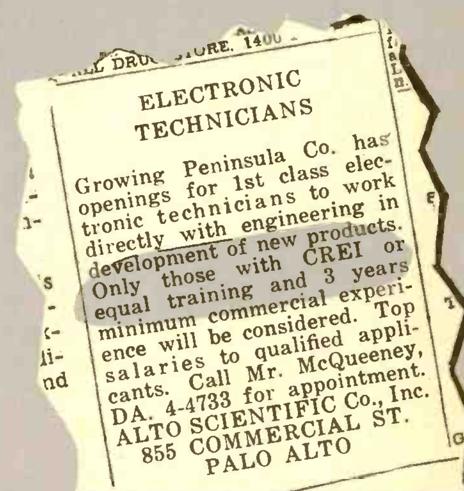
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by loosening the tape which holds it in place. Trim the tape to a length to go just around the antenna and protect the end turns. Use cellophane tape to fasten the loop to the case.

3. Proceed with the wiring. Wire the ferrite-loop antenna, tuning capacitor and diode detector combination first. Take the usual precautions in soldering semiconductor leads and in handling Litz wire.

Next place the TA-11 inside the front half of the case and fasten the earphone lead temporarily in place with cellophane tape. Wrap the TA-11 output lead (numbered 7) around one phone lead tip. Wrap all the lead length you can around this tip, but don't put tension on the TA-11 lead. *Do not solder this connection!* With cellophane tape, fasten the phone tip securely to the side of the case.

Now connect leads 5 and 6 to the volume control. By running the leads up the side of the case and bending them back on themselves you can avoid cutting them. There's enough space and the leads are stiff enough to prevent short circuits. If you wish, slip fine spaghetti over these leads. Connect lead 1 to the volume control and the ground side of the tuning capacitor. Lead 2 is brought up around the variable capacitor and connected to the diode. Lead 3 connects to the switch. The other side of the switch is connected to the plus side of the battery. Put a piece of thin plastic spaghetti (may be stripped from plastic-covered hookup wire) on lead 4 of the TA-11 and wrap the end of this lead around the second phone tip. *Do not solder this connection.* Solder the end of this phone tip to the negative end of the battery. The phone tip and battery should be cleaned with a file prior to soldering. Secure the phone tip and battery with cellophane tape.

Finally, solder the antenna wire and tape it in place. I used 12 inches of No. 18 silk-covered wire. If you are going to use your radio in a city speckled with radio stations, the antenna is unnecessary. (Perhaps some reader will come up with a small telescoping antenna that will handle any eventuality.)

Make it smaller

Examination of the Tiny-Tran layout will probably prompt many experimenters to ask why I didn't make the radio smaller. The question is a fair one because it is quite apparent that it can be miniaturized further. There's plenty of space in the case and the tuning capacitor's shaft can be shortened. A smaller battery could be used. By taking advantage of these space-saving possibilities, Tiny-Tran's size can be cut in half. I didn't resort to these measures because the wiring would have been more difficult. Besides, with the usual experimenter's initiative to do more things with new gadgets, I'll probably expand Tiny-Tran to a Speaker-Tran by next issue. END

TRANSISTORS

SENSITIZE RELAY CIRCUITS

Eight circuits that will increase the usefulness of your relay control

By EDWIN BOHR

TRANSISTORS can multiply the sensitivity of conventional control circuits by tens, hundreds or thousands of times. Transistor relay control circuits are excellent for extending the sensitivity of photoelectric devices, garage-door openers, radio remote control, carrier-current circuits and the like.

Most of the popular crystal diode circuits can be souped up and given new vitality. Just select a suitable transistor relay from this article and you're in business. Transistor relay control circuits can be used in hundreds of ways.

But several limiting factors enter into any consideration of dc transistor amplification.

Sensitive relays

Very sensitive relays are expensive and fragile, and the contact adjustments are always delicate. Except for moving-coil types, the contact movement is exceedingly small. Armature movement is almost invisible on many types.

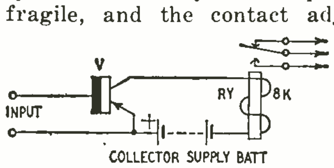


Fig. 1—Typical transistor relay circuit.

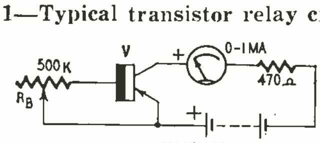


Fig. 2—Experimental circuit shows effects of leakage and temperature.

With these conditions, vibration sensitivity and contact sticking from the slightest overload are real headaches. Such troubles, however, disappear when relays are used and adjusted to operate from signals larger than 25 mw.

A specific example is the Sigma type 4F relay with an 8,000-ohm coil. This relay, adjusted to operate with a coil current of 2 ma, is reliable despite large inductive contact loads (the type usually found in model control circuits), vibration, temperature changes and dust.

This relay also operates pretty well on 1.5 ma if the armature air gap and spring tension are carefully adjusted. But, attempts to increase this relay's sensitivity further take it out of the good old "idiot-proof" category and place it in the "apologetic" group.

You know what we mean. An apologetic component is one with just enough margin of satisfactory operation to operate perfectly until we want to boast or demonstrate performance to someone important. Then it fails. Of course we can make a hurried screwdriver adjustment and get it to work. But, somehow, the sweetness of the moment is lost.

A Sigma 4F relay, adjusted for 30-mw operation, plus transistor amplification, will replace almost any special sensitive relay including polarized types. And there are many advantages in such an arrangement. Relay operation time—in most instances—is greatly improved; the cost is less and the complete unit is more immune to vibration, dirt, and contact wear. The characteristics of these two devices, the transistor and mechanical relay, are mutually complementary.

Typical circuit

For some time, transistor circuits for driving relays have appeared in popular technical magazines. Unfortunately, many of them have suffered from misapplication and poor design. Before going further, let's look at one of these circuits.

Fig. 1 shows a typical transistor relay circuit. The relay coil is simply connected in the collector circuit of a grounded-emitter stage. Current supplied to the base is amplified and operates the relay.

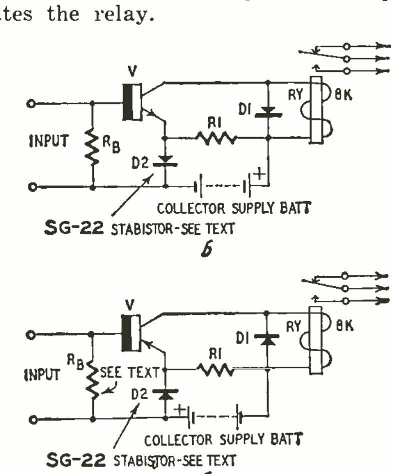


Fig. 3—Improved circuit eliminates heat and leakage problems: a—for p-n-p transistors; b—for n-p-n types.

This circuit is usable only with *good-quality low-gain* transistors at very moderate power levels. Preferably, the collector potential should be limited to 6 volts or less and the collector current to a couple of ma. These limitations hold two serious defects to a minimum.

The first defect results from leakage and temperature-induced transistor currents. These currents, in the grounded-emitter circuit, are amplified by the transistor — just like an input signal would be.

At temperatures of 90°F and higher, currents of this type are troublesome. High-gain transistors amplify these currents enough to keep the relay closed, even when there is no input signal. This condition becomes worse with higher collector currents and voltages.

The second defect is circuit-imposed. When the relay is energized, magnetic energy, of course, is stored in the coil windings. If the transistor input signal is suddenly removed, the magnetic field collapses and throws a high flyback voltage across the transistor. The flyback from a sigma type 4F, for example, is enough to cause early transistor failure.

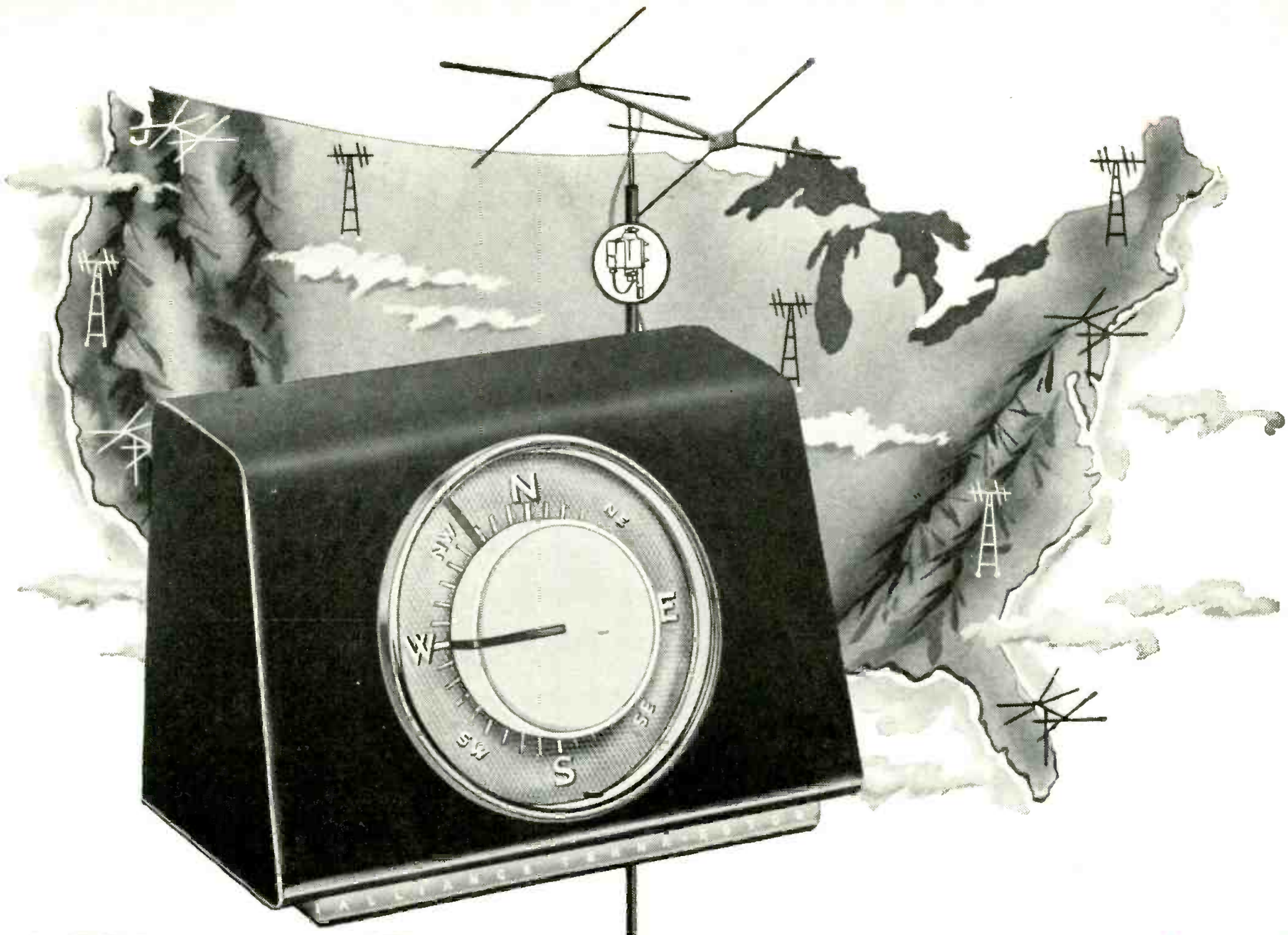
Experimental circuit

If you have a transistor and a few spare minutes, a simple experiment clearly shows these first effects of leakage and temperature.

Set up the circuit shown in Fig. 2. A multimeter with a current range of less than 1 ma is ideal for the collector indicator. The 470-ohm collector resistor is a safety, current-limiting device. Initially, the collector can be at about 6 volts.

Any handy transistor will do if it is an alloy-junction type. (Many of the more common transistors are alloy-junction types. Among them are the CK721, CK722, 2N77, 2N104, 2N105, 2N107, 2N109, 2N139, 2N180, 2N229 2N233, GT14 and OC70.) Fig. 2 shows battery polarity for a p-n-p type. If an n-p-n alloy transistor is used, reverse the collector battery polarity.

Before starting the experiment, short the transistor base directly to the emitter. Then connect the collector battery and read the current. It should be no more than 50 or 75 ma. Now increase the base-to-emitter resistance R_B and notice the rising collector current. De-



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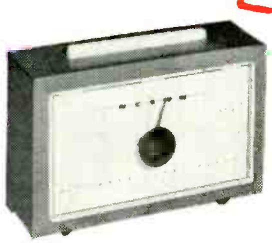

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pending upon the individual transistor's characteristics and the room temperature, the collector current may climb to more than 1 ma with 500,000 ohms resistance between base and emitter. Lower values decrease the current.

Grasp the transistor between your fingers. Added heat from your body will cause the current to rise also. Cool the transistor, if you wish, with a small piece of ice held in Saran Wrap and collector current will drop *tremendously*.

Increasing collector voltage at room temperature causes an increase in the meter reading. Reduce collector voltage and the current decreases. These effects

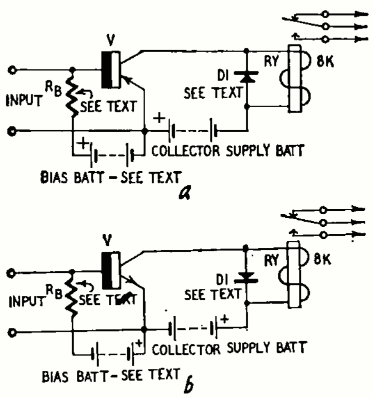


Fig. 4—Separate bias battery replaces one crystal diode. a—for p-n-p transistors; b—for n-p-n types.

are more pronounced with high-gain transistors. Prove it to yourself. If you have high-and low-gain transistors, try both kinds.

If a silicon transistor were subjected to these experiments, it would show no effects. The initial collector current under any conditions would probably be too small to read on the *microamp* meter range.

This experiment shows us that ambient temperature is not a problem, as long as the base-to-emitter resistance is very low. Temperature effects are reduced by using low collector voltages. High-gain transistors amplify temperature effects even more, with resulting larger indications.

With these facts in mind, let's improve transistor relay performance by circuit modifications.

Improved circuit

The circuits in Fig. 3 eliminate the difficulties just mentioned. The elements responsible for this improvement are back bias and relay coil damping.

Diode D2 is a silicon unit, a type SG-22 Stabistor (Transitron Electronics Corp., 168 Albion St., Wakefield, Mass.), that maintains an essentially constant drop of 0.5 volt in its forward direction. This 0.5-volt bias effectively swamps out temperature currents by preventing them from flowing through the emitter.

Resistor R_B returns the base to ground. The lower the value of this resistance the more effective the bias. Even for very-high-gain transistors, 2,000 ohms should be low enough—10,000 ohms may be satisfactory for low-gain units.

Resistor R1 supplies the bleeder current through diode D2. For a collector supply voltage of 22, R1 should be about 27,000 ohms.

D1, across the relay winding, acts as a damper to short out the flyback voltage but not the actuating signal. If the diode were wired in backward, the relay would not operate. This diode is a general-purpose germanium unit such as the 1N34.

Notice that the maximum available relay current is the collector voltage divided by the coil resistance (8,000 ohms). The Sigma requires about 18 volts. A few extra volts of margin are always necessary. So 22 volts is about right. More voltage will exceed the conservative ratings of most transistors. If a 4,000-ohm relay were used, the collector supply voltage could be cut in half but the driving current, of course, would be doubled. A collector supply of 12 volts is satisfactory for a 4,000-ohm coil. Resistor R1 is changed, for this condition, to 15,000 ohms.

Circuits similar to those in Figs. 3-a and -b appear in a Transitron Electric Corp. application note titled "Transistor Relay Circuits."

Fig. 3-a is specifically for p-n-p transistors and Fig. 3-b for n-p-n types. Grown-junction transistors, the 2N170 for example, are not suitable because of their low rating.

These circuits are sensitive to input signals of only one polarity. Fig. 3-a responds to negative signals and 3-b to positive signals. The bases (inputs) of these two circuits can be connected, forming a polarized two-way relay. Thus each of the two relays would respond only to a specific input-signal polarity.

Battery-bias circuit

Figs. 4-a and 4-b are almost identical to the previous circuits. However, separate batteries supply the bias rather than constant-voltage diodes. One or more additional dry cells are necessary.

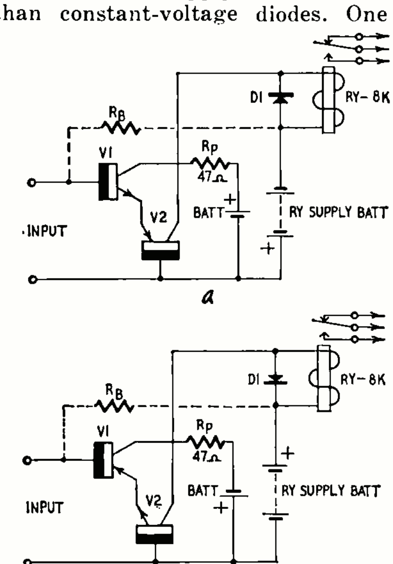


Fig. 5—Two-transistor circuit provides additional gain; a—keyed by positive inputs; b—keyed by negative inputs.

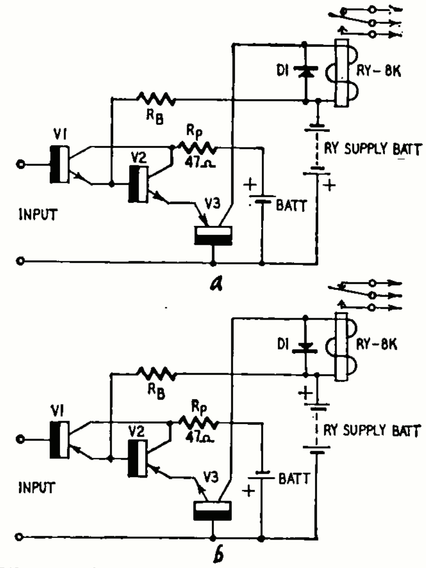


Fig. 6—Ultimate relay control circuit uses three transistors: a—keyed by positive inputs; b—keyed by negative inputs.

For a single 1.5-volt bias battery and a high-grain transistor, R_B should be roughly 6,000 ohms. For 3 volts of bias, double this value. The advantage of increased bias voltage and resistance is reduced input shunting. Otherwise, the results are the same as far as reducing temperature effects is concerned.

If maximum gain is necessary, the value of the resistor R_B is selected to hold the collector current down to about 0.25 ma at the highest operating temperature. This means using fairly high values of resistance, about 47,000 ohms for a 1.5-volt bias. Using a transistor like the 2N43, it is possible to obtain current gains of 60 under these conditions.

Figs. 5-a and 5-b provide us with the ultimate in a simple, ultra-reliable, low-cost, transistor relay circuit. This circuit separates the functions of current amplification and relay driver.

Two transistors are used. The relay driving transistor is connected with its base grounded. There are a couple of advantages in using a grounded-base transistor driver. First, because this circuit provides *no* current gain—only power gain—temperature and leakage currents are reduced and inconsequential. Second, the grounded-base circuit is electrically more robust. It can withstand higher collector voltages and currents. Grounded-base circuits absolutely cannot be damaged from thermal runaway.

This relay driving transistor (V2) should be a *low-priced* unit since a high-priced, high-gain transistor in the grounded-base connection gives no better performance than a low-gain unit.

The input transistor (V1) provides the current gain and functions at a very low collector voltage. Since the burden of supplying power has been removed to a grounded-base circuit, this input transistor operates at near optimum for minimum temperature and leakage effects. Grown-junction transistors like the 2N78, 2N150, 2N165, 2N168A and 2N293 (or any low-power transistor) may be used in this input stage.

One of the transistors must be p-n-p and the other n-p-n. Because of the reversed characteristics of these two classes of transistors, amplified current from the input transistor flows from its emitter into the emitter of the grounded-base transistor. Fig. 5-a is sensitive to positive input signals and Fig. 5-b to negative signals.

The optimum working conditions for the first stage obviate the need for reverse bias, unless the temperatures are high or the transistor very poor in regard to leakage or I_{co} temperature effects.

If a reverse bias is needed—indicated by high relay coil current with no input

Fig. 7—**Simple circuit protects transistors against excessive input.**

signal—it can be taken from the relay collector supply through resistor R_B, shown in dashed lines. R_B should have a value of about 10,000 ohms per volt of relay collector voltage.

A small resistor is in series with the input transistor's collector. It protects the transistor from excessive collector current, caused by input-signal overloads.

Very-high-gain circuit

Tacking on another current amplifier, we come up with the high-gain amplifiers of Figs. 6-a and 6-b. Depending upon the gains of the two current-amplifying transistors, these circuits give current gains from about 75 to over 2,000.

Usually a reverse bias is necessary for these high-gain circuits. Use the values given for R_B in the preceding circuits (10,000 ohms). Or, and this is even better, connect a 100,000-ohm thermistor such as the VECO 51R2 in place of R_B and connect it to a tap on the relay collector battery that will reduce relay current to say 50 ma. A tap of 3 or 4.5 volts, from the relay collector battery, would be typical.

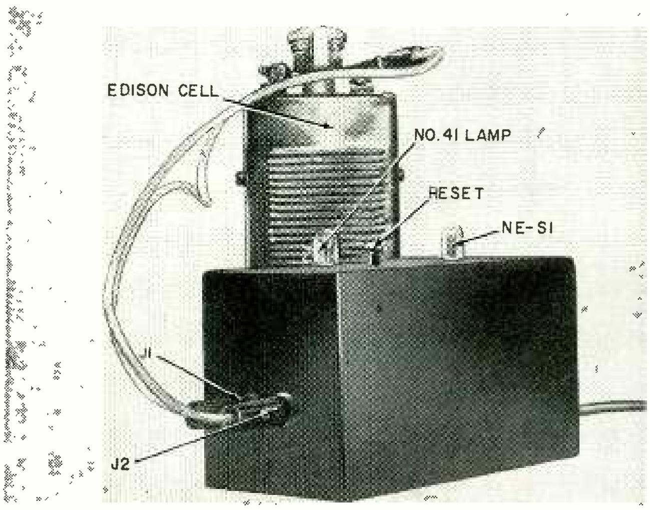
Fig. 7 is a circuit to protect the input transistors from accidental burnout due to excessive input signals. Use the same diode type as D1 in the preceding diagrams. This circuit is used when more than 10 ma of input signal could exist. Grown-junction transistors have a delicate base lead that is faster than the fastest fuse. This circuit protects your transistor by offering a high resistance to large signals, but little resistance to small signals.

These circuits are useful for amplifying the outputs of self-generating selenium photocells, the CdS or new CdSe photocells, thermistor thermometers, small dc signals from radio control circuits, and for innumerable industrial applications. I have shown you some first-class transistor-relay circuits. Now let's see what you can do. END

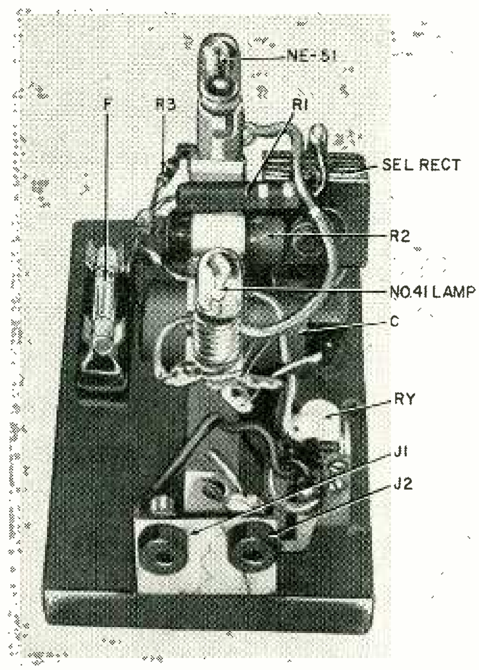
POWER FAILURE ALARM

A robot reporter that calls attention to even momentary interruptions.

By GEORGE P. PEARCE



The Robot Reporter hooked to its external battery.

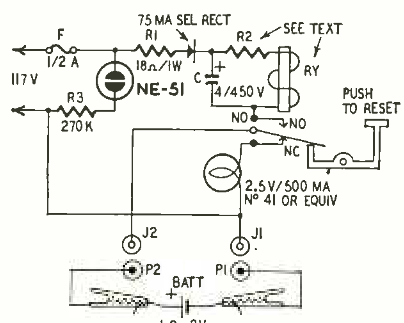


Component layout inside the case.

IT is very important with some electronic assemblies — motor-operated devices, battery charging equipment, automatic timers, etc.—to know if the electric power has failed even momentarily because relays may have dropped to open circuits, time records may be messed up and many important tests need corrections for power failures.

At the first glance this may seem very simple. All that appears necessary is to put a 117-volt relay across the power line and watch it. Power failure trips the relay and, when you notice that the armature has fallen, you know there has been a power failure. Unfortunately, this is not practical. For the first few days you may glance at the relay frequently but it soon becomes a familiar sight and then is rarely noticed.

The most satisfactory setup is that which—when power fails—operates a small relay arrangement that instantly switches on a warning light. This type of indicator is very satisfactory, for the light promptly catches the eye. Power for the light is supplied by a small storage cell. The cell is constantly charged by rectifying the small current required to energize the relay



R1—18 ohms, 1 watt
R2—see text
R3—270,000 ohms, ½ watt
C—4 µf, 450 volts
BATT—1.2-2 volts, Edison cell or equivalent
F—½ amp
J1, 2—banana jacks
P1, 2—banana plugs
RECT—selenium, 75 ma, 130 volts
RY—see text
Neon lamp, NE-51
Pilot lamp, 2.5 volts, 500 ma (No. 41 or equivalent)
Pilot-lamp assembly, bayonet base
Pilot-lamp assembly, screw base
Alligator clips (2)
Case
Chassis
Miscellaneous hardware

Fig. 1—Circuit of the handy indicator.

and passing the direct current the same as a trickle charger does.

(Operators of frozen-food lockers, hatcheries and similar businesses may require immediate notice of power failure. In these cases, the pilot lamp may be replaced by a buzzer or bell and the battery voltage raised to the level needed to operate the alarm.—*Editor.)*

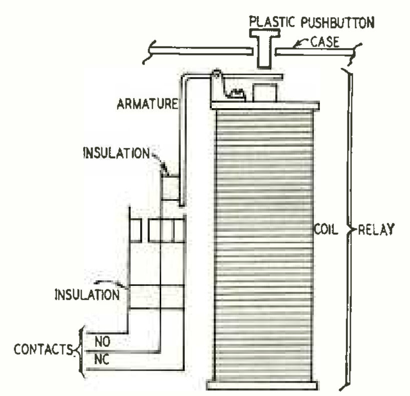


Fig. 2—Adding reset button to relay.

A very simple and dependable design is shown in the photos and Figs. 1 and 2.

How it works

This little robot can be plugged into any standard circuit that requires a continuous check. It is designed so that the instant the circuit is energized, the

NE-51 glows. As long as it is glowing, you know that the power is on. Suppose, some time during the night a power failure occurs. The neon lamp goes out, the relay drops out and the No. 41 warning lamp is switched on. The Edison cell will keep the warning lamp lit for about 4 days. This provides ample reserve, even over weekends.

Power may come back in a second or perhaps not for several hours, but the warning light will immediately signal the first person who approaches that there has been a power failure. The engineer in charge can check promptly all parts that may have been affected. After the check, a slight tap on the plunger (white button) closes the relay armature, cuts the warning light out of the circuit and starts the storage battery on its recharging cycle.

The alarm advises the operator when any of the following events occur:

1. No power failure. Indicated by the neon lamp burning and the warning lamp out.
2. Power failure was corrected; power restored. Indicated by the neon lamp and the warning lamp being lit.
3. Power failure; power still off. Indicated by the neon lamp being out and the warning lamp lit.

When the alarm is not in use, the warning lamp must be loosened in its socket or the storage cell disconnected. Otherwise the lamp will burn until the battery runs down. This is a good arrangement for, when the alarm is next used, the warning lamp should light before power is switched on and the plunger pressed down to lock the armature. Thus, the cell and lamp are automatically checked. The life of the lamp is unusually long in this service because it is designed for 2.5 volts whereas the cell gives only 1.2 volts. If a brilliant light is desired use a lower voltage lamp.

It is important to note that the amount of current through the relay is controlled by resistor R2. This current must be only strong enough to hold the armature closed after it has been shut by pushing the plunger. The current *must not* be strong enough to attract the armature automatically to its closed position. The relay I used has a 300-ohm coil and requires 45 ma to close automatically. But 25 ma is enough to hold it closed. Thus, if a 25-ma current is flowing, as soon as the armature is manually closed, it stays closed until power fails.

Resistor R2 was selected to permit only 25 ma to flow with a 117-volt line potential. The current flowing is not too critical and it is not necessary to measure it with a milliammeter. A little experimenting with various resistors is all that is required. First use, say 5,000 ohms. If it does not hold the relay closed, use smaller resistances until one is found that will pass enough current to hold the relay closed and yet not enough to cause it to automatically close when it is connected to the monitored circuit. END

ELECTRONICS

Sensitive Photocell

By I. QUEEN
EDITORIAL ASSOCIATE

THE cadmium sulphide (CdS) photocell is far more sensitive than previous cells and compares well with germanium phototransistors. Photocells have been used for two general purposes: for control, as with a relay, and for measuring light intensity. The CdS cell can be used for both since it can supply over 1-ma output where required, yet its response is linear at low illumination. It is sensitive to X-rays, gamma rays and infra-red.

The cadmium sulphide cell has one disadvantage and one big advantage when compared with the popular selenium cell which needs no power supply; the cadmium type must be supplied with either ac or dc up to about 200 volts. This is not an important problem, since the needed power is very small. The big *advantage* is sensitivity. A typical selenium cell puts out 13 μa at 100 foot-candles. The type CL-2P Clairex (cadmium sulphide) cell puts out 100 μa at 2-foot-candles. This comparison is made with cells having approximately the same diameter (¼ inch).

Because of its small size and high sensitivity, the CL-2P and similar cells may be pinpointed directly on a luminous target. Also, it may be hidden in a convenient location or made inconspicuous. For extremely high sensitivity, it is a simple matter to rig up some sort of optical or focusing system to increase the illumination on the cell.

Although the CdS cell requires a high voltage to excite it, the current input is fortunately very small. Therefore a transistor oscillator and diode voltage doubler is sufficient. The diagram shows such a power supply which puts out 60 volts or more for a photocell. This circuit is described in more detail in RADIO-ELECTRONICS for December, 1955, page 61. Briefly, the transistor oscillates at af, which is stepped up and then rectified by the diodes. The penlight cells must supply only about 3 ma so they will have long life. When size AA cells are used, this represents an operating cost of about .04 cent per hour.

Just what do we mean by high sensitivity? Well, here are typical measurements made on the photocell powered by a transistor oscillator.

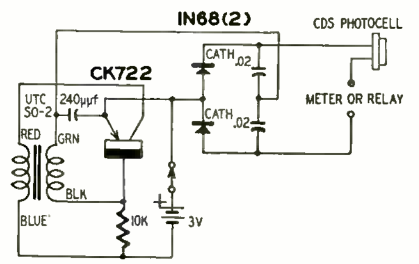
An output of about 100 μa through 100,000 ohms (that is, about 10 volts) is available from the following sources of illumination: a 14-watt fluorescent lamp at a distance of 2 feet; the beam from a two-cell flashlight at 5 feet; a clear sky through a window, even after sunset. A supersensitive relay will easily operate on this output. For example, a Barber-Colman type O high-impedance relay operates on about 100 μa at 1 volt.

The above output is by no means the maximum obtainable from the circuit. It may be increased by applying greater input power to the transistor oscillator. One method is to reduce the base resistance. Alternatively, three or four cells may be used to power the oscillator, to increase the output voltage and power.

As examples of weaker light measurements, the following sources provide about 25 μa output through 25,000 ohms: a pair of 40-watt incandescent lamps at a distance of 8 feet or a pilot lamp (No. 47) at 6 inches. A lighted match deflects the meter to 6 μa at a distance of 6 inches.

The optimum load for the photocell is not a critical value. It lies between 10,000 and 50,000 ohms.

Many practical applications suggest



1—10,000-ohm resistor, ½ watt; 1—240-μμf capacitor; 2—.02-μf capacitors; 1—CK722 transistor; 2—1N68 crystal diodes; 1—spst switch; 1—audio transformer, 1:3: primary impedance 10,000 ohms, secondary 90,000 (UTC SO-2 or equivalent); 1—3-volt battery for transistor supply; 1 chassis.

Power supply used with the photocell.

themselves for this circuit. Any weak sources of illumination may be compared, measured or calibrated. For example, one common method of measuring rf power is to measure its heating effect on a filament. The brilliance of the filament is compared with that of a known lamp fed from a known source. For example, if a lamp gives the same illumination as that of a 25-watt lamp fed from the line, rf power is 25 watts.

The density of filters, films or paper may be measured and compared. For example, a filter may be placed between the cell and a standard source of illumination and the meter will indicate the amount of light transmitted. The small window of the cell (¼-inch diameter) permits accurate measurements.

Even the light reflected from a dark wall or other surface will give readings of several microamperes. With suitable calibration the instrument becomes a photographic exposure meter.

The angle from which light can fall on this photocell is easily controlled. The cell is fitted into a polystyrene tube whose inner diameter is ¼ inch. This makes a neat fit. The tube should be painted black. As the cell is pushed deeper into the tube, the shield becomes more effective and the angle more limited. END

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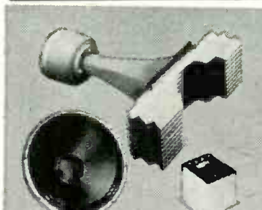

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It has always been the purpose of this column to review new recordings with the accent on the technical and aural excellence achieved by each record. For our purposes, the fidelity of a recording is just as important as its musical and aesthetic excellence, if not more so. In the past, we have restricted ourselves principally to the review of long-playing discs. However, high-fidelity reproduction now includes another important recording medium: prerecorded tapes.

The potential of prerecorded tape rests in stereophonic recordings. A good guess is that in less than 10 years the stereophonic recording will replace the present long-playing record in popularity. We say this confidently because a practical dual-channel, single-groove stereophonic LP is certain to be developed and perfected during the next decade.

Some stereo playback systems incorporate a third speaker placed midway between the outer two and connected so that it produces an output which is the sum of both stereo channels. This "bridge" speaker is sometimes helpful for minimizing the "hole-in-the-middle" effect which is present, to some extent, in two-channel stereo recordings. This is because the two stereo microphones are a considerable distance from the musical instruments on the center of the stage and those instruments are recorded at lower volume than they are actually performing. On playback, the lower volume of these center instruments is heard as an apparent volume "hole" midway between the two outer speakers. We did not include a bridge speaker in our setup for reviewing because the evaluation of the "hole-in-the-middle" effect present in each stereo tape is an important indication of the quality of the recording technique used.

A new year is upon us. For our new tape and disc column, 1958 is full of promise, with provocative record developments in the offing. We will share some of this excitement with you monthly in our expanded column.

THE BEST STEREO TAPES OF 1957

Best Recording: For Outstanding Fidelity and Performance. BERLIOZ: *Symphonie Fantastique*—Munch: BSO (RCA Victor GCS-6; $18.95)

Best Chamber Work:
STRAVINSKY: *L'Histoire du Soldat*—Mandell: Ars Nova (Sonotape SWB-8013; $11.95)

Best Symphonic Band:
Brass and Percussion—Morton Gould Band (RCA Victor CCS-30; $10.95)

Best Orchestral Suite:
BIZET: *Carmen Suite*—Paray: DSO (Mercury MDS5-3; $12.95)

Best Choral Work:
Christmas Hymns and Carols—Robert Shaw Chorale (RCA Victor CCS-86; $10.95)

Best Organ Work:
Boardwalk Pipes—Elmore (Mercury MDS5-5; $12.95)

Best Stereo Demonstration:
Sounds of the Subway (Sonotape SWB-8013; $11.95)

Best Stereo Concerto:
BEETHOVEN: *Concerto in D*—Heifetz: Munch: BSO (RCA Victor FCS-24; $16.95)

Best Dance-Band Recording:
The Mightiest Little Band—Lenny Herman (Livingston 1083-BN; $11.95)

Best Collection and Packaging:
The Orchestra—Stokowski Orchestra (Capitol ZH-8; $16.95)

Best Stereo Sampler:
Demonstration Tape Number Two (Concert Hall BX-37; $4.)

STEREOPHONIC RECORDINGS

STRAUSS: *Die Fledermaus Overture*
Tales of Vienna Woods
Blue Danube Waltz
Barbirolli conducting Halle Orchestra
Mercury MDS5-4

CARPENTER: *Adventures in a Perambulator*
Hanson and Eastman-Rochester Symphony Mercury MDS5-2

Music for Hi-Fi Bugs
Pete Rugolo and Orchestra
(Stacked only) Mercury MDS3-1

Mercury continues its issue of stereotapes that really show this medium off. The first two have the Olympian dynamic range which can be achieved so impressively on tape. Neither of these is as spectacular as previous Mercury tapes reviewed here, but the *Adventures* with its rather small sound and in-turn presentation of various sections of the orchestra is especially good in the directional effects, while the Strauss, presenting a big orchestra in big sound, is sure to impress.

The first Mercury pop is also excellent, with fine drums, very good string bass and lots of highs. Multiple miking produces a rather contrived but excellent stereo effect.

Chicago–New York Audio Show Stereophonic Demonstration Tape
Sonotape CNY (stacked or staggered)
(7-inch, playing time—14 minutes)
$6.95

It was interesting to note how the New York Audio Fair's top stereo demonstration tape faired in the living room. The effect is not as impressive at home. First, the Audio Fair setup used four speakers, two outer stereos, a center bridge and monaural, and a rear effects. When relegated to two stereo speakers, without the lighting effects used at the Fair, most of the impact is lost. The tape impresses those who have never heard stereo before but has little lasting value. The announcements get tiring with repetition. The musical selections are too short; before you settle down with a selection, it's over. However, because of this brevity, there's plenty of variety here—riveters, spirituals, elephants, Christmas carols, four-engine bombers, bowling alleys and, oh yes, full symphony orchestras. The fidelity and stereo effectiveness are very good and typical of Sonotape stereo quality. Not recommended for continued listening, but good for showoff material for stereo's power.

Havana in Hi-Fi
Richard Hayman and his Orchestra
Mercury MDS2-2 (stacked only)
(7-inch, playing time—33 minutes)
$12.95

Place an unusually large orchestra in front of two Telefunken U-47 capacitor mikes, add a gifted conductor, choose the right music and you've got the ingredients for hi-fi excitement. In *Rhapsodero* the mikes are close and the sonic impact of biting brass and percussive bass drum contrasted with soft solo guitar realistically recreates the impact so characteristic of Latin American music. The full fidelity of blaring brass and powerful bass at almost unbearably high power levels, so tyical of the "living presence" technique, is thrilling in all quick-tempo rythms. On the other hand, the lush, swaying lilt of South American sensuous rythm is also faithfull captured. Besides *Rhapsodero*, there's *My Hopeful Heart, Cordoba, Tropical Merengue, Maria-La-O, Caminito, La Comparsa, I Won't Stand in Your Way* and *Amor Que Bonito.* Only in the spacious realm of stereo can this changing, Cuban portrait be fully appreciated.

Demonstration Tape No. 2: Highlights From Best Sellers
Various Artists
Concert Hall BX-37
(stacked or staggered)
(7-inch, playing time—31 minutes) $4

Through experience we have come to expect little from demonstration tapes of this type. This one's different. Concert Hall's refreshing approach produces a notable demonstration tape that contains seven selections from their stereo

NEW RECORDS *(Continued)*

best sellers, and most of the excerpts are complete. Missing is the almost inevitable announcer with the long-winded sales pitch that made previous demonstrators annoying at first and unbearable in subsequent hearings. No 2-second samples here, but a full 31 minutes of music. Sam Price and his Kaycee Stompers play *Jonah Whales Again* from HX-16, the Varieton Concert Orchestra plays Waldteufel's *España* in its entirety from HX-27. *Sleepy Lagoon* by Marco Gregory's Orchestra is taken from HX-34, followed by an excerpt from HX-24, Ravel's *Ma Mere L'Oye* with the Pasdeloups Orchestra. The delightful Lehar *Merry Widow* (HX-17) is featured, followed by the finale of Beethoven's *Symphony No. 2 in D* with the powerful Frankfurt Opera Orchestra (HX-35), and, finally, the last movement of Gershwin's *Concerto in F* displaying the talent of pianist Sondra Bianca (from HX-30).

IBERT: *Escales (Ports of Call)*
Charles Munch conducting Boston Symphony Orchestra
RCA Victor ACS-57 (stacked only)
(7-inch, playing time—15 minutes)
$6.95

Ibert's score for *Escales* calls for an unusually elaborate percussion section—military drum, four kettledrums, tambourine, bass drum, cymbals, xylophone, triangle, gong, castanets and celeste. This is ideal, for the fame of the Boston Symphony rests in its percussion section and its drama. This charming work is rich with contrasts that show off this powerful orchestra and stereo to best advantage. The climax of the *Valencia* section is a truly exciting experience with snare drum, tambourine, kettle drums and strings on the left and brass and more percussion on the right, filling the entire room with sound. The transients are sharp, yet the orchestra is poetically smooth and silky. The performance is excellent, too. Good, relaxed stero listening.

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

GERSHWIN: *Concerto for Piano in F*
Rhapsody in Blue
Eugene List, Piano
Hanson conducting Eastman-Rochester Symphony Orchestra
Mercury MG-50138

The opening of the *Concerto* on this disc offers one of the most spectacular demonstrations of high fidelity you are likely to find, with terrific drums and big cymbals in near-life-sized dynamic peaks. Plenty of fireworks later on as well, and an excellent piano, to boot. The popularity of the music should make it all the more in demand. Though the peaks on this seem even more Olympian than usual for Mercury, they are also cleaner than usual and less likely to overdrive pickups, except on the inner grooves. The performance seems to me to be topnotch and altogether artistically the most satisfying version of this music for me, both artistically and sound-wise.

Landmarks of a Distinguished Career
Stokowski
Capitol P-8399

For the third of its Stokowski recordings, Capitol has produced a concert of six popular classics. These are his very fine orchestral transcription of Bach's *Toccata and Fugue in D Minor*, *Claire de Lune* and *Afternoon of a Faun* by Debussy, *Finlandia* and *Swan of Tuonela* by Sibelius, and *Blue Danube Waltz*. Unless you have definite and sophisticated ideas about music, this cannot fail to please, both for music and sound. The recording is up to the very high standard set by the previous two in this series—bright, clean, well-balanced and exceptionally well-defined despite the liveness. Between them, the works give a sampling of every variety of sound from the restful to the brassy, and show off the symphony orchestra beautifully. Both in tutti and solo the instruments are very natural, especially the string basses. END

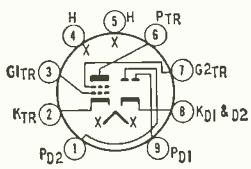
Name and address of any manufacturer of records mentioned in this column may be obtained by writing Records, RADIO-ELECTRONICS, *154 West 14 St., New York 11, N. Y.*

New Tubes & Semi-conductors

This month brings a 12-volt auto-radio tube, a 30-mc tetrode transistor, a 250-mc drift transistor and selenium replacements for the 6AL5.

12DL8

A multiunit tube of the 9-pin miniature type containing two diodes and a high-perveance power tetrode. It is intended for use in hybrid automobile receivers in which tube and transistor electrode voltages are obtained directly from a 12-volt storage battery. In these



12DL8

sets the diode units are used for AM signal detection while the tetrode section acts as the driver for the transistor af power output stage.

Announced by both RCA and Sylvania, typical operating characteristics of the 12DL8 are:

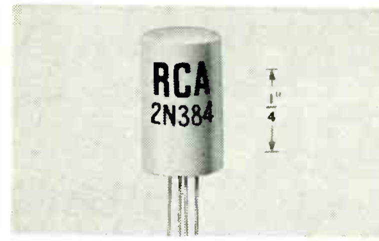
V_{htr}	12.6
I_{htr} (approx) (ma)	550
V_p	12.6
V_{g2} (by rectification through a 2.2-megohm resistor)	−2
V_{g2} (peak af from 100,000-ohm source)	2.5
V_{g1}	12.6
I_p (zero sig) (approx) (ma)	40
(max sig) (ma)	8
I_{g1} (ma)	75
R_{load} (ohms)	800
Total harmonic distortion (%)	10
Max Sig power output (mw)	40
R_{g2} (max) (megohms)	10
Maximum ratings each diode I_p (ma)	5

2N384

A hermetically sealed drift transistor of the germanium p-n-p type, designed primarily for military and industrial use as an oscillator up to 250 mc or as an rf amplifier in compact mobile communications equipment. The 2N384, announced by RCA, features a base region in which the impurity distribution is carefully controlled to produce a built-in accelerating field.

Maximum ratings for class-A rf amplifier service are:

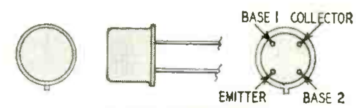
V_{CB}	−30
V_{EB}	−0.5
I_C (ma)	−10
I_E (ma)	10
P_c (at 25° C) (mw)	120
(at 55° C) (mw)	70
(at 71° C) (mw)	35



Basing is the same as the 2N274 (New Tubes and Semiconductors RADIO-ELECTRONICS, October, 1957).

3N32, 3N33, 3N34

These grown–diffused silicon tetrode transistors are especially designed and tested for amplifier applications at frequencies up to 30 mc.



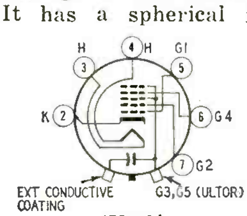
3N32, 3N33, 3N34

Made by Texas Instruments, the maximum ratings of these units are:

V_C		30	
I_C (ma)		10	
I_{B1} (ma)		5	
I_{B2} (ma)		5	
Total power dissipation			
at 25°C (mw)		125	
at 100°C (mw)		50	
at 125°C (mw)		25	
I_{CO} ($V_C = 20$, $I_E = 0$) (max μa)			0.2
BV_{CO} ($I_C = 10$ μa, $I_E = 0$) (min)		30	
	3N32,	33,	34
Power gain, common emitter ($V_C = 20$, $I_E = -1$ ma, $I_{B2} = -0.3$ ma (min db)	20	18	16
Frequency (mc)	4.3	12.5	30

17BWP4

Another addition to the line of 110° picture tubes, the 17BWP4 is a 17-inch rectangular glass tube made by Sylvania. It has a spherical faceplate,



17BWP4

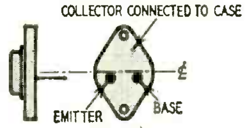
aluminized screen and a straight gun design which needs no ion trap. Its 6.3-volt 600-ma heater has an 11-second warmup time.

Maximum ratings are:

Ultor voltage	17,600
V_{g1} (pos value)	1,000
(neg value)	550
V_{g2}	550
V_{g1}	
(neg bias value)	154
(neg peak value)	220
(pos bias value)	0
(pos peak value)	2
Peak heater–cathode voltage (htr neg with respect to cath)	
(15-sec warmup)	450
(after warmup)	200
(htr pos with respect to cath)	200

2N297

A p-n-p alloy junction germanium power transistor designed for use in high-current switching and audio-frequency power amplifier applications.



2N297

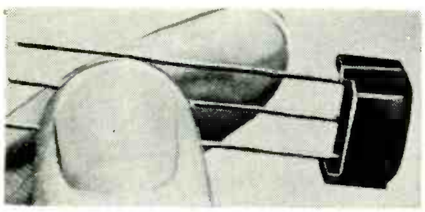
Announced by Clevite, the unit's maximum ratings are:

V_{CB}	−60
V_{EB}	−9
I_E (amps)	5
Total power (watts)	15
Junction temperature (°C)	85

Selenium replaces 6AL5

Selenium rectifiers, designed to replace 6AL5's in TV circuits have been released by G-E and Bradley Labs (illustrated).

The G-E assembly is center-tapped by connecting the two cathodes together.



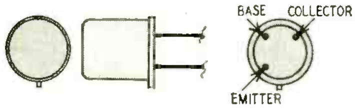
It is rated to handle a forward current of 0.5 ma at 2.0 volts dc, reverse current of 5 μa at −20 volts dc.

The Bradley Labs unit can be used where the peak inverse voltage does not exceed 40. Specifications are: maximum applied voltage, 26 rms; maximum dc output voltage, 20.

2N341

A grown-junction, n-p-n silicon transistor designed for use in audio or servo amplifier stages requiring medium power output, this Texas Instruments

2N341



transistor has a welded case with a glass-to-metal hermetic seal between case and leads.

Maximum ratings at 25° C case temperature are:

V_c	125
I_c (ma)	40
P_c (mw)	1,000
at 100°C	400
at 125°C	200
Power gain (V_{CE} = 67.5, I_C = 10 ma) (min db)	30

Other types

A xenon thryatron, type 7086, has been announced by RCA for use in welding and X-ray tube operation.

The 7092, a radiation-cooled high-power industrial triode for applications in ultrasonic, induction or dielectric heating equipment, has been presented by Amperex. END

Technicians' News

NEW YEAR'S RESOLUTIONS

1. To treat my customers with the greatest respect.
2. To give as prompt service as possible.
3. To pay my bills promptly and get the discount.
4. To buy wisely, knowing discounted merchandise can be most expensive.
5. To buy from distributors who recognize our mutual problems.
6. To try to obtain new members for my association.
7. To work in my association for the promotion of the service fraternity.
8. To work when I work and try to have time for more relaxation.
9. To improve my technical knowledge and skill.
10. To charge enough to make a reasonable profit, but not enough to be unfair.
11. To expand my business by more aggressive advertising.

(This item appeared last year in the *Raster*, an official publication of the Electronic Service Council of the Ozarks. We thought it was interesting enough to rate another trip around.—*Editor*)

HOT-CHASSIS PROTECTION

The safety committee of the National Alliance of Television & Electronic Service Associations (NATESA) has recommended that all members take immediate steps to protect themselves on all cases involving hazards caused by "hot TV chassis service."

According to the council, as reported in *NATESA Scope*, should such a set be serviced, the last servicer could be held responsible. It is suggested that a statement similar to that below be made part of the delivery ticket.

"This TV set is of the 'hot-chassis' type. We have exercised all possible precaution to eliminate danger in handling. However, since the set is outside our control, we can assume no responsibility for electrical shock and other hazards."

This statement may save you from damage claims.

$5 SERVICE CHARGE

Service dealers in Queens, N.Y., have increased their service charge to $5. One dealer, France's Radio & Refrigeration, feels that customer acceptance of the increase is excellent. At the time the rate was raised the firm discovered that the customer who turned to another dealer for service was the individual who would have complained no matter what the price.

The Guild News, published by the Radio Television Guild of Long Island, reports that the movement has been under way for about eight months.

The paper also stated that "dealers, by charging $5, are at last realizing the cost of their overhead and a reasonable amount for themselves. The dealers who have been ostriches and maintain $2 and $3 service charge have not recognized the value of their own labors."

TORONTO TECHNICIANS UNFIT?

Edward Reale, director of the Toronto Radio Electronics Technicians Association, Toronto, Canada, has said that of the 1,200 "so-called" television and appliance service technicians, less than half are qualified to work on TV sets. The statement was made at an association meeting held to develop ways of eliminating dishonest and incompetent technicians from the group.

Mr. Reale was strongly criticized for his stand, but the 74 members at the meeting agreed that fewer than 100 technicians in the area could measure up to the standards the association has set for its members. A resolution requiring all members to pass a tough examination within a year was passed. Grades of technician proficiency were set and a list of operating standards proposed.

ESFETA OPPOSES PAY TV

The Empire State Federation of Electronic Technicians Association went strongly on record in opposition to pay TV at its regular meeting held in Rochester Nov. 10, 1957. Max Liebowitz of New York City led the opposition to toll viewing, urging that the organization oppose any form of TV transmission that would rob the public of its right of free access to the present television channels. ESFETA urged all its member groups to write their Congressmen, the FCC and other Government agencies involved, strongly protesting pay TV.

The meeting also discussed plans for opposing any attempted unjust licensing measures at the State capital. Secretary George Carlson, 69 Forest Heights, Jamestown, N.Y., appealed to all nonaffiliated associations to forward their addresses to him so that ESFETA can keep them informed of activities in the State Legislature.

FOUR-WAY CLINICS TO BE HELD

Service information on transistors, color television, high fidelity and tape recorders is to be disseminated through a series of two-day clinics under the auspices of the RCA Service Co. E. C. Cahill, president of the company, stated they would be held in most of the major centers of the nation. A booklet covering each of the four products demonstrated is given to each service technician attending.

THE REAL MEANING

A number of clichés seem to be universal with the electronics service customer, according to *The Raster*, official service publication of the Electronic Service Council of the Ozarks. A few are listed with what we believe is the real meaning.

"It's just a bad tube." *It's a 24CP4A.*

"I don't think there is much wrong." *He's been working on the set.*

"It won't take you a minute to fix it." *I don't want to pay for more than a minute's work.*

"The bill is too high." *Fifty cents would be too high.*

"There's not much wrong, it just quit." *It's a dog.*

"I could have fixed it myself if I had the right tools." *I tried to fix it with the screwdriver I had.*

"I don't want to spend much on this radio, but I want it fixed up good. It's a keepsake, been in the family a long time." *IT SURE HAS!* END

Patents

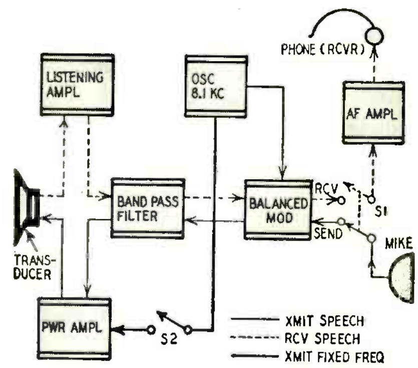
SKINDIVER'S TELEPHONE

Patent No. 2,798,902

Daniel Richard Kursman, Philadelphia, and Sigmund P. Rosen, Plymouth Meeting, Pa.

Skindivers and swimmers can now communicate directly and without connecting wires. This new transceiver can be made compact and portable.

For transmitting speech, S1 is in the position shown, and the solid line shows the signal path. A balanced modulator receives two signals, one



from a microphone, the other from a fixed-frequency oscillator. The fixed frequency itself is balanced out, and the filter passes only the upper sideband. When the speech frequencies are 250 to 3,000 cycles, this sideband ranges from 8.3 to 11.1 kc. It is amplified and transmitted through the water by a conventionel underwater transducer.

To receive, S1 is thrown to its other position. The same transducer acts as pickup. The underwater vibrations cause it to generate a voltage at frequencies from 8.3 to 11.1 kc. Follow the dashed line in the diagram. This sideband is amplified and noise is removed by the filter. Now it beats against the fixed 8.1-kc frequency in the modulator, resulting in speech frequencies from 200 to 3,000 cycles, the original signal.

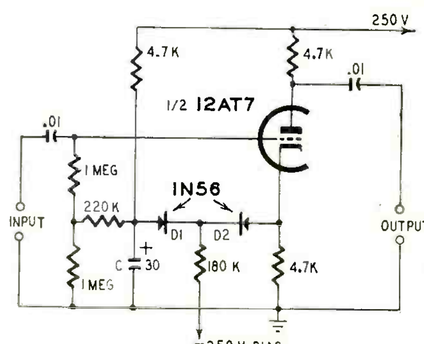
Both the receiver and microphone can be fitted into a skindiver's mask. Transmitting power of 0.6 watt generates sufficient signal to be heard about 2,000 yards. S2 is a test switch. When closed, a fixed-frequency signal is transmitted.

INSTANTANEOUS AGC

Patent No. 2,782,268

William E. Ayer, San Carlos, Calif. (Assigned to United States of America as represented by Secretary of the Navy)

It is difficult to design agc for a radar receiver, because the signal is pulsed. Agc must be quick-



acting. Further, it must operate on both positive and negative pulses. This diagram shows a video stage using a new agc circuit.

The triode may be half a 12AT7. Normally both D1 and D2 conduct due to the large negative potential at their cathodes. Then when signals are weak, capacitor C effectively bypasses the cathode resistor and gain is at a maximum.

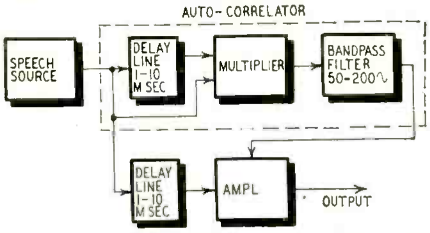
When a strong *negative* pulse arrives, the tube's cathode current drops. The cathode goes sufficiently negative to block D2. For all practical purposes, C no longer bypasses. Due to cathode degeneration, gain drops quickly and considerably. A strong *positive* pulse drives the cathode more positive, blocking D1. Again the cathode resistor is unbypassed and gain is low. In each case the strong pulse (positive or negative) instantly removes the bypassing effect of C so there is no time lag.

SPEECH BRIGHTENER

Patent No. 2,799,734

Glen D. Camp, Chevy Chase, Md. (Assigned to Melpar, Inc., Alexandria, Va.)

Most speech sounds carry fairly steady power over an interval of time, but a few (notably



s, z, t, p, k, ch) fluctuate rapidly. Since these sounds have the same characteristic of noise, they tend to get lost passing through noise limiters. These sounds need extra amplification if speech is to remain brilliant and easy to understand.

The steady components are distinguished from those like noise by an auto-correlator network (see diagram). There are two signal paths to the multiplier, one through a delay line. This delay has little effect on waveforms that vary slowly, so the multiplier inputs are nearly identical. This means that the output is proportional to the square of the input.

On the other hand, noiselike components are highly irregular and each pulse lasts but an instant. Due to the delay, each such variation appears as two distinct pulses at the multiplier. Each receives minimum amplification because of lack of coincidence. Gain is maximum during presence of noiselike components, since these are essentially higher frequencies which cannot pass through the bandpass filter and do not appear at the output.

Output from the auto-correlator becomes avc for the amplifier. Thus gain is maximum during presence of the noiselike components which account for minimum avc. During passages of the more steady tonal sounds, avc is greatest and amplifier gain is minimum. This brightens the speech.

The second time delay equalizes for the time required for a signal to pass through the auto-correlator.

IMPROVED ELECTRONIC FLASH

Patent No. 2,775,718

William Dubilier, New Rochelle, N. Y.

This well-known inventor discloses an improved flashlamp for photographic purposes. It can be made at low cost and has long life. The side view of Fig. 1 shows that it has two main electrodes, A and B. Also, there is an auxiliary electrode C which extends from B. The front of the bulb is a Fresnel lens with a number of convex sections. The rear has a reflective surface and carries a conductive layer which connects one pin to the upper electrode A. Electrode B is tied to the other pin.

The camera shutter release operates in two steps. First, it closes battery switch S1 (Fig. 2). This charges capacitors C1 and C2. The "ready light" is a small gas tube that indicates when the battery circuit has been switched on. As the charge nears completion, current through R1 drops off and the ready light is extinguished. This indicates that the speed light is ready to be flashed.

When the shutter release is advanced further, it closes S2, the flash switch. C2 sends a high-voltage high-frequency pulse through T. This initiates an auxiliary discharge at electrode C. The main discharge follows at once, and C1 delivers its full power across A and B. Resistor R3 dissipates any voltage still remaining across capacitor C1, and the flashlamp is ready for the next cycle of use.

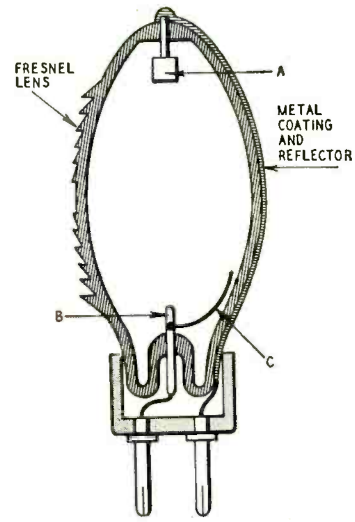


Fig.1

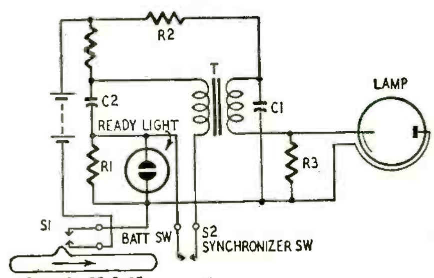


Fig.2

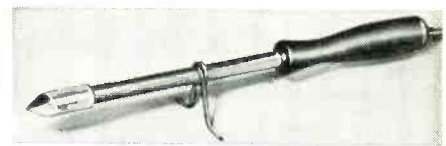
For indoor photography, the battery could be replaced with a power unit operated from the line.

END

try This one

SOLDERING-IRON REST

Are you always misplacing that soldering-iron rest carried in your toolbox? Here's one that is always there when you most need it—it's attached to the iron! Cut a length of heavy wire from a wire clotheshanger, bend the

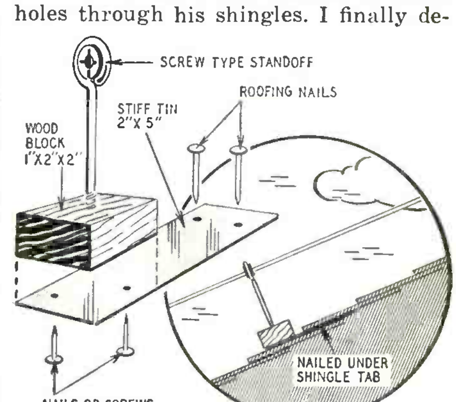


rest to shape around your iron's barrel and bend out the ends to form feet. If the rest fits loosely, pinch the coiled section lightly with pliers.

There's no danger of accidentally burning the customer's carpet with this soldering-iron rest!—*John A. Comstock*

STANDOFF FOR SLOPING ROOFS

On a long roof run of antenna lead-in I had to get the wire tied down to keep it from blowing around. The customer insisted that he would tolerate no screw holes through his shingles. I finally de-

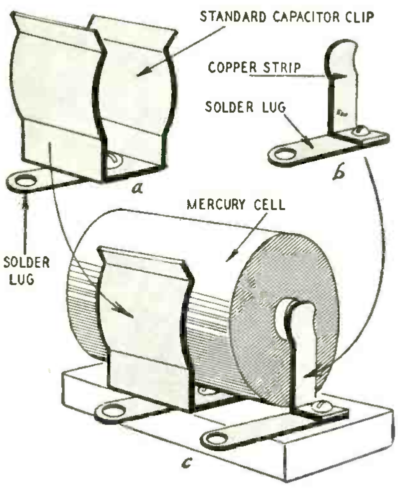


vised a method that would leave no marks or cause any leaks. A block of wood is fastened to a strip of tin (see diagram). The standoff is screwed into the wood block. The remainder of the metal strip goes under the shingles, where it is nailed down.—*A. Zanelli*

MERCURY-CELL MOUNT

With the ever growing popularity of transistors, the need for mercury cells has also increased. Since soldering leads to a mercury cell is somewhat difficult, mounting the cell and making good electrical contacts is a problem.

One way to beat this is to fasten a standard capacitor mounting clip (*a*) (one which holds the cell snugly) and a piece of copper with a 90° bend (*b*) onto a thin strip of wood or some

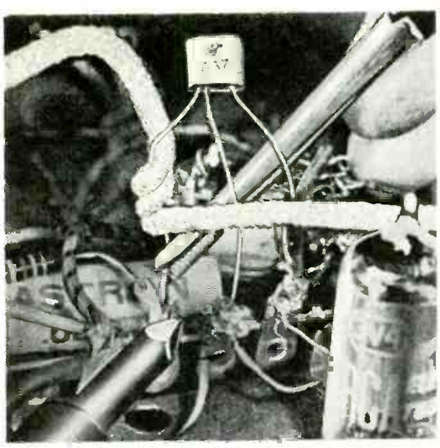


other insulator. Place solder lugs under the mounting screw.

Slip the mercury cell into the clip and push it forward (*c*) until its negative post makes contact with the copper strip. The clip will hold the cell in this position. Now you have a simple mount that provides for easy and rapid replacement of dead batteries.—*Leonard Lyons*

PIPE-CLEANER HEAT SINK

A moistened pipe cleaner makes a good thermal shunt when soldering transistors, diodes, small bantam electrolytics, etc. Simply wet the pipe cleaner and give it a twist or two

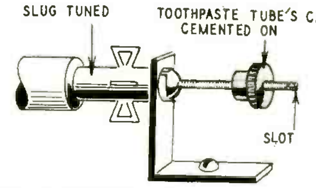


around the wire lead to the transistor, etc., as shown in the photo. The pipe cleaner adds a safety factor to a pair of tweezers or pliers also used for a similar purpose. You don't need an extra hand to hold the pipe cleaner in place either.—*A. R. Clawson*

KNOB FROM TOOTHPASTE-TUBE CAP

Subminiature ferrite coils with micrometric screws are a big improvement over the earlier hard-to-tune types. Yet tuning is still very difficult because the shaft's diameter and the screw slot are very small. I have found that toothpaste-tube caps make ideal knobs for these coils. Drill a hole in the cap slightly smaller than the shaft's diameter. Then cover the end of the shaft with a good grade of multipurpose

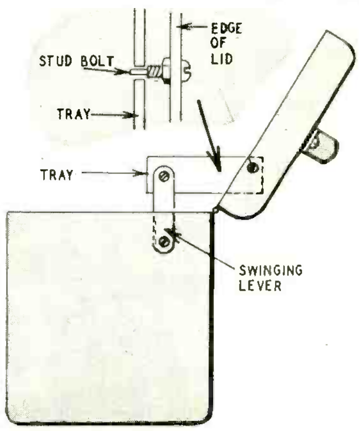
TRY THIS ONE *(Continued)*



cement and force the cap on the shaft. Let it dry for 24 hours and it will remain tight and tune like a charm. If you hold the threaded shaft with a pliers, be sure you place a sheet of cardboard over the threads to prevent damage. Ferrite coils make ideal inductances for tuning controls in transistor circuits. The addition of the toothpaste cap permits very fine, easy and rapid adjustment.—*Joseph Amorose*

POP-UP TOOL BOX

Your tool box with the lift-out tray will be handier with the modification shown, which raises the tray automati-



cally when the lid is opened. Mount the front of the tray with swinging levers of sheet metal at each end. Determine the dimensions by trial. Support the tray's back edge with studs through the lid, located to project through holes in the tray.—*Hugh Lineback* END

Thirty-Five 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

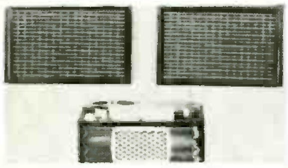
Some larger libraries still have copies of ELECTRICAL EXPERIMENTER on file for interested readers.

In January, 1924, *Science and Invention* (formerly *Electrical Experimenter*)

Path of Trans-Atlantic Radio Message.
The Radio Invasion Continues.
New French Power Tube.
Radio Makes Transoceanic Circle.
Latest Designs in Radio Cabinets.
Radio Transmission of Photographs, by A. P. Peck.
The Biography of a Vacuum Tube.
Untuned Primary Receiver, by W. L. Pearce.
Radio for the Beginner (No. 23), by Armstrong Perry.
The Radio Oracle.

new Devices

STEREO TAPE SYSTEM, *model 3-Stereo.* Built-in balanced amplifiers. In-line stereo heads. 40–16,000 cycles. Three speeds: 7½, 3¾ and 1⅞ inches per second. Speaker system, *model 266*, is

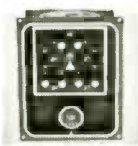


matched to the amplifiers. Each enclosure contains *model 165BK* 8-inch dual-cone speaker. Stereo playback, monaural record.—**Tandburg,** 10 E. 52 St., New York.

MAGNETIC TAPES. Long wearing. Smoother oxide surface decreases head wear. *Long Wear No. 148* in reels of 1,200, 2,500 and 5,000 feet, uses 1.5-mil back-

ing. *No. 149* in reels of 1,800, 3,600 and 7,200 feet, uses 1-mil backing. Scotch brand. —**Minnesota Mining & Mfg. Co.,** 900 Bush St., St. Paul 6, Minn.

IMPEDANCE DIVIDING NETWORK, *model N2600.* Either set of output terminals can be switched from 16–32 ohms. Two

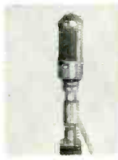


16-ohm drivers can be connected in series when the appropriate switch is in 32 position.—**James B. Lansing Sound, Inc.,** 3249 Casitas Ave., Los Angeles 39, Calif.

HIGH-FIDELITY SYSTEM, *model PT-1055.* FA-550 tuner, 410A, 20-watt-amplifier, 4-way 5-speaker system consisting of 15-inch woofer, 8- and 6-inch mid-range and two 3-inch tweeters and a Garrard RC-88 record changer with variable-reluctance cartridge and diamond–sapphire styli. One-cabinet system.—**Pilot Radio Corp.,** 37-06 36th St., Long Island City 1, N. Y.

EXPERIMENTAL PHONO CARTRIDGE, *XP-3.* 0.7-mil diamond stylus. Flat response from 10–20,000 cycles within 0.2 db. Tracks at from 2–4 grams stylus pressure.—**Fairchild Recording Equipment Co.,** 10-40 45th Ave., Long Island City 1, N. Y.

RIBBON VELOCITY MICROPHONE, *Trix Sixty Special.* Response: 50–12,000



cycles ±2 db. Bidirectional. Triple horseshoe magnet supports relatively long corrugated limp aluminum ribbon encircled with 4 breath shields. Impedance, 50 ohms.—**Fen-tone Corp.,** 106 5th Ave., New York 11, N. Y.

TV TONE ADAPTER. Small loop antenna placed near TV chassis picks up 4.5-mc frequency-modulated signal from set. Delivers high quality audio signal output to existing hi-fi system.—**Tapetone Inc.,** Webster, Mass.

SPEAKER SYSTEM, *110.* 12-inch coaxial speaker, *CA-12*, with L-C

dividing network covers 40–14,000 cycles. Complete unit measures 30 x 20 x 14 inches. Mahogany, blond or walnut hand-rubbed finishes.—**Sonotone Corp.,** Saw Mill River Road, Box 200, Elmsford, N. Y.

HI-FI SPEAKERS, 9 new models include a 3-way 15-inch *Triax, model G-600;* 4 type CX coaxial 3-element units in both 12- and 15-inch sizes; two *Duax* 2-ele-

ment units in 12- and 15-inch sizes; and 2 *Unax* extended-range speakers.—**Jensen Manufacturing Co.,** 6601 S. Laramie Ave., Chicago 38, Ill.

SPEAKER SYSTEM, *Hartley Luth Holton.* Uses *220* speaker. 1–18,000 cycles, handles 20 watts.

Input impedance, 4–8 ohms. 5-lb. magnet.—**Hartley Products Co.,** 521 E. 162 St., New York 51, N. Y.

POWER AMPLIFIER AND PREAMP, *Quartet 344A.* 20–22,000 cycles, 20 watts, 138-db gain, 32-db bass control range, 35-db treble control range. 6 inputs: 3 low level and 3 high level. — **Altec Lansing Corp.,** 1515 S. Manchester Ave., Anaheim, Calif.

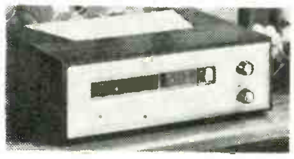
FM–AM TUNER. *model 90-T.* Cascode rf amplifier, FM muting, AM bandwidth control and built-in audio control center. Control center has 4 input jacks for magnetic cartridge, tape playback head, plus stereo channel, TV sound, ceramic or crystal cartridge. Less than 0.1% dis-

tortion for 3 volts output. Response ±1 db from 25–40,000 cycles. Hum and noise 80 db below signal for 2-volt output. *Model 90-R* same without audio control center.—**Fisher Radio Corp.,** 21-21 44th Drive, Long Island City 1, N. Y.

FM–AM TUNER, *Bantam KN-100.* FM has avc and temperature-compensated oscillator.

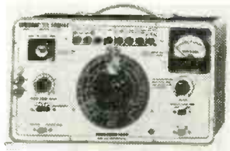
Sensitivity: 3.5 μv for 20-db quieting on FM; 10 μv for AM. 10-kc whistle filter in AM section. Indoor dipole antenna for FM and adjustable ferrite loop for AM.—**Allied Radio Corp.,** 100 N. Western Ave., Chicago 80, Ill.

HI-FI TUNER, AM-FM, *model 300.* FM selectivity, 3 μv for 20-db quieting. 2-mc wide-band detector and 10-kc sharp-tuned



whistle filter. Outputs include main, multiplex and tape. 2-position AM bandwidth switch for normal and hi-fi programs.—**H. H. Scott,** Dept. P, 111 Powdermill Rd., Maynard, Mass.

CAPACITOR ANALYZER, *model TO-5.* Measures capacitance, power factor, leakage current,



insulation resistance of capacitors and turns ratio of iron-core transformers. Capacitance ranges from 1 $\mu\mu$f–20,000 μf. All capacitors are automatically discharged when range selector switches are released.—**Sprague Products Co.,** 125 Marshall St., North Adams, Mass.

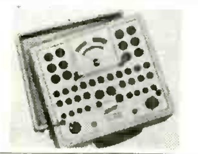
VOLT-OHM-MILLIAMMETER, *model 260, series III.* Polarity reversing switch to end lead reversal. Printed circuitry. 50-ma–250-mv range. Dbm ranges from −20 to +50 Dbm, 1 mv in 600 ohms. Ac sensitivity, 5,000 ohms

per volt. Frequency response. 5–500,000 cycles. Full-wave bridge-rectifier system.—**Simpson Electric Co.,** 5200-18 W. Kinzie St., Chicago 44, Ill.

VAN DE GRAAFF GENERATOR. Produces 350,000 volts at 12 μa. Can draw 18-inch

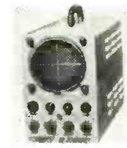
spark. Uses 1/20-hp 3,500-rpm motor and precision ball bearings. Available in kit or finished form.—**F. B. Lee,** 230 Hampton Pkwy., Kenmore 17, N. Y.

TUBE TESTER, *model FC-1.* Two panel settings to check for quality, shorts, life expectancy of more than 600 tube types. 41 tube sockets accommodate all



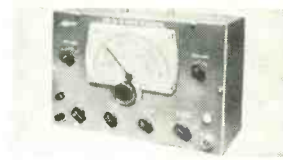
present tube types. 7- and 9-pin tube pin straighteners mounted on panel.—**Century Electronics Co., Inc.,** 111 Roosevelt Ave., Mineola, N. Y.

GENERAL-PURPOSE SCOPE, *Handiscope model 466.* 5-inch



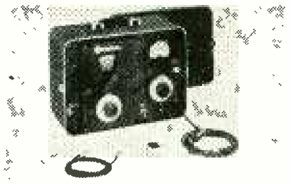
screen, filter type graticule and universal-fit bezel. For industrial maintenance, production testing and general electronic servicing. — **Simpson Electric Co.,** 5200-18 W. Kinzie St., Chicago 44, Ill.

SWEEP GENERATOR, *LSW-40* (illus.). Range: 2–260-mc in 2 bands. Continuously variable sweep width of 0–12 mc. 3-volt



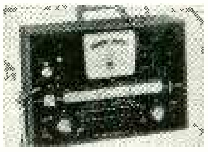
rms sine-wave scope sweep output with phase control. Rf output: 100 mv. *Model LSG-30,* combination marker generator and vertical–horizontal bar generator. *LSG-50,* TV–FM sweep, marker and alignment generator.—**Lafayette Radio,** 165-08 Liberty Ave., Jamaica 33, N. Y.

RF SIGNAL GENERATOR, *model TU576.* For servicing land



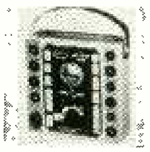
mobile communications systems. 6, calibrated direct-reading scales cover 25–54-, 140–175-, 400–470- and 890–960-mc bands. Each range calibrated to 0.5%. Signal is stable to within .001%. Output voltage variable from 0.1–100,000 μv.—**Motorola Inc.**, Dept. SG, 4501 W. Augusta Blvd., Chicago 51, Ill.

TUBE TESTER KIT, *model T-60*. Checks AM–FM–TV tubes,



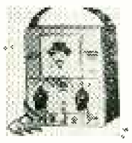
including series-string types. 5-inch meter. Illuminated roll chart. Accessories include picture-tube test cable and 110° adapter.—**Paco Electronics Co. Inc.**, 70-31 84th St., Glendale 27, N. Y.

GRID CIRCUIT TESTER, *model*



GCT-8. Checks condition of control grid of vacuum tubes for control grid emission, gassy tubes and internal shorts.—**Seco Manufacturing Co.**, 5015 Penn Ave. S., Minneapolis, Minn.

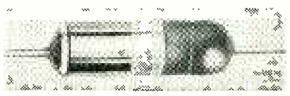
TRANSISTOR CHECKER, *model TRC4*. Tests for opens, shorts, current gain and leakage on all transistors and forward-to-reverse currents on crystal diodes



and rectifiers.—**Service Instruments Corp.** (SENCORE), 171 Official Rd., Addison, Ill.

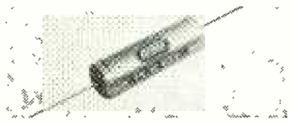
REPLACEMENT FLYBACKS. *HVO-67* exact replacement for Sylvania 241-0019; *HVO-70* for Bendix NH 265051-1,-2; *HVO-71* for Sparton PC-70010 and PC-70012; *HVO-72* for Sparton PC-70015; *HVO-73* for Sparton PC-70019; *HVO-74* for Sparton PC-70025.—**Merit Coil & Transformer Corp.**, 4427 N. Clark St., Chicago 40, Ill.

WIRE TANTALUM CAPACITORS, *type WT*. Polar construc-



tion. Case and attached lead form cathode terminal. All units color-coded to indicate capacitance and voltage ratings. Operating temperature range: −20° C to 50° C.—**Aerovox Corp.**, 740 Belleville Ave., New Bedford, Mass.

METALLIZED CAPACITORS, *type RLR*. Metalized Mylar un-

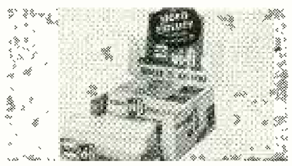


cased unit. For potted asemblies, military and commercial applications. — **Astron Corp.**, 255 Grant Ave., E. Newark, N. J.

SILICON RECTIFIERS. For radio, TV and other electronic equipment. Screws onto the chassis or plugs into a holder. Typical unit ratings, 750 ma at 400 volts. Other values for commercial purposes range from 750 - 1,000 ma at between 100 and 400 volts. — **Audio Devices Inc., Rectifier Div.** 620 E. Dyer Rd., Santa Ana, Calif.

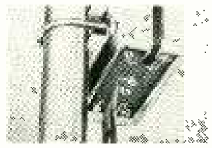
INDOOR ANTENNA, *model PB4 Piggy Back*. Attaches to rear of TV set. Out of sight when not in use. For vhf and uhf.—**Clear Beam Antenna Corp.**, 21341 Roscoe Blvd., Canoga Park, Calif.

INDOOR TV ANTENNA, *Vi-Fi*. Vhf and uhf models. Tuner



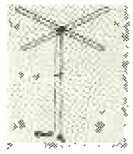
matches antenna to channel frequenices. Transformer coupling for matching to set impedance. —**Amphenol Electronics Corp.**, 1830 S. 5th Ave., Chicago 50, Ill.

TV SET COUPLERS. Mount to the antenna mast. Use permits all wiring runs outside the house to TV rooms. Completely encapsulated to protect components from weather. *Model AC-40* for coupling two 300-ohm sets; *AC60* for 3 sets; *AC70* for



4 sets.—**JFD Mfg. Co. Inc.**, 6101 16th Ave., Brooklyn 4, N. Y.

FM ANTENNA KIT, *No. A-124*. Turnstile design with self-supporting base. No alignment or



orientation needed. All mounting hardware supplied.—**Telco Electronics Mfg. Co.**, 400 S. Wyman St., Rockford, Ill.

TV ANTENNAS, *Colortennas*. Gold-anodized aluminum. Impervious to staining, spotting, tarnishing, fading and corrosion. Includes all 11 helix and single

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8-inch "Hi-Fi" speaker, No. 8007 offers the most highs, the most lows, the most watts in a medium-price speaker. Designed for replacement use and high fidelity audio systems.

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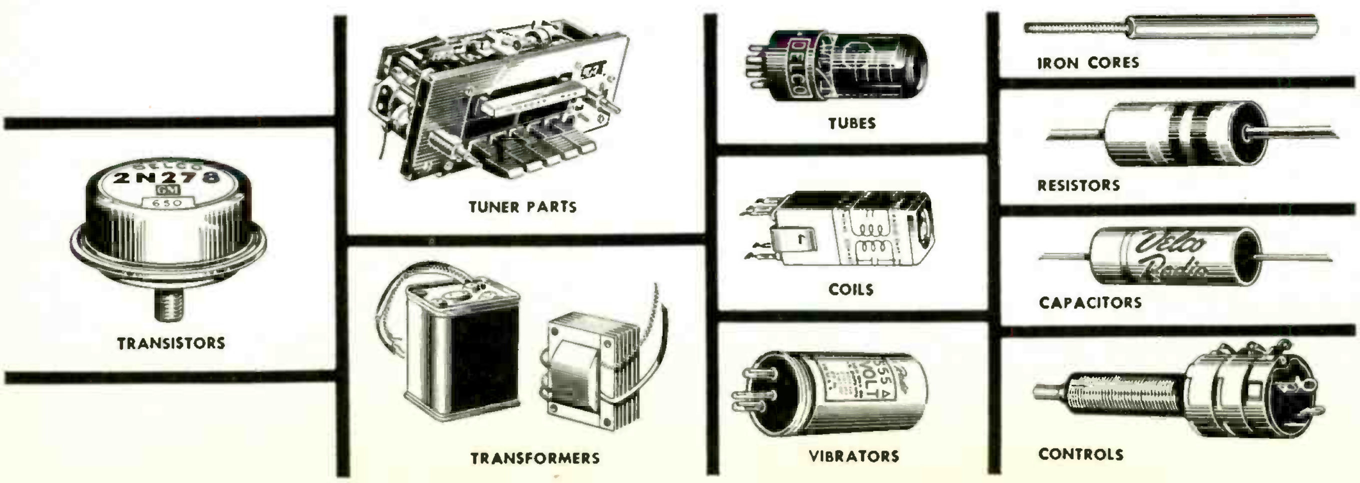
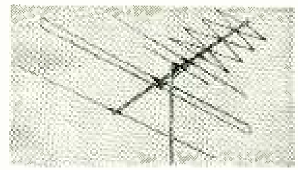
DELCO RADIO

DIVISION OF GENERAL MOTORS, KOKOMO, INDIANA

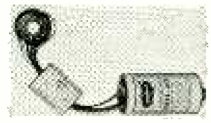


NEW DEVICES *(Continued)*



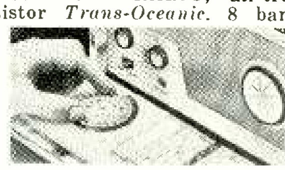
and stacked Fireball models.—**JFD Mfg. Co., Inc.,** 6101 Sixteenth Ave., Brooklyn 4, New York.

PIX TUBE REJUVENATOR, *Kure-All.* For parallel or series circuits. Claimed to cure open-cathode and heater–cathode shorts; control grid shorts, slow



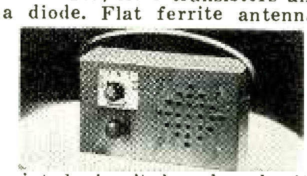
heating or low emission. Base design fits all TV picture-tube sockets without adapters.—**Anchor Products Co.,** 2712 Montrose Ave., Chicago 18, Ill.

PORTABLE RADIO, all-transistor *Trans-Oceanic.* 8 bands



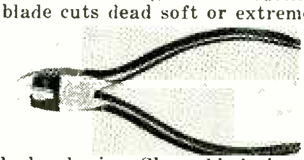
with electronic bandspread to stretch distance between stations on dial. 13 lbs., including batteries. Ordinary flashlight batteries power set up to 300 hours.—**Zenith Radio Corp.,** 6001 W. Dickens, Chicago 39, Ill.

TRANSISTOR RADIO KIT, *model TR4-K.* 4 transistors and a diode. Flat ferrite antenna,



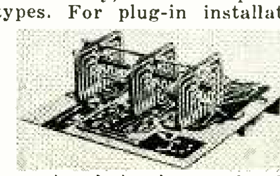
printed circuit board and 2½-inch speaker.—**Superex Electronics Corp.,** 4-6 Radford Place, Yonkers, N. Y.

CUTTING PLIERS, *No. 207-5C.* 5½ inches long. Shear cutting blade cuts dead soft or extreme-



ly hard wire. Shear blade is replaceable. Coil spring separates jaws.—**Mathias Klein & Sons,** 7200 McCormick Rd., Chicago 45, Ill.

PRINTED-CIRCUIT SWITCHES. Rotary, 8- or 12-position types. For plug-in installation

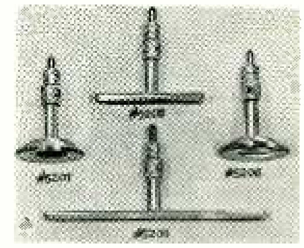


on printed-circuit boards. Dip-soldering circuit board makes all switch contacts in one process.—**Knight Electronics Corp.,** 210 S. Desplaines St., Chicago 6, Ill.

CABLES. Full line with molded-on connectors. 10 to 72 inches with various combinations of phono pin plugs and jacks, alligator clamps, spade lugs and

phone jacks. Transparent plastic envelopes.—**Walsco Electronics Manufacturing Co.,** 100 W. Green St., Rockford, Ill.

PRINTED-CIRCUIT SOLDERING KIT. 4 interchangeable tips fit this manufacturer's regular *model 250A* soldering gun. Tip *No. 5209* designed for removal of circuits in straight line. *No. 5208* for multiple connections requiring simultaneous removal;

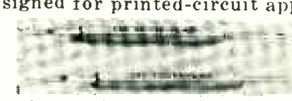


No. 5207 for removing all standard sockets from printed-circuit boards; *No. 5206* for removal of difficult components like if cans.—**Gregg Electric Co.,** 2 S. Broadway, Lawrence, Mass.

TUBE CADDIES, *Pacemaker TC-100* (left). With meter and tools, holds 262 tubes or less.

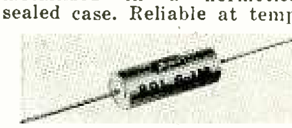
Pacemaker Jr. TC-200 (right), 143 tubes or less.—**Argos Products Co.,** 310 Main St., Genoa, Ill.

SOLDERING AIDS, miniaturized. Two types. Specially designed for printed-circuit appli-



cations.—**Available from CBS-Hytron** tube distributors.

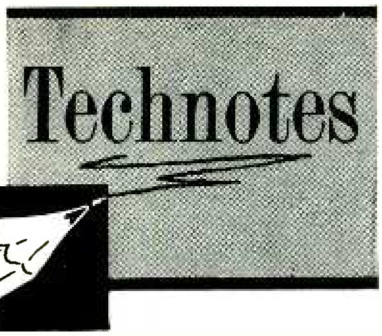
CAPACITOR, *type RQL.* Mylar metallized in a hermetically sealed case. Reliable at temper-



atures up to 125° without derating.—**Astron Corp.,** 225 Grant St., E. Newark, N.J.

TURNTABLE, *G. I. Special.* 33⅓ rpm. 50- or 60- cycle operation by shifting the drive belt to the appropriate step on the turntable's pulley.—**Components Corp.,** Denville, N. J. END

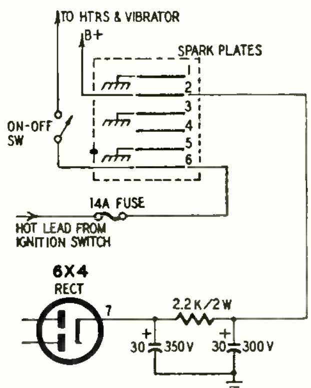
All specifications given on these pages are from manufacturers' data.



MOPAR 821X AUTO RADIO

After the set blew a replacement 14-amp fuse, I pulled it out of the car for a check. Not having 6-volt power at the bench, I checked for opens, shorts and in-betweens.

Tubes, vibrator, buffer and filter capacitors appeared normal, but the B-plus filter resistor, a 2,200-ohm unit,



was cooked down to around 300 ohms and indicated a dead short in the B-plus line.

A check of all components failed to locate the short until the spark-plate assembly was suspected. It was dismantled by filing and punching out the rivets. A small hole burned in the insulation between plates 1 and 2 proved to be our trouble.

The spark plates were reassembled with a layer of electrical tape backing up the defective insulation. And, with the set reinstalled, the total damage amounted to one 2,200-ohm 2-watt resistor, two fuses and a lot of valuable time.

The moral of all this? Spark plates are *not* as rugged and dependable as they appear.—*Paul B. Lavallee*

FLYBACK SINGING

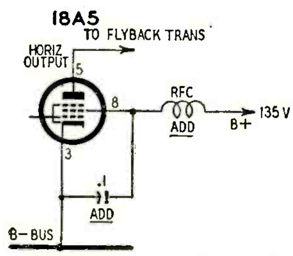
Flyback transformer "singing" is a high-pitched whine occurring at 15,750 cycles and is caused by an inherent mechanical resonant condition. The core is usually the vibrating medium although a loose lead connected to the transformer or a loose turn of wire within the transformer itself is also often responsible for this condition. Singing is usually objectionable and sometimes nerve-racking to those whose hearing is acute at high frequencies. (Most people can't hear it.)

To eliminate or minimize this condition, tighten and dress all leads; tighten all screws on the terminal board and mounting bracket, being careful not to crack the transformer core or terminal board. Pack insulating wax or carbon compound between the core and terminal board and between the core and mounting bracket. If the difficulty still persists, as it sometimes does in more stubborn cases, mount the flyback transformer with rubber shock mounts and tighten the mounting screws securely. Also try readjusting the horizontal drive, width, and horizontal linearity controls.—*Warren J. Smith*

SNIVET CURE

A General Electric 9-inch portable (model 9T001) had dark smudges on the right-hand side of the picture.

A bypass to ground at the screen grid of the horizontal output tube re-

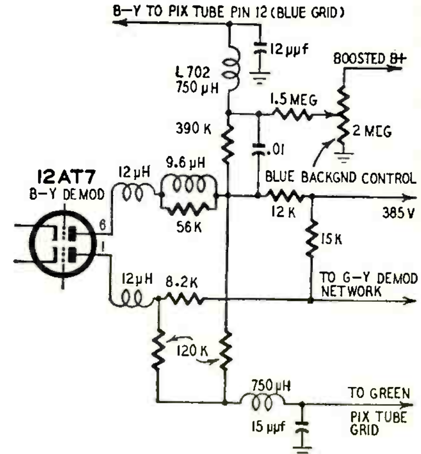


duced the intensity of the smudges (the snivets) somewhat but not enough to be considered a cure. As the accompanying schematic shows, a filament choke was installed in series with the 135-volt B-plus feed to the output tube's screen grid to finish the job.

This filter prevented radiation of the disturbances at the horizontal output's screen grid all over the set via the 135-volt B-plus bus.—*James A. McRoberts*

NO B — Y, BLUE SCREEN

We have had a couple of sets come in with this trouble. An RCA CTC5 came



in with a complaint that the screen had a predominant blue tint on monochrome programs. A check of the circuit showed no B—Y signal applied to the color picture tube. Further work pinned it down to L702. The coil had opened, cutting off the signal to the picture tube. The coil was replaced and the blue tint disappeared.—*L. Warren* END

THE FUND REACHES $12,294.37

HELP-FREDDIE-WALK FUND

As we enter 1958, the Help-Freddie-Walk Fund, through the generosity of our readers, has collected almost $12,500 for little Freddie Thomason, son of a radio technician of Magnolia, Ark., and born without arms or legs.

We have not heard from the Thomasons for some time but, believing that "no news is good news," we are certain that Freddie is making steady progress in his fight to adjust to the normal life of a 7-year-old.

It goes without saying that we are sincerely grateful for all donations, no matter how small, but at this time we would like to say a special "thank you" to John Stefanuk of New York City, who has contributed $50 to the fund, and to Walter C. Hieber, Jr., radio and television technician of Maracaibo, Venezuela, who wrote us at length congratulating us on our efforts in Freddie's behalf and enclosed his check for $25. We would also like to thank Meridian TV Service of Washington, D. C., who for several months have sent in almost-weekly donations.

Won't *you* send in your contribution as soon as possible? All donations are acknowledged by letter and are forwarded to Magnolia, where they are allocated according to Freddie's needs. *Make out all checks, money orders, etc., to Kiwanis Club of Magnolia, Ark.* Send all contributions to:

Help-Freddie-Walk Fund
c/o RADIO-ELECTRONICS
154 W. 14 St., New York 11, N. Y.

RADIO-ELECTRONICS Contributions as of July 10, 1957	$11,691.87
FAMILY CIRCLE Contributions	602.50
Anonymous, Philadelphia, Pa.	1.00
Norman Fletcher, Toledo, Ohio	1.00
Cdr. Gantz, USN, Seattle, Wash.	5.00
Walter C. Hieber, Jr., Maracaibo, Venezuela	25.00
Clayton Loyd, Oneida, Tenn.	15.00
John MacDonell, Jersey City, N. J.	10.00
Meridian TV Service, Washington, D. C.	32.00
Alexander Rys, Minneapolis, Minn.	.10
H. B. Scroggs, Baltimore, Md.	1.00
Peter Shvaykus, Singac, N. J.	2.00
John Stefanuk, New York, N. Y.	50.00
TOTAL CONTRIBUTIONS as of Nov. 11, 1957	$12,436.47

CORRECTIONS

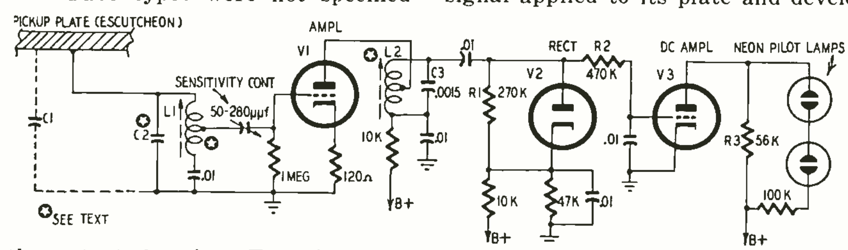
There is an error in the coil table for the 108-mc converter described in the article "Tracking U.S. Satellites" on page 45 of the December issue. L4 is listed as 19 turns of No. 16 wire. It should be 9 turns as specified in the schematic.

Transformer T5 in the "7-Transistor Pocket Radio", November, 1957, is a Lafayette type MS-341. An error in the manufacturer's original specifications led us to list its primary impedance as 18,000 ohms. It is 25,000 ohms.

radio-electronic Circuits

TV DIAL LAMP CONTROL

Dial lights on TV sets are often too dim, or contrariwise, bright enough to distract the viewer. Patent No. 2,743,433, issued to B. S. Parment and assigned to Motorola, describes a system that turns on the dial lights when the viewer approaches the set to adjust its controls. The circuit is shown with typical resistance and capacitance values. Tube types were not specified in the patent drawing. Experimenters may try typical voltage-amplifier type triodes in the amplifiers and half of a 6AL5, a germanium diode or a similar rf detector diode in the rectifier circuit.



Coil L1 is tuned to a harmonic of the horizontal sweep frequency by C1 and C2, and L2 is tuned to the same frequency by C3. C1 is the capacitance between a metal control escutcheon and the chassis or ground. The .01-μf capacitor in series with L1 helps to insulate the escutcheon from the chassis.

When the set is operating, a harmonic of the flyback pulse is picked up by the escutcheon and a sine-wave signal is fed to the grid of V1. The variable grid capacitor combines with the input capacitance of V1 to form a capacitive voltage divider. It is adjusted so the signal applied to the grid drives V1 just to the point of saturation.

The amplified output of V1 is applied to the plate of rectifier V2. The grid of the dc amplifier (V3) is biased positive by a connection through R2 and R1 to a voltage divider consisting of 10,000 ohms from B plus and 47,000 ohms to ground. V2 rectifies the signal applied to its plate and develops a voltage across R1 that opposes the positive voltage on V3's grid. The negative voltage on V2's plate and V3's grid overcomes the positive bias and drives V3 to cutoff.

When the viewer's hand approaches the controls, the capacitance of C1—the capacitance between the escutcheon and ground—changes, detuning the input circuit and reducing the signal applied to V1. The rectified voltage developed across R1 drops, reducing the bias on V3's grid and permitting it to conduct.

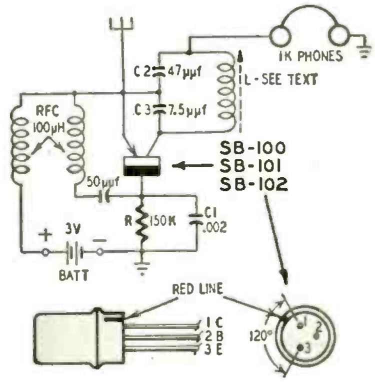
R3 draws plate current through R2 and develops a voltage drop across it. This voltage is applied to the neon or gaseous type pilot lamps through a 100,000-ohm limiting resistor. V3 cuts off and the lamps go out as soon as the viewer's hand moves away from the control escutcheon.

Optimum values for L1, C2 and L2 may be determined experimentally. L1 and L2 may be tapped TV linearity or width coils such as the J. W. Miller type 6323 with an inductance range of approximately 0.5 to 5 mh. C2 can be an adjustable mica padder with a maximum capacitance of around .001 µf.

SURFACE-BARRIER SUPERREGEN

This circuit, although quite simple, has great sensitivity. I proved this to myself one night while tuning across the bands. Using a 4-foot test lead as an antenna, I picked up WWV on 15 mc, and a local ham. I could even hear the California ham he had contacted on 10 meters. (I'm in Belleville, Ill.)

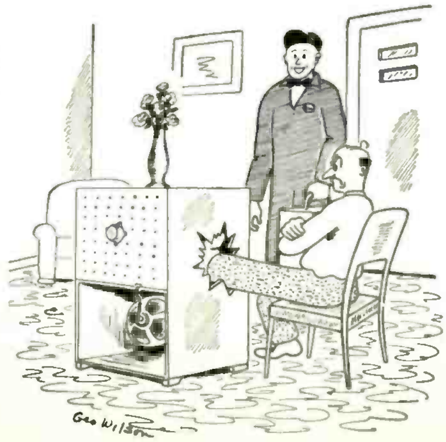
I use tapped capacitance feedback, which eliminates the need for a tapped coil. For L you can use a Cambridge



Thermionic LS3—5-, 10- or 30-mc coil, depending on the desired operating range.

Quenching action takes place in the transistor's base circuit, with R and C1 determining the quench frequency. Variations in the values of R and C1 are left to the builder, but be careful not to make R too small and exceed the transistor's current rating.

Values of C2 and C3, which form part of the tank circuit, may be changed to obtain the desired operating range, but take care to maintain the proper ratio of these two capacitors. If this ratio is not maintained, oscillation will not occur. The earphones can be replaced with a transformer, and a transistor audio amplifier added.—*Donald S. Belanger, K9HGT* END



"Didn't work this time, did it?"

"You're using my Jensen Needle again, I see."

technical Literature

TEST INSTRUMENTS, including vom's, vtvm's, scopes, tube testers and signal generators, are presented in a colorful folder. A brief description and illustrations accompany each item.—Hickok Electrical Instrument Co., 10514 Dupont Ave., Cleveland 8, Ohio

ELECTRONIC KITS, including test equipment, amateur equipment and hi-fi units, are described and illustrated in this detailed 57-page 1958 catalog. Vtvm's, oscilloscopes, transmitters, receivers, amplifiers and many other such items are presented—Heath Co., 305 Territorial Rd., Benton Harbor, Mich.

HI-FI COMPONENTS are described in three bulletins. *ST-75* features turntables, tuners and complete systems; *ST-76* lists speakers, enclosures and speaker systems; *SK-77* describes complete systems and individual units.—Lafayette Radio, 165-08 Liberty Ave., Jamaica 33, N. Y.

CAPACITORS. Subminiature electrolytics are described in *Engineering Bulletin TE-250;* Mylar-metallized capacitors in *RM-300;* flat and round miniature Mylar dielectric types in *RM-325;* and metallized Mylar units in *RM-375.* —Astron Corp., 255 Grant Ave., E. Newark, N. J.

SPEAKERS AND SPEAKER SYSTEMS are presented in a 12-page catalog covering the manufacturer's entire line. Full product descriptions, specifications and application information are to be found. Enclosures and do-it-yourself kits are also included.—University Loudspeakers Inc., 80 S. Kensico Ave., White Plains, N. Y.

ELECTRONIC COMPONENTS, *Catalog 58.* A grouping of many types of electronic parts, with brief descriptions and illustrations thereof, fills its 226 pages.—Radio Shack, 167 Washington St., Boston 8, Mass.

OK METHODS MANUAL C4 gives detailed advice on how to assemble and use many of this manufacturer's connectors. Single- and multiple-contact units are listed in the manual's 44 illustrated pages. —Amphenol Electronics Co., 1830 S. 54 Ave., Chicago 50, Ill.

TEFLON INSULATED WIRE, *Bulletin 8050.* Military specification wire, standard and Teflon-insulated are listed along with their specifications in an illustrated 4-page pamphlet.—**Belden Manufacturing Co.,** 4647 W. Van Buren St., Chicago 44, Ill.

ALL ABOUT FM ANTENNAE and their installation by L. F. B. Carini is a handy booklet about types and characteristics of various FM antennas. An 8-page directory, listing commercial FM stations in the United States, and their frequencies is included.—**Apparatus Development Co., Inc.,** Wethersfield 9, Conn. **25c.**

AMATEUR RADIO EQUIPMENT is described in this colorful 24-page catalog *No. 957.* Viking transmitters and accessories are presented. Circuit diagrams of many items are also shown.—**E. F. Johnson Co.,** Waseca, Minn.

RESISTOR COLOR CODER is a device to help read resistor color codes. Indicators are set opposite the colors for reading the resistor's value. The color coder is 3 x 3¼ inches with colors printed on a white background. EIA (formerly RETMA) 10% standard values are listed on the reverse side.—**General Cement Manufacturing Co.,** 400 S. Wyman St., Rockford, Ill. **25c.**

MANUFACTURER'S SWITCH CATALOG offers complete specifications for this firm's complete line of rotary, slide and lever switches. This new catalog, available to interested parties, presents switches capable of handling power from a kilowatt to a microwatt.—**Centralab,** 900 E. Keefe Ave., Milwaukee, 1, Wis.

ELECTRONIC CONNECTOR, a 4-page quarterly publication, announces the firm's recent product developments and, specifically, designs in electronic connectors.—**H. H. Buggie, Inc.,** Box 817, Toledo 1, Ohio.

MIT LINCOLN LABORATORY'S fundamental research program and other activities are covered in an illustrated 12-page booklet. Subjects includes the SAGE system, heavy radar, memory devices, transistor digital computers, scatter communications and systems analysis. — **MIT Lincoln Laboratory,** Box 24, Lexington, Mass.

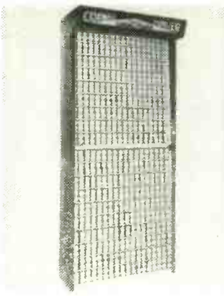
SPEAKER CATALOG. An attractive, descriptive folder outlines the complete line of Wigo speakers.—**United Audio Products,** 202 E. 19 St., New York 3.

INDICATOR LIGHTS, *Form L-159.* Subminiature indicator lights that incorporate the NE-2D neon glow lamp are described and illustrated in this 4-page brochure. The units shown are designed for panel mounting.—**Dialight Corp.,** 60 Stewart Ave., Brooklyn, N. Y.

REGULATED DC POWER SUPPLY is described and illustrated in *Bulletin 250.* Specifications, too, are presented for this laboratory unit.—**Opad Electric Co.,** 69 Murray St., New York. END

Business and People

Cornell-Dubilier Electric Corp., South Plainfield, N. J., designed a new self-



service display rack for distributors of its twist-prong electrolytic capacitors.

Electronic Instrument Co. Inc., Brooklyn, N. Y., recently held a sales meeting in New York for its representatives. Design and promotional plans for its 1958 EICO high-fidelity and test instrument lines were outlined. Photo shows Harry R. Ashley and Phil A. Portnoy, EICO president and vice president, respectively (third and fourth from left

front row), with the representatives who attended the meeting.

Jensen Industries, Inc., Forest Park,

Ill., is merchandising its silicon-treated Record Sweep phono tone-arm attachment with a new display-stock card.

JFD Manufacturing Co., Brooklyn, N. Y., was granted a patent for its Magic Genie indoor TV antenna.

ORRadio Industries, Opelika, Ala., has come up with a "Tape It Off the Air" promotion for its Irish-brand re-

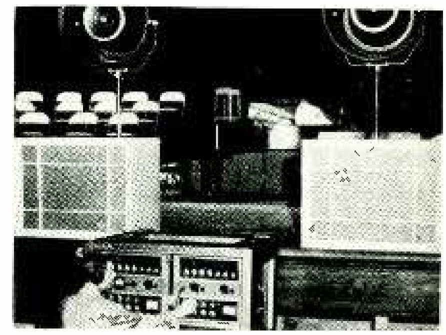
cording tape. Complete promotional kits are available to distributors.

Rek-O-Kut, Inc., manufacturer of recording turntables, tone arms and cartridges, opened a new $250,000 plant in Corona, N. Y.

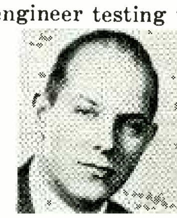
Sarkes Tarzian Rectifier Div., Bloomington, Ind., designed new display pack-

ages for its silicon rectifiers. The Kit Paks hold 20 M-500 TV conversion kits or 20 M-150 radio replacement kits.

University Loudspeakers, White Plains, N. Y., is participating with Fred Waring and his Pennsylvanians in a 10-week National Hi-Fi Holiday Tour. University developed an elaborate sound

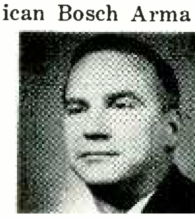


reinforcement system to improve listening in theatres and auditoriums where the concerts will be held. Photo shows engineer testing the system.

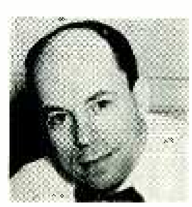


Lawrence LeKashman, widely known in the hi-fi, radio and television industries, has resigned as vice president of the David L. Bogen Company & Presto Recording Co., Paramus, N.J., to rejoin Electro-Voice, Inc., Buchanan, Mich., as vice president in charge of sales. Prior to joining the Bogen organization in 1956, Mr. LeKashman had been vice president of Electro-Voice for over four years, and previously had been associated for several years with the RCA Tube Division, Harrison, N.J., resigning as advertising manager to join Electro-Voice.

Frederick H. Guterman was elected a vice president of Allen B. Du Mont Labs., Clifton, N. J. He is general manager of the Industrial and Military Equipment Div. He came to Du Mont some months ago from American Bosch Arma Corp.



Daniel P. Knowland, Jr., was promoted to assistant general manager of Heath Co., Benton Harbor, Mich. He had been comptroller and assistant secretary.



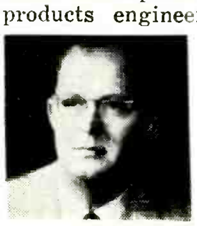
Lester A. Bogen, president of Bogen-Presto, Paramus, N.J., division of the Siegler Corp., announced a new alignment of the sales department. Mortimer Sumberg who was distributor sales manager of David Bogen Co. becomes responsible for all commercial sales to distributors for both Bogen and Presto. Thomas L. Aye, who joins the organization, will manage the sales of professional products and David E. Pear will continue as advertising and sales promotion manager. Mr. Aye was formerly sales representative for Presto in the New York Metropolitan area and prior to that was a partner in Henry Geist & Co. Mr. Bogen reports that sales for Bogen products for the third quarter of 1957 were up 49% over last year and Presto's sales up 15%.

A. L. (Al) Pezman was appointed sales manager of Trio Manufacturing Co., Griggsville, Ill. He has been associated with the firm for four years in executive post and prior to that had wide sales and advertising experience.

Donald T. Lucas was promoted to manager of receiving tube sales for Raytheon Manufacturing Co. **Paul R. Keeler** (below left) was named mana-

ger of Government relations and **C. W. Duncan**, sales engineer of receiving tubes, TV picture tubes, transistors and semiconductor diodes. Lucas who has been with Raytheon since 1948, will work out of the Franklin Park. Ill., plant. Duncan, who has had 11 years' experience as a TV design engineer, will also work out of Franklin Park. Keeler will maintain his office in Newton, Mass.

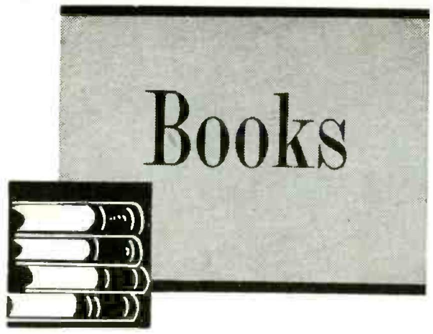
Lee Gunter, Jr., (left) and **Robert Troxel** were named chief development engineer and chief products engineer



respectively, of Shure, Bros. Inc., Evanston, Ill. Both have been with the company for more than 12 years.

Obituary

Gerard Swope, former president of the General Electric Co., died at the age of 84. Mr. Swope, who started with G-E in 1895 as a helper at $1 a day, became its president in 1922 and remained in that position until his retirement in 1939 at the age of 67. He was also a director of the National Broadcasting Co., RCA Photophone Co., RCA Victor, RCA Radiotron Co., and 14 other companies in the electric, electronics and power fields. END



Books

TV AND RADIO TUBE SUBSTITUTION GUIDE, Harry G. Cisin, Amagansett, N. Y. 5½ x 8½ inches. 22 pages. 50c.

The 1957 edition of this handy booklet lists direct replacements for many common types of vacuum tubes. Saves the need of a second trip when you're out on a job and don't have the tube you need. All tubes listed fit into the same socket without any wiring changes. A chart of 600-ma series-string tubes with controlled warmup is also presented. In a separate section is a TV picture tube substitution guide. As practical as the first section, it emphasizes substitution rather than conversion. Many of the recommended substitutions can be made without changes of any kind.—*LS*

INTRODUCTION TO SEMICONDUCTORS, by W. Crawford Dunlap, Jr. John Wiley & Sons, Inc., 440 Fourth Ave., New York, N.Y. 5¾ x 9 inches, 417 pages, $11.75.

Written for students and engineers, this book goes into considerable detail to explain what a semiconductor is and why it behaves as it does. Transistors, rectifiers, photocells and thermistors are covered. The author stresses physical aspects rather than mathematical, using graphs and charts often.—*IQ*

LEARNING ELECTRICITY FUNDAMENTALS, by Leonard R. Crow. Howard W. Sams & Co., Inc., 2205 E. 46 St., Indianapolis 5, Ind. 5½ x 8½ inches, 408 pages. $5.95.

Electricity is a fascinating subject, and according to this author its study is more important than that of any other scientific subject. Certainly it is well explained here, and written so that all may understand. The reader learns how to experiment with electricity, to wire doorbells and automatic alarms and even how to wire a house safely. Motors, magnets and transformers and their applications are described. Except for simple Ohm's law, there is no math.

BASIC PHYSICS (Vols. I and II) by Alexander Efron. John F. Rider, Publisher, Inc., 116 W. 14th St., New York, 11, N.Y. 6¼ x 9½ inches, 724 pages.

In every branch of physics, basic research has paid off in practical benefits to mankind. Modern physics includes heat, sound, light, chemistry, mechanics, electronics and atomics. This book is complete and up to the minute. It describes multiple-stage rockets, transistors, thermistors and

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RECORDERS, Hi-Fi, Tapes. Free Wholesale Catalogue. CARSTON, 215-T East 88th St., New York 28, N.Y.

THREE LINE Rubber stamp $1. ELDREDGE INDUSTRIES 152 Rosemont Ave., Trenton 8, N.J.

PROFESSIONAL Electronic Projects—Organs, Timers, Intercoms, Counters, etc. $1 each. List Free. PARKS, Box 946 Redwood City, Calif.

LONG PLAYING RECORDS 20 to 50% Discount Brand-New Factory Fresh Unplayed—All Labels—Send 20c for catalogue to RECORD SALES, 1110 Winbern, Houston 4, Tex.

DIAGRAMS! Repair Information! Radios—Amplifiers—recorders $1, Televisions $1.50. Give make, model, chassis. TV MILTIE, Box 101EA, Hicksville, N.Y.

LABORATORY QUALITY equipment and Military Surplus Electronics bought, sold. ENGINEERING ASSOCIATES, 434 Patterson Road, Dayton 9, Ohio.

UNUSUAL CONFIDENTIAL QUOTATIONS on all your "Hi-Fi" requirements. No Catalogs. KEY ELECTRONICS, 120 Liberty Street, N.Y. 6, N.Y. EVergreen 4-6071.

DIAGRAMS FOR REPAIRING RADIOS $1. Television $2. Give make, Model. DIAGRAM SERVICE, Box 672-RE, Hartford 1, Conn.

WANTED: Electronics technicians desiring educational achievement accreditation in electronics. CRAMWELL RESEARCH INSTITUTE, INC., EM-7, Adams, Mass.

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1500 PERSONALIZED ⅝" x 1¾" Labels $1. Your 3 line name & address printed with blue ink on fine quality white gummed paper. Money back guarantee. HAMILTON-WARD, Dept. 11B, Westfield, Mass.

TELEVISION Tuner Repairs. DAN'S TELEVISION LABORATORY, 606 Sunrise Highway, Babylon, N.Y.

COMPLETE Television Sets $11.95. JONES TV, 1115 Rambler, Pottstown, Pa.

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PORT ARTHUR COLLEGE—Training for FCC Licenses. Enrollment Monthly. PORT ARTHUR, Texas.

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atomic energy. The basic experiments and discoveries by Thomson, Maxwell, Newton, Fermi and Einstein are clearly described. Algebra, geometry and logarithms are used to a limited extent.

The book is divided into two parts. Vol. I provides an overall view of physics for the beginner. Vol. II covers more advanced ground and in greater detail. Hundreds of illustrations and many problems are presented to help the self-student. The course meets requirements of college boards.—*I.Q.*

COMMERCIAL OPERATOR'S LICENSE GUIDE—Elements 1 and 2, by Martin Schwartz. American Electronics Co., 1203 Bryant Ave., New York 59, N.Y. 48 pages. 75c.

This text is one of a series that covers the test for a commercial operator's license given by the FCC. Separate books cover the many elements. This one concerns itself with Basic Law and Basic Operating Practice. A question-and-answer type presentation forms the instructional sections. Sample FCC type practice examinations using multiple-choice questions let the reader test himself.—*LS*

WHO'S WHO IN ELECTRONICS, Electronic Periodicals, Inc. 2775 S. Moreland Blvd., Cleveland 20, Ohio. 8¾ x 11¼ inches, 495 pages, $10.

An index to supply sources of electronic components and equipment. Thumb-nailed sections list components by manufacturers, manufacturers by geographical locations, trade names, field representatives by manufacturer, representatives by state and city and distributors and their products by state and city. *RFS*

THE HOW AND WHY OF HIGH FIDELITY, by Milton Sleeper. Heath Co., 305 Territorial Road, Benton Harbor, Mich. 6½ x 9½ inches, 47 pages. 25c

This hi-fi guide book is written by a pioneer radio writer and publisher of high-fidelity magazines. Without technical terms he tells how to get started in this fascinating and rewarding hobby and shows the advantages of assembling from a kit. Although concerned with the products of one particular manufacturer, the booklet outlines plans for a complete hi-fi outfit whether its sound source is to be FM, tape or disc (or all). Simple diagrams illustrate ways to connect components to form systems ranging from 20 to 70 watts.—*IQ*

SMALL APPLIANCE SERVICING, by P. T. Brockwell, Jr. McGraw-Hill Book Co., 330 W. 42 St., New York, N. Y. 5½ x 8¼ inches, 180 pages. $4.50.

A basic guide to operating principles and preferred servicing and testing techniques for electric irons, toasters, mixers, roasters, perculators, waffle grills, sandwich grills, and rotisseries. Also includes a chapter on establishing and conducting a profitable appliance servicing business.—*RFS* END

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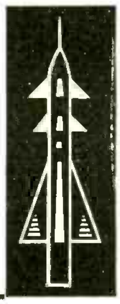

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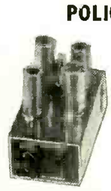

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Enjoy FM Programs While You Drive.

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• 30-50 MC
• 108-176 MC

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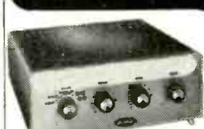

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Advanced 7 tube circuit plus Rectifier for full sensitivity and selectivity. Distortion less than 1%. Sensitivity is 5 uv for 30 db quieting on FM, 25 uv AM. Armstrong FM Circuit with limiter. Foster-Seeley Discriminator. 20-20,000 cps response. Full AFC control — no drift. Easy assembly. **$28.95***

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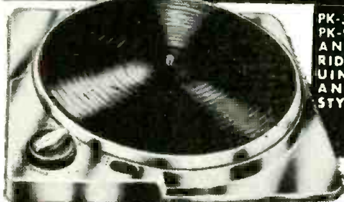
Exclusive Lafayette Money-Saving Values

PROFESSIONAL TRANSCRIPTION TURNTABLE AND VISCOUS-DAMPED TONE ARM

THE FINEST TRANSCRIPTION TURNTABLE AND TONE ARM FOR THE PROFESSIONAL USER AND THE AUDIOPHILE



PK-300 TURNTABLE, PK-90 TONE ARM AND G.E. CARTRIDGE WITH GENUINE DIAMOND AND SAPPHIRE STYLI.

72.50

PK-300

ILLUMINATED BUILT-IN STROBOSCOPE & VIEWER

COMBINATION DEAL

PK-90

LATEST IMPROVED MODEL PK-300 TRANSCRIPTION TURNTABLE

New 3-speed instrument with built-in stroboscope and viewer for exact speed determination, and magnetic brake for instantaneous speed variation. Precision engineered to meet professional standards for wow, rumble and flutter content. Heavy 12" cast aluminum rim-driven turntable. Variable speed control permits adjustment of each speed within ± 7% using efficient frictionless magnetic brake. Heavy-duty constant speed 4-pole induction motor freely suspended and isolated by shock-mountings to eliminate vibration transferral. R-C filter network suppresses "pop" in speaker. Truly a delight for the connoisseur. Size: 13½" x 14" and requires 2¾" clearance above and 3¾" below motorboard. For 110-130V and 60/50 cycle AC. Power consumption 12 watts. Handsome hammertone gray finish. Shpg. wt., 20 lbs.

PK-300 .... Net **49.50**

PK-90 VISCOUS-DAMPED TONE ARM

This transcription arm assures dependable and stable operation, utilizing the "floating action" principle of "viscous-damping." The arm is supported at a single point by a pivot and jewel bearing having negligible friction. Damping is accomplished by a silicone fluid occupying the gap between a ball and socket. This damping control permits high compliance and negligible tracking error, and prevents damage to either record or stylus should the tone arm be accidently dropped. Low frequency resonance, skidding and groove-jumping are likewise minimized. The tone arm accepts all records up to 16" and accommodates virtually all hi-fi cartridges by means of precisely engineered adapters which simplify installation and provide proper stylus pressure.

This tone arm is a quality companion to the PK-300 with matching finish. Shpg. wt., 2½ lbs.

PK-90 .... Net **11.95**

PK-160

TRANSCRIPTION MANUAL PLAYER

with TONE ARM and TWO PLUG-IN HEADS

- MAGNETIC BRAKE FOR FINE ADJUSTMENT OF EACH SPEED
- 4-POLE, HEAVY DUTY TRANSCRIPTION-TYPE MOTOR
- ACCOMMODATES ALL POPULAR CARTRIDGES
- STYLUS WEIGHT ADJUSTMENT SCREW ON TONE ARM

All the important features of professional transcription players have been incorporated in this precision turntable. Extremely smooth and quiet heavy duty 4-pole motor plays 78, 45 and 33⅓ RPM records. Exclusive magnetic brake, controlled by knob on base plate, permits instantaneous fine adjustment of each speed. Stroboscope disc included checks speeds. Speed selector safety switch protects mechanism by making it necessary to pass through OFF position when switching from one speed to another. 10" weighted turntable has rubber traction mat.

Mounting plate has pickup rest and ON-OFF switch. Size 12-15/16" left to right. 10⅞" front to rear. Requires 2¾" clearance below motor board and 3" above. With AC line cord, 2 plug-in heads, output cable, 45 RPM adapter. For 105-120V., 60 cycles AC. Shpg. wt., 12 lbs. *(NOTE: For protection in shipping, tone arm is separate. Just fasten to mounting plate.)*

PK-160—Less cartridge and base .... Net **25.95**

PK-164—Same as above except equipped with new genuine GE VRII Triple Play Magnetic Cartridge with diamond-sapphire cartridge .... Net **37.50**

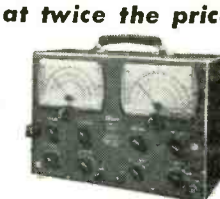
PK-162—Wood base for PK-160. Shpg. wt., 5 lbs. .... Net **3.95**

PK-163—Unfinished mounting board only. Shpg. wt., 1 lb. .... Net **.95**

TV-FM SWEEP & MARKER ALIGNMENT GENERATOR

Compare it with instruments at twice the price!

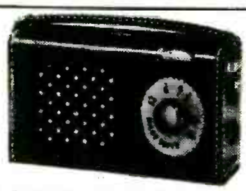
- SWEEP RANGE 3MC-260MC
- MARKER RANGE 3MC-225MC
- COMBINATION CRYSTAL AND VARIABLE MARKER—1% ACCURATE
- SUPPLIED WITH 4.5MC CRYSTAL 0.002% ACCURATE
- SWEEP WIDTH 0-12MC CONTINUOUSLY VARIABLE
- 2-5" DIALS



LSG-50 **79.50**
FACTORY WIRED AND TESTED

The Lafayette LSG-50 is a factory-wired and calibrated precision instrument for fast alignment of IF and RF stages of TV and FM receivers. Accurate, linear electromagnetic sweep system covers 3MC-120MC and 140MC-260MC. Sweep width continuously variable 0-12MC. 3 volts RMS, 60 cps sine wave (for oscilloscope) available from front panel. Marker covers 3MC-225MC in 4 ranges. Combination of crystal and variable marking. Marker calibration accuracy better than 1%. 4.5MC crystal mounts on front panel and accurate to 0.002%. Extra input for external marker. The built-in marker may be used independently of the sweep. RF output 100,000 microvolts, controlled by 3-step (X1, X10, X100) and continuously-variable fine adjustment attenuators. Output impedance 75 ohms, unbalanced. CONTROLS: Sweep Width, Horizontal Phase, Retrace Blanking with Off position, Marker Amplifier, RF Attenuators, Sweep Range Selector, Marker Range Selector. Crystal socket, pilot light, external marker input also on front panel. 2-5" easy-to-read dials with vernier-driven dial pointers. Sturdy gray wrinkle metal cabinet with handle. Complete with tubes. 75 ohm output and external marker input cables. 4.5MC crystal. Size 9" x 13½" x 6". Shpg. wt., 20 lbs.

MODEL LSG-50 .... Net **79.50**



6 TRANSISTOR SUPERHET RECEIVER KIT

- 100% SUBMINIATURIZED
- SENSITIVE, SELECTIVE, STABLE
- PUSH-PULL OUTPUT — PLENTY OF POWER
- AN INCOMPARABLE VALUE

The Lafayette KT-119 6 Transistor Superhet Transistor Kit provides superior commercial quality with maximum sensitivity, selectivity and stability. The circuit features 6 selected transistors and crystal diode, a specially matched set of 3 IF's, Oscillator coil, high Q loop, and audio transformer coupling. Has efficient 2¾" speaker and earphone jack for private listening. Complete with all parts, transistors, pre-punched chassis and easy to follow step-by-step instructions. 6½" x 3½" x 1½". Shpg. wt., 3 lbs.

KT-119—Complete Kit—Less Case & Battery .... Net **29.95**

BATTERY RCA VS300 ...... Net **1.23** **BURGESS P6** .... Net **.77**

MS-339—Sturdy, attractive brown leather case with carrying strap for KT-119. Shpg. wt., 1 lb. .... Net **2.95**

MS-366—Sensitive matching earphone Net **1.29**

NEW POCKET AC-DC VOM MULTITESTER

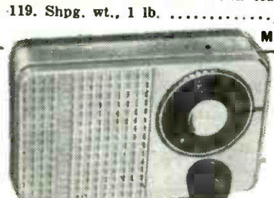
2,000 ohm per volt sensitivity on both DC and AC

160 ua 3" METER 1% PRECISION RESISTORS
SILVER CONTACT SELECTOR SWITCH
FULL SCALE RANGES

D.C. Volts: 0-10; 0-50; 0-500; 0-1000 Volts—**A.C. Volts:** 0-10; 0-50; 0-500; 0-1000 volts—**D.C. Current:** 500 ua and 500 ma—**Resistance:** 0-10K; 0-1 Meg—**Decibels:** —20 to +22; +20 to 36 db (0 db—0.775 V)—**Capacity:** 250 mmfd. to .2 mfd—.005 mfd to 1 mfd—**Output Ranges:** 0-10; 0-50; 0-500; 0-1000 volts.

Best Buy in America! A very accurate and sensitive VOM. This Multitester is a complete instrument (not a kit) with high quality and sensitive 160 microamp meter; 2000 ohm per volt on both AC and DC. Single selector switch, 1% precision resistors, 3" meter. Features extreme versatility, accuracy and ruggedness. In attractive plastic front panel, with metal bottom for ruggedness and shielding. First capacity range requires 50 volt AC source. Second capacity range requires 10 volt AC source. Size 4¼" x 3¼" x 1⅝". Complete with test leads and batteries. Shipping weight 4 lbs.

RW-27A .... Complete **8.95**



3 TRANSISTOR SUPERHET POCKET RADIO KIT

- A TRUE POCKET SUPERHET RECEIVER
- NO EXTERNAL ANTENNA
- NO EXTERNAL GROUND

A remarkable sensitive, super-selective pocket superhet receiver with astonishing performance over the complete broadcast band. Uses 2 high-frequency and one audio transistor plus efficient diode detector and features 2 specially matched IF transformers for maximum power transfer. The components are housed in a professional looking beige plastic case. The receiver's appearance enhanced by attractive maroon and silver station dial. Sensitive built-in ferrite antenna eliminates need for external antenna. A designer's dream in a true pocket superhet receiver! Complete with all parts, transistors battery, case, dial and easy to follow step-by-step instructions. 4⅛" x 2⅝" x 1-1/16". Shpg. wt., 1 lb.

KT-116—Complete Kit, less earphone .... Net **16.95**

MS-260—Super Power Dynamic Earphone .... Net **3.95**

HIGH SENSITIVITY 20,000 OHM PER VOLT DC 10,000 OHM PER VOLT AC MULTITESTER

LOOK AT THESE FULL SCALE RANGES!

D.C. Volts: 0-6; 0-30; 0-120; 0-600; 0-1200; 0-6000 Volts—**A.C. Volts:** 0-6; 0-30; 0-120; 0-600; 0-1200 Volts—**Resistance:** 0-10K; 0-100K; 0-1 Meg; 0-10 Megohms—**D.C. Current:** 0.60 Microamp; 0-6; 0-60; 0-600 Milliamps—**Decibel:** —20 to +17 db (0db—0.774V)—**Capacity:** .0001-.01; .005-.15 mfd—**Inductance:** 20-2000 millihenry—**Output Ranges:** 0-6; 0-30; 0-120; 0-600; 0-1200 Volts.

The new Lafayette high sensitivity Multitester is a complete instrument (not a kit). In addition to its unusual sensitivity of 20,000 OHMS PER VOLT ON D.C. AND 10,000 OHMS PER VOLT ON A.C., and the extraordinary number and scope of its ranges, it is packed with features that would make it cost at least twice as much if made in this country. Uses 1% precision resistors, silver contacts on selector switch, 35 ua 3" meter. Dependable, rugged and accurate. Even the test leads are heavy duty with high voltage insulation. Voltage source required for low capacity range is 120V for high range capacity and inductance scale is 6V A.C. Attractive plastic front with metal botton. Size 6¼" x 4¼" x 2½". Complete with batteries and leads. Shipping weight 4½ lbs.

RW-30A .... Singly, Each **19.95**
in lots of 3, Each **19.25**

Lafayette Radio 165-08 Liberty Ave. JAMAICA 33, N. Y.

INCLUDE POSTAGE WITH ORDER

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BOSTON, MASS., 110 Federal St. PLAINFIELD, N. J., 139 West 2nd St.
NEWARK, N. J., 24 Central Ave. BRONX, N. Y., 542 E. Fordham Rd.

"HUNTERS & SPORTS HEATERS"

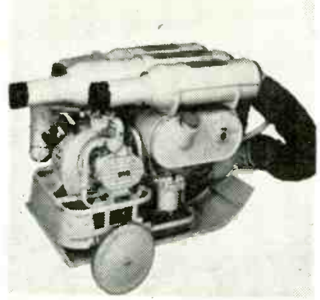
Kerosene or Gasoline Heater
Reduced to $4.95

Brand new. Evans blue flame heater. Output approx. 50,000 BTU. Ideal for garage or shack where not confined. Size: 10" dia. x 12" high. Cost Govnmt. many times our low price. Shipped in orig. packing: wt. 47 lbs.......$4.95

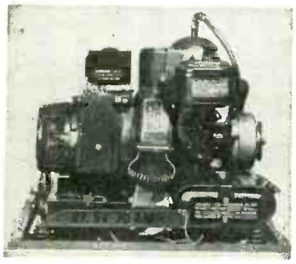
PORTABLE HEATER

$99.50

100,000 BTU self-contained heater. Model D-1 mfgd. by Stewart Warner. Super-charged blasted heated air is uncontaminated and ideal for quickly heating garages, aircraft, construction or emergency use. Heat may be directed at will thru any of three flexible ducts up to 35 ft. from heater. Ducts compress into top metal tubes on unit when not in use. 2 H.P. engine operates entire heater. Units are like new, rebuilt by Air Force. Original cost $600. Ship. wt. approx. 300 lbs.



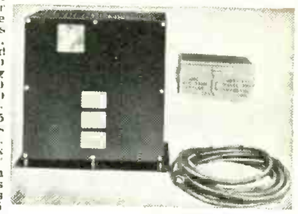
HRU-28A GENERATOR—$79.50

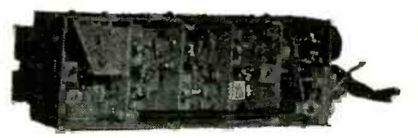


Homelite gasoline generator 28.5 V. DC at 2 KW. 3400 RPM motor speed. Electric or rope start. Use to power surplus aircraft radio equipment, cabin or marine power, aircraft starting, etc. These units rebuilt like new by the U.S. Air Force and have not been run since. Size 21½" x 24⅝" x 17½". Wt. 115 lbs. Original AF boxed. Guaranteed. Ship. wt. 210 lbs. "Instruction book included."

30 AMP. BATTERY CHARGER WHILE SUPPLY LASTS—$12.50 ea.

Cost Government $300 ea. Our purchase of large quantity allows this bargain. Ward-Leonard Mfgd. Type ED 33510. Charging rates up to 30 amps. on 12-30 volt battery combinations (6-15 cells). Operates from 110 V.D.C. Size 20" wide x 20" high x 10" deep. Shipped in original overseas pack with spares and cord. Wt. 65 lbs. Ship. wt. 145 lbs.





Receiver R-1/ARR-1—$1.95

A two-stage RF superhet converter in range of 234-258 Mc. Ideal for conversion to various preselectors, ham 220 Mc. converter, or other uses. Uses 4—954 acorn tubes supplied. In compact aluminum case 10" x 3½" x 3". Filaments operate from 12 or 24 V. by merely throwing switch contained in unit. Complete with conversion article as in Jan. 1949 "Radio-TV News." Brand new demilitarized units (input coil insulation broken—easily repaired). Used units that are not demilitarized also available—specify new or used. Ship wt. 4 lbs.
Price $1.95 ea.

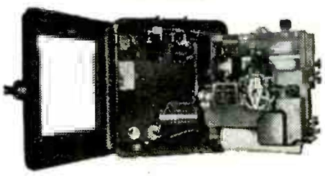
12 or 24 V. co-axial antenna relay for above or other mobile transmitter-receiver equip. New.......$1.25 ea.

M-1 Odograph, over $5,000 value—$89.50

See Nov. 1944 Electronics for Full Description

This is a survey instrument for automatically drawing a map of the terrain over which the jeep or other vehicle to which it is attached traverses. These instruments mfgd. currently by Monroe Calculating Machine Co. and sold in excess of $5,000. Our surplus purchase allows passing on these machines at this value. Order early, only 200 in stock. Units have been rebuilt by Corps of Engineers, U.S. Army and guaranteed good condition. Ideal for prospectors, oil companies, power line and farm use. Nothing else needed for operation except vehicle. Many are using the compass unit for automatic pilots on boats—many, many applications. A real machine. Ship. wt. approx. 300 lbs.......Our Price $89.50 ea.

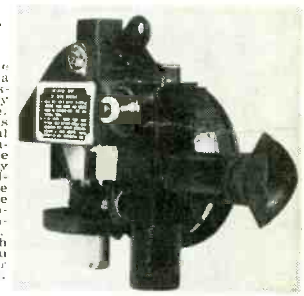
LEEDS & NORTHRUP MICROMAX RECORDERS



Strip type recorder used for controlling and recording wide variety of processes. Used originally for temp. range of 350-550° C. but may be changed for other applications. Operates on Wheatstone bridge principle using AC galvanometer movement. Original cost several times our low price. Removed from demilitarized equipment which in many cases was new. Sold as used but guaranteed, or money back if not satisfied. Ship. wt. approx. 165 lbs. $179.50 ea.

SEXTANT $254 value $17.95

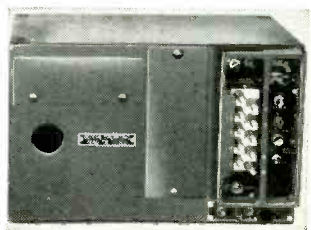
Air Force Bubble type sextant at a price to move quickly a large quantity surplus purchase. These instruments come in original carrying case complete with telescope but less battery case used for artificial light source (this can be made from 2-cell flashlight). Mfg. by Ansco or Fairchild. Optics alone worth this price if you have no need for sextant. Ship. wt. approx. 10 lbs.



Freq. Crystals...Less Than 5¢ Ea.

Imagine crystals costing Govnmt. $3.50 to $12.50 ea. in this assortment. 100 brand new; various freqs.: plenty in ham bands. Practically all types of holders; all mounted; guaranteed to oscillate.

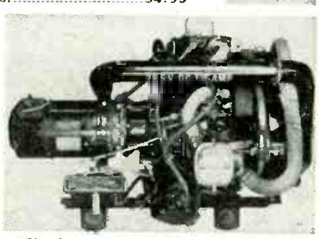
Assortment of 100. Ship. wt. 4 lbs.......$4.95



BC-604 Transmitter—$9.95 ea.

30 watt crystal controlled on 10 preselected channels in range of 20-27.9 Mc. F3 emission. Operates from 12 V. or 24 V. DC (dynamotor not supplied). Tubes and meter supplied worth the price of entire unit. Size 18" x 10" x 12". Excellent to new condition. Ship. wt. approx. 100 lbs. ea. Price $9.95 each.

Andover Power Plants $185 ea.



This is the D2 plant that has been always in such great demand for use as portable welders and auxiliary power. Delivers 28.5 V. DC up to 200 amps. continuous. The lightweight aircraft type motor on these plants had a Gvnmt. acquisition cost of $2937.00 ea. Motor is 2 cylinder 4 cycle aircooled with hi-tension magneto type shielded ignition rated at 10 HP at 3200 RPM. Entire unit weighs approx. 125 lbs. Guaranteed good condition. Ship. wt. 300 lbs. Price.......$185

Engines only from above plant for only $125 ea. Ship. wt. 250 lbs.

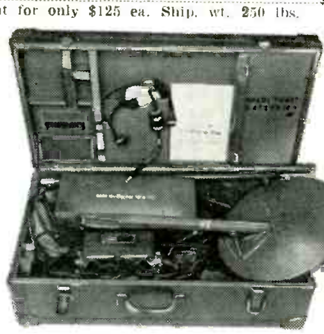
110 V. RECTIFIER SPECIAL—$2.85

New G.E. dry disc rectifiers for changing 115 V. AC to DC. Has one amp. rating-more intermittant or with forced air cooling. Size approx. 9" 3½" x 3½". Ship. wt. 10 lbs.

Metal Locators—$39.50

The famous SCR-625 mine detector which has been found to be unexcelled for locating hidden metallic objects such as pipes, treasure, etc. Hundreds in use by prospectors, mining companies, plumbers, veneer mills, etc. Comes complete in carrying case and checked ready for operation with addition of batteries below. Case size 28¼" x 16" x 8¼". Operating carrying wt. approx. 15 lbs. Ship. wt. 55 lbs. Price $39.50 ea.

Batteries for above SCR-625 $4.25 set.



TS-9 Handset—$1.99

Ideal for your mobile rig. Contains 250 ohm rec. element and single button carbon mike transmitter unit. Will replace your T-17 handmike or other SB mike. Excellent to new condition. Ship. wt. 5 lbs. Price.......$1.99 ea.

SURPLUS ENGINE—New—$17.95

2.3 H.P. 2 cy. horizontal engine manufactured by or for Jacobsen. Ball bearing crankshaft. Weighs only 8½ lbs. Attach your own coil and battery. Ideal for air-propelled boats, ice sleds, models, etc.......$17.95
Shipped as shown with propeller but less hub for attachment.

CT-Control Transformer; D-Differential Motor; DG-Differential Generator; F-Motor (Follower); G-Generator. Mfgd. by Bendix, Ford Instrument Co. and General Electric. Specify. Bendix, Ford and GE in stock.

G-E SELSYN 2J1G1
$4.95 PR.

Brand new small size Selsyns for beam direction indicator and other devices. 57.5 volt 400 cycle. Connect rotors in series on 115 V. Will operate for intermittent duty on 60 cycles. approx. size 2¼" dia. x 4½" long. Shpg. wt. 3 lbs. per pair.
Sale Price.......pr. $4.95

SYNCHROS, SELSYNS, AUTOSYNS!!!
At Money-saving prices ! ! !
Large Quantity—20,000 in stock
110 V. 60 Cycle Units

Size & Type	Approx. Wt. lbs.	Approx. length (In.)	Approx. Dia. (In.)	Price Used	Price New
5G Navy	5	6.0-6.8	3.4-3.6	$5.00	$20.00
5F Navy	5	6.0-6.8	3.4-3.6	5.00	none
5DG Navy	5	6.0-6.8	3.4-3.6	5.00	none
5CT Navy	5	6.0-6.8	3.4-3.6	5.00	none
XV CT Army	5	6.0-6.8	3.4-3.6	none	20.00
Sperry 78360 voltage TR. Brass Case	8	6.0-6.8	4.3-3.6	none	20.00
Sperry 78359 voltage REC. Brass Case	8	6.0-6.8	4.3-3.6	none	20.00
6G Navy	8	6.4-7.5	4.5	7.50	25.00
7G Navy	18	8.9-9.2	5.8	10.00	30.00
7DG Navy	18	8.9-9.2	5.8	10.00	20.00
400 Cycle Units					
1J1G1 GE	1.5	4.3	2.3	none	3.50
5F Navy	5	6.0-6.8	3.4-3.6	3.50	none
5G Navy	5	6.0-6.8	3.4-3.6	3.50	none
5DG Navy	5	6.0-6.8	3.4-3.6	3.50	none

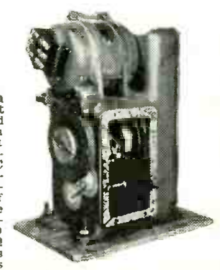
Mobile Hams Attention!

6-12-24 V. VIBRATOR POWER SUPPLY $9.95

PE-237 Non-synchronous vibrator type. Input: 6 V. 36 amp., 12 V. 17 amp., or 24 V. 9.5 amp. DC. Output: 525 V. DC. .095 amp., 1105 V. DC. 4.2 Ma., 6.5 V. DC 2 amp., 6 V. DC ½ amp., 1.35 V. DC. 450 Ma. Higher current drain may be obtained with no ill effect. This power supply has been successfully used for powering the BC 604 Xmtr. below. Steel brown crackle case size 20¼" x 11" x 10". Ship. wt. 119 lbs. ea. Excellent to new condition.
Price $9.95 ea.

New Torque Amplifier Only $7.95

FOR USE WITH SYNCHROS SIZE 5, 6, 7



Provide torque amplification and ease in rotation of input shaft. Rotating power applied to input shaft is reproduced in any direction on the output shaft. Torque supplied entirely by a 1/40 HP 110 V DC motor through gear and planetary drive hookup. Speed varies directly with rotation of input shaft with noticeable loss of accuracy. Motor requires capacitor of 85-120 mfd. for starting. Designed for use on gun control devices and cost the Govnmt. hundreds of dollars to mfg. In cast aluminum case. Size: 12" h. x 5⅜" w. x 7½" d. Wgt. 23 lbs.

Packed in original wood box. Shpg. wt. 45 lbs.

Brand New.......$7.95

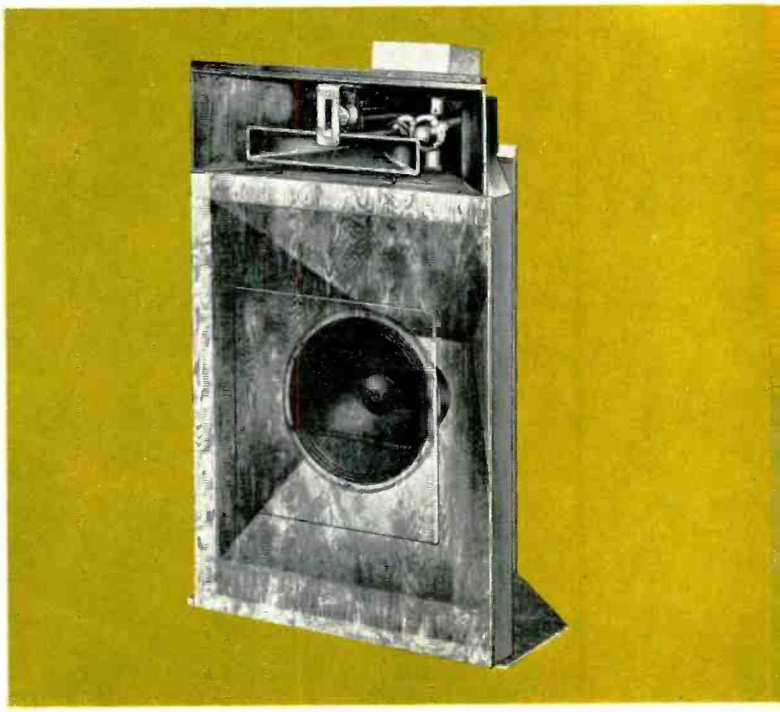
Starting capacitor for above Torque Amplifier. New....$1.00

ESSE RADIO CO. 42 WEST SOUTH ST. INDIANAPOLIS 25, IND.

REMIT SHIPPING CHARGE AND INSTRUCTIONS WITH ALL ORDERS. OTHERWISE ORDER WILL BE SHIPPED EXPRESS COLLECT. ALL ITEMS GUARANTEED TO YOUR SATISFACTION OR MONEY REFUNDED IF RETURNED PREPAID WITHIN 10 DAYS OF RECEIPT

Easy to Build . . . Ready to Assemble . . .

SUPERLATIVE Electro-Voice® SPEAKER ENCLOSURE KITS



Low-Bass Section Employing an advanced principle of folded corner-horn loading, the new Patrician IV utilizes high-fidelity's only 18-in. low-frequency driver, Model 18WK. The taper rate has been extended to 35 cps. The first three octaves, to the first crossover point at 200 cps., are reproduced by a tremendous bass driving section . . . the largest, most highly developed ever designed for a home audio system. When the Patrician is placed in a corner, the entire room becomes part of the bass horn, allowing the large wave lengths of the second and the upper part of the first audible octave to be formed properly.

Mid-Bass Section A separate horn employed as an indirect radiator with its two complementary Model 828HF driver units takes over for only the next 1½-octave range to 600 cps. Because no metal horn presently developed satisfactorily reproduces down to 200 cps, the horn load for the intermediate bass drivers is fabricated of wood and the A8419 phenolic tubes of the Mid-bass speakers.

Treble Section, The vital "presence" range—from 600 to 3,500 cps or the next 2½ octaves, the Electro-Voice Model T25A treble driver exhausts into a 600-cycle Model 6HD diffraction horn. This diffraction horn is another exclusive Electro-Voice design. The principles of optical diffraction are employed to disperse high frequencies far more uniformly than possible with conventional cellular type horns.

Very-High Section The range above 3,500 cps, extending beyond the range of hearing, is reproduced by the new Model T350 Super-Sonax very-high-frequency driver. Again the exclusive Electro-Voice diffraction horn is used. Through the Model T350, the remaining octaves of the upper audible register are completely accomplished with practically no measurable distortion.

Crossover Network To allocate the various portions of the spectral energy to the respective driver units, the Model X2635 crossover network divides the amplifier power into four separate portions, and eliminates upper harmonic and intermodulation distortion from one driver in the region covered by the next.

Completely Engineered for the Ultimate in Sound Reproduction!

Now you can own an acoustically correct Electro-Voice high-fidelity, folded-horn speaker enclosure for your home music system and save up to one half! Build it yourself . . . seven models to choose from . . . wall types . . . corner models . . . for full-range loudspeakers . . . for separate two, three and four-way systems. Everything is ready to assemble . . . all parts pre-cut, shaped and drilled. Simply follow the easy, step-by-step instructions included.

Model KD1 PATRICIAN IV Interior Assembly

For those desiring the utmost in reproduced music, the bass section design extends the lows and uses room walls as extensions of the exponential horn air load. Indirect radiation and employment of low crossover frequency allows exploitation of the sealed cavity feature, assuring more than one full octave of added bass with unprecedented efficiency, providing direct front radiation of higher frequencies and musical balance.

Size: 57⅛" high, 34½" wide, 26⅞" deep.
Shipping weight: 135 lbs. Net: $118.00

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See your Electro-Voice Distributor. For facts about high fidelity, write for Bulletin W81

Electro-Voice

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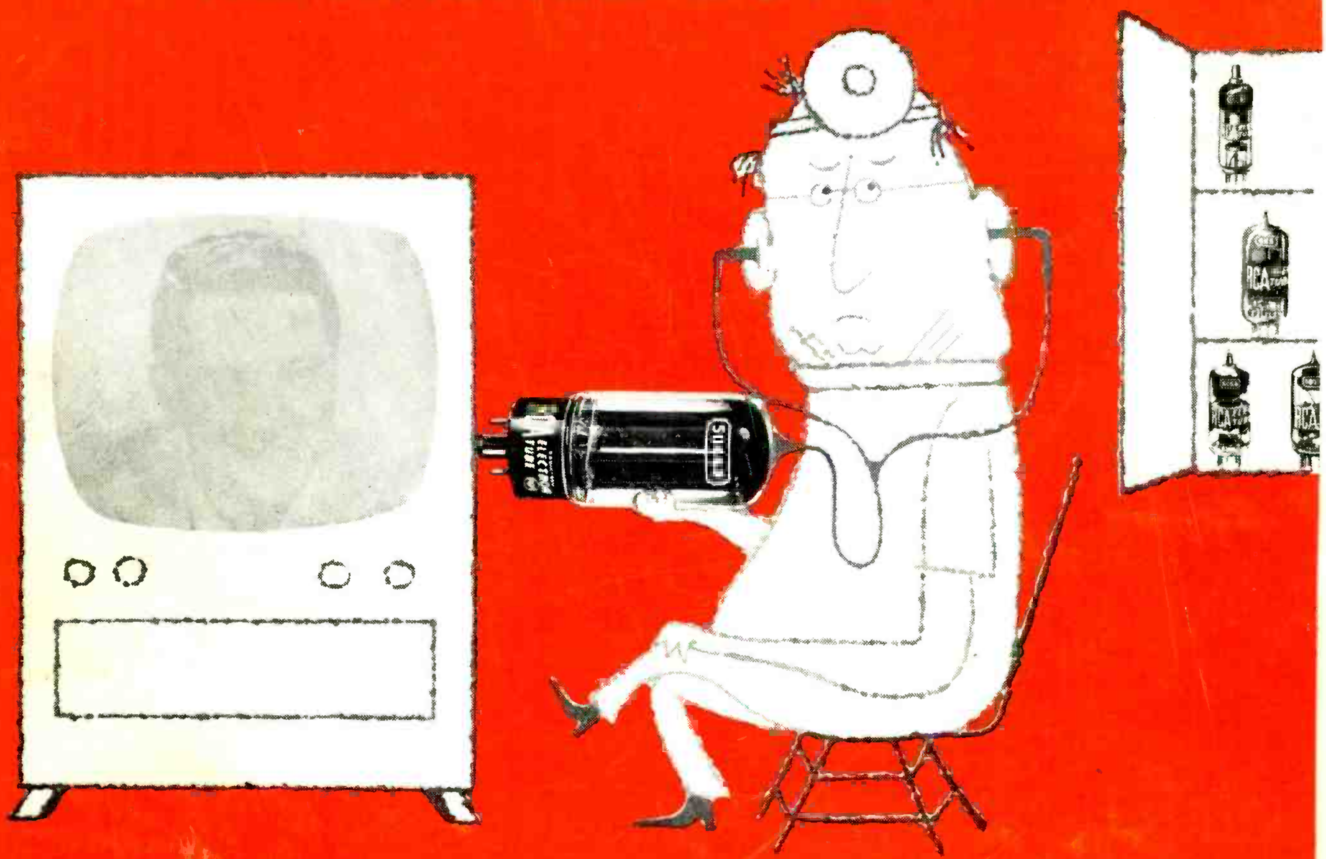
When the Diagnosis is "That WASHED-OUT Look"...



pep up the picture with

RCA TUBES

Light output is low, focus okay...but, oh, that "washed-out look"! You can fix it quick. Check the front end and video-if tubes, low- and high-voltage tubes. If new tubes are indicated, "pep up" the picture with the most dependable tubes for TV replacement—TOP QUALITY RCA TUBES.

Selected materials, advanced manufacturing processes, costly and painstaking inspection techniques, combine to give you maximum assurance of top-performance when you replace with RCA TUBES.

For the top-quality brand—always ask your tube distributor for RCA, of course!

RCA MICROSCOPIC INSPECTION OF POPULAR TV RECEIVING TYPES

Helps Reduce Costly Callbacks!

RCA Quality-Control Procedures include *microscopic inspection* of *popular TV receiving types!* Specially trained inspectors help reduce costly callbacks in the field. You gain the valuable assurance from this *extra* care that you can always service your customers with the confidence that RCA TV Receiving Types are *top quality* Replacement tubes.

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