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JULY 1957

Radio-Electronics

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•

FM Tuner is Easy To Build and Align

•

New Unijunction Transistor-Diode

•

Build a Preamp For Tape and Mike

•

Polarizing The Diode

(See page 4)

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JULY, 1957

Radio-Electronics

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EDITORIAL

AUDIO—HIGH FIDELITY

TEST INSTRUMENTS

RADIO

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TELEVISION

ELECTRONICS

ON THE COVER

Winsome operator at the Hughes Aircraft semiconductor plant in Los Angeles checks germanium diodes with special instrument which indicates visually and audibly whether the diode's polarity coding is correct.

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News Briefs

OPERATION SMOKE-PUFF, the first in a series of attempts to establish two-way radio communications by bouncing signals off man-made clouds of ionized gas, will get under way some time this month. The project will be conducted by the United States Air Force and the nation's amateur radio operators. Rockets will be fired 70 miles into the ionosphere to release nitric oxide gas in an attempt to create an artificial reflecting layer.

Amateur frequencies used in the test are between 14 and 148 mc. Tests are planned for morning twilight, noon, evening twilight and possibly at night. Due to the Earth's curvature, the chance of signal bounce is limited within a circle of roughly 700 miles radius around Alamogordo, N. M.

In March, 1956, an Aerobee rocket released a cloud of gas which was detected by radar. However, to check the possibility that the radar reflection was a coincidence, the assistance of amateur operators is requested to confirm the existence of artificial clouds.

SUNSPOT STUDY repudiates the popular belief that all sunspots are bad. Results of a 10-year study of solar radio disturbances reported by John H. Nelson of RCA Communications Inc. "prove that transmitting conditions on international radio circuits actually get better as the number of sunspots increases. This leads to only one conclusion," Mr. Nelson continued, "as far as we are concerned—we like sunspots."

Mr. Nelson, RCA's propagation analyst or "radio-weather" man, has been studying the sun from a skyscraper observatory in downtown Manhattan since 1946.

One part of his report stated, "There is, of course, such a thing as a bad sunspot but, fortunately for international radio communications, there is an oversupply of good sunspots—more than enough to counteract the effects of the occasional bad ones."

As an example of how this theory works, Mr. Nelson cited an incident that occurred in February, 1956. From a low point of 40, the sunspot count climbed to 270 in 8 days. Despite this situation, signaling conditions on *all* of RCA's radio circuits actually improved—positive evidence that even a radical increase in sunspot activity doesn't necessarily bring on a period of bad radio weather.

A SILICON CARBIDE rectifier has been operated at temperatures from −100° to +1,200°F, the General Electric Research Laboratory announced. Similar devices made with other semiconductor materials, notably silicon, have been able to operate only up to the 400–500°F range.

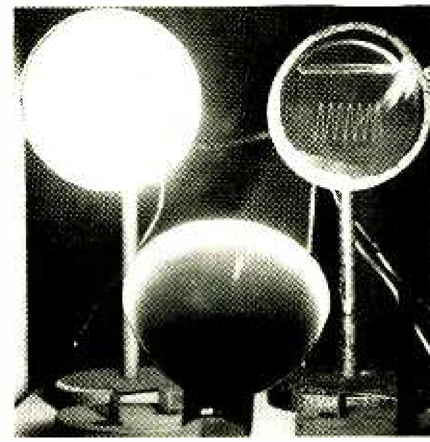
Dr. Guy Suits, G-E vice president and director of research, said, "Most of the semiconductor devices now on the market have been made from single-element materials—principally germanium and silicon—but future progress appears to depend on learning more about compounds. A major problem in all semiconductor research, that of achieving extremely pure materials, becomes increasingly difficult when more than one element is involved."

It was emphasized that the silicon carbide rectifier is still in laboratory development.

TRANSPARENT PHOSPHORS have been applied to C-R tube screens by a method developed by Dr. Charles Feldman, a Naval Research Laboratory physicist. While probably too expensive for immediate use in TV picture tubes, the method promises much for the future of both monochrome and color television.

To place a phosphor coating on a sheet of glass, using Feldman's method, the phosphor is first allowed to evaporate in a vacuum. It decomposes and is condensed on the heated glass surface. Then it is fired in a suitable atmosphere and baked. This process forms a phosphor with excellent crystal structure, required for good luminescence.

The Feldman tube retains contrast even with a photoflood lamp held close to its face. This is possible because the



Light washes out standard TV tube (left).

light from the floodlamp passes through the transparent phosphor and is absorbed by the blackened interior of the tube, instead of being reflected by the phosphor, as in present tubes.

For color TV, three layers of different phosphor compounds would be laminated on one glass surface. Color would be selected by varying the deflection voltage. Although this has been proposed before, it was not possible without transparent phosphors.

TOLL TELEVISION could draw a "gilded curtain" over TV screens across the country, warned Donald N. Martin, assistant to the president of The National Association of Radio and Television Broadcasters (NARTB) in an address to the Vermont Federation of Women's Clubs.

He feels that one of the major threats posed by toll television is the fact that ability to pay will become the factor determining who sees what. In areas served by only one station, toll TV would mean a total blackout for those who could not afford decoding fees.

Even though the FCC has been considering the question for some time, Martin believes that such a revolutionary proposition should be decided by Congress.

Calendar of Events

Britsh IRE Convention, June 27–July 1, University of Cambridge, England.

Annual Electronics Clinic and Fair, Aug. 2–4, Texas Hotel, Fort Worth, Tex.

NATESA Convention, Aug. 16–18, Chicago Sheraton Hotel, Chicago, Ill.

West Coast Electronic Show and Convention (WESCON), Aug. 20–23, Cow Palace, San Francisco, Calif.

12th General Assembly of International Scientific Radio Union, Aug. 22–September 5, National Bureau of Standards, Boulder, Colo.

American Institute of Electrical Engineers Pacific General Meeting, Aug. 28–30, Pasco, Wash.

National Radio & Television Exhibition Aug. 28–Sept. 7, Earls Court, London, England.

SPOT WOBBLE, a technique for moving the electron beam in a picture tube up and down about 15 million times a second, eliminates those familiar black scanning lines.

Research has shown that the viewer moves back from the screen until he

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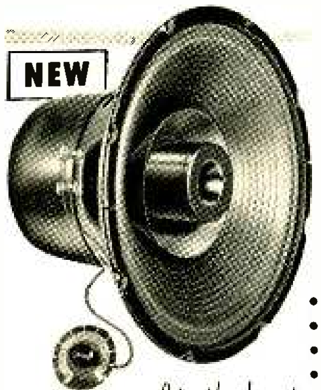

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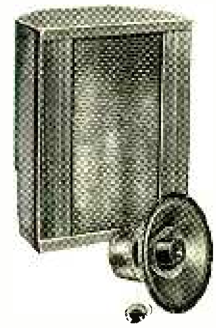

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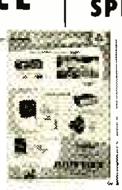

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Photos show value of spot wobble. Top, a normal TV picture. Bottom, same picture with spot-wobble system.

just fails to distinguish these lines. If they are reduced or eliminated, television pictures of a larger size can be viewed with comfort at shorter distances.

Using the new technique, developed by Dr. E. Atti and J. A. Hall for Westinghouse, one of the picture tube's focusing grids is split in half. The split grid still serves its normal function of concentrating the beam on the screen, but at the same time acts as a pair of deflecting plates, to which a fluctuating voltage is applied to wobble the beam up and down at a 15-mc rate. The voltage is supplied by a single tube fitted to the socket into which the TV picture tube is plugged.

Difficulties inherent in earlier spot-wobble systems (see RADIO-ELECTRONICS, September, 1953), used mostly in Britain, are avoided or greatly reduced. The British system, which used coils on the tube's neck, radiated interference which was detrimental to reception on some channels.

THREE NEW TV STATIONS have appeared since our last report:

WSOC-TV, Charlotte, N. C. 9
KHVH-TV, Honolulu 12
WLBR-TV, Lebanon, Pa. 15
(This station returns to the air after having been absent since October 16, 1954.)

Two Western stations have changed their call letters:

KOLD-TV, Tucson, Ariz. 13
(formerly KOPO-TV
KELP-TV, El Paso, Tex. 13
(formerly KILT)

Three stations have closed down:

WCMB-TV, Harrisburg, Pa. 27
WGBS-TV, Miami, Fla. 23
KPTV, Portland, Ore. 27

These changes bring our total of operating U. S. stations up to 499 (407 vhf and 92 uhf). Of these, 25 are non-commercial (6 uhf).

Canada inaugurated its 39th station with:

CFCR, Kamloops, B. C. 4

END

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Fluxvalve-Unipoise pickup-arm

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Correspondence

TUBE TESTER

Dear Editor:

On page 123 of RADIO-ELECTRONICS, February, 1957, there was an item by Thomas Oda Miller on the model 534 Hickok tube tester. While it was offered in an excellent spirit, I would like to clarify two points.

A shorted 0.1-μf capacitor used on the short switch of the 534 will cause a neon glow in all short positions only when there is a tube in the socket.

Concerning the wiring of the lugs on the switches, I believe if Mr. Miller would examine them closely he would find that a very fine piece of wire has been wrapped around the lugs before soldering. This was done to prevent the lugs from separating during normal use of the switch.

The space which you have devoted is appreciated. This instrument is now obsolete, but there are still thousands of them in the field and in use today. I am sure your readers will appreciate the service notes you have given them on this tester.

C. E. LENKE
Hickok Electrical Instrument Co.
Cleveland, Ohio

LOUDSPEAKERS AND ACOUSTICS FUNDAMENTALS

Dear Editor:

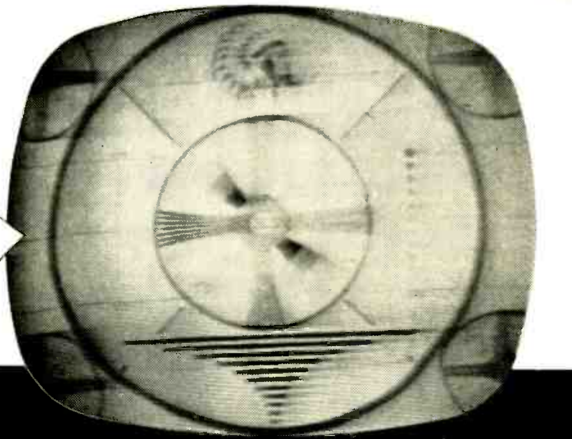
As the pioneer, and possibly the leading exponent, of smallish cone speakers for the best quality reproduction, I have a feeling that Mr. Paul Klipsch's letter on the above subject in RADIO-ELECTRONICS (May, 1957) may be directed against me on account of my contributions to the technical press during the past year. The question is, is what was written true?

Mr. Klipsch has made some notable contributions to audio knowledge in the past and it is a pity that he has abandoned the scientific attitude and become dogmatic and inaccurate. He states, on no quoted authority, that "an excursion of .06 inch . . . is regarded as about the maximum limit for tolerable distortion." In the same issue on page 45, Mr. A. L. George says, "In some high-fidelity speakers such as the Hartley, cone excursions on the order of ¼ inch are handled almost disdainfully by the powerful magnet structure."

Mr. George correctly points out that a wide-range speaker requires a large magnet to provide the extended field needed by a voice coil having a large excursion and in point of fact my speakers have, for 30 years, had to pass

how long would it take you to solve this service problem?

SYMPTOM: Smeared Picture (showing black streaks trailing from blacks)



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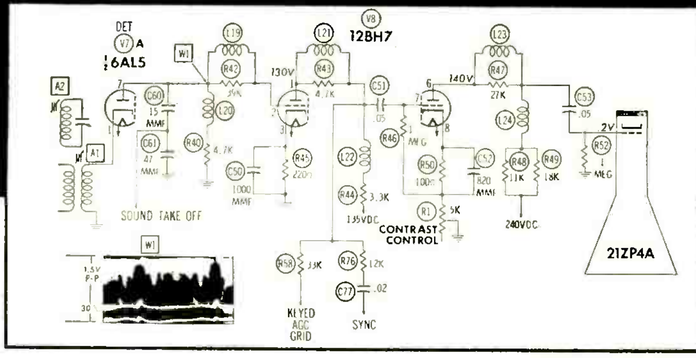

(Based on an actual case history taken from the Howard W. Sams book "TV Servicing Guide")

Let's take a look at this problem: A smeared picture such as illustrated above is caused by excessive low-frequency response coupled with poor high-frequency response. Look for the following possible causes:

1. Defective video amplifier, video output, or Picture tube
2. Low value of coupling capacitor C51 or C53
3. Low value of grid resistor R46 or R52
4. Open cathode bypass capacitor C50 or C52
5. Open series-peaking coil L23 or L21
6. High value of plate resistor R44, R48 or R49

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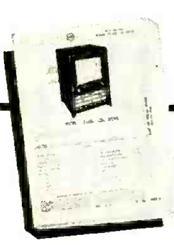

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City ____________ Zone ______ State ______ a test of ½-*inch total excursion* without cross-modulation. On the other hand I believe I am right in saying that the speaker units used by Mr. Klipsch in his assemblies have the limited excursion to which he refers and must consequently have the distortion which he deplores.

It is obvious to any observer that most speakers do have tight suspension, simply to produce the maximum middle-range output for the minimum expenditure on magnet steel. But to cite this as a reason why smaller cone speakers cannot move more than .06 inch is simply ridiculous. Among the famous names in speaker design who knew how to design good speakers can be mentioned Rice, Kellogg, H. J. Round and Voigt, and they all used free suspension.

Equally absurd is the statement that "the undistorted output of a small cone at low frequencies would be too small to hear." This, of course, derives from his supposition that a cone cannot move more than .06 inch without distortion occurring. The lack of truth in this statement must be obvious to hundreds of thousands of discriminating listener-users of various types of speakers (including my own) who seem to be able to derive a great deal of enjoyment by listening to what I maintain is much less that an acoustic watt, but the real point at issue is the argument developed from the assumption that a 10-inch piston is capable of producing only .0072 watt at 60 cycles, to take one set of Massa figures. If we accept the Massa data (published in 1942), which I for one do not, having compiled quite different figures in my own research department over the period 1927–34, the Hartley 215, with a permissible amplitude of 0.375 inch, will produce .0072 × 6.25 = .045 acoustic watt at 60 cycles. Can this be heard?

I have recently completed a strictly controlled series of tests on an investigation into cone behavior. The efficiency of the 215 is certainly not more than 5%, and the mean ac input to the speaker during the tests was 1 watt, thus giving an acoustic power output of .05 watt. The "audience" was chosen from expert musicians or music lovers, and they had no difficulty whatever in hearing what was going on, whether the output was sine wave or music. The tests went below audible frequency, but several observers stated that response in the 30–40-cycle range was perfectly satisfactory. A pilot speaker with a 55-cycle bass resonance was used as a demonstration of frequency trippling when trying to reproduce frequencies below the bass resonance.

I believe that an acoustic watt in an ordinary livingroom would be unbearably loud. His citation of Keller's proposal to use 54 8-inch cones indicates that the sound output is going to be very considerable indeed, but Mr. Klipsch's implied argument can be destroyed if he will just convert the

(*Continued on page* 20)

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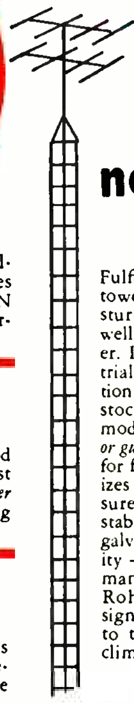

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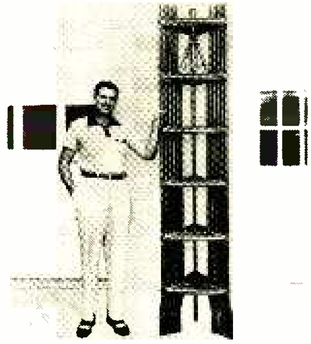

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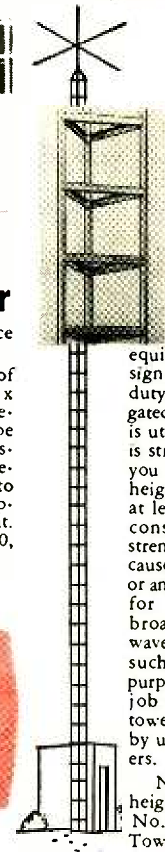

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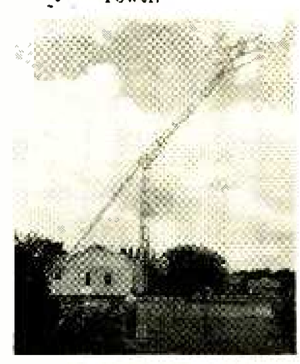

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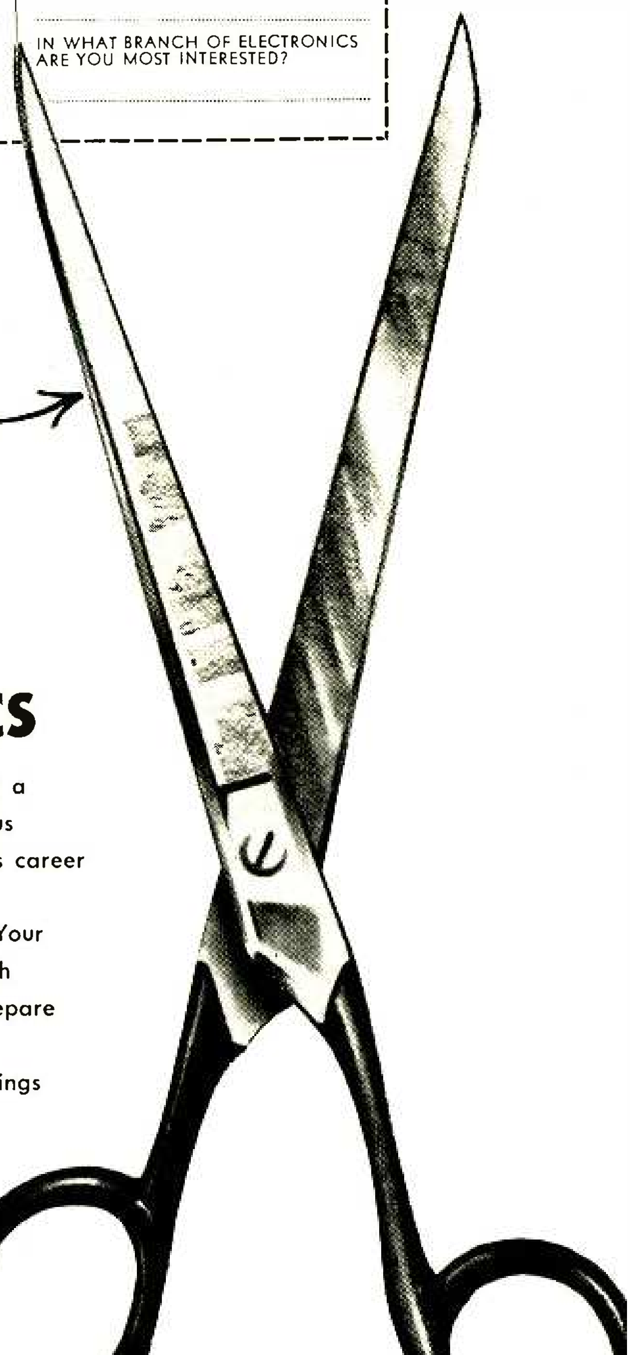

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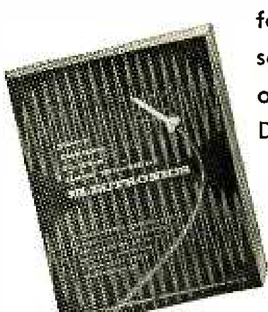

 (Continued from p. 16)

Massa figures into curves plotted on one sheet of paper, a curve for each cone diameter from 5–18 inches. He will find that, whereas the required amplitude for low frequencies drops rapidly in the 5–10-inch range, it then changes very little up to 15 inches and there is hardly anything to be gained at all by increasing the cone size to 18 inches.

To conclude, little speakers are not the only ones to have had big claims made about them but, leaving the Madison Avenue technique on one side, it is as true in speaker design as in other technical fields that knowledge of theory and practical experience in the laboratory and outside it are essential for proper design. I understand that Mr. Klipsch is best known for his work on enclosures, but the best enclosure in the world is not enough. The speaker that drives it must be good too, and free from all defects so far as our knowledge permits. H. A. HARTLEY
London W. 6, England

LUMISTRON PROBLEMS

Dear Editor:

This letter is in reference to an article by Mahommed Ulysses Fips, IRE, on the Lumistron which was featured in the April Issue of RADIO-ELECTRONICS.

This article was misleading in stating that the average home experimenter could construct a Lumistron. Had I not had the facilities of the General Electric X-Ray Laboratories, construction of this unit would have been impossible.

The information in the article was clear enough in describing the receiver, but we had much difficulty with the transmitter. In fact, we revised the basic wiring before getting an operable unit.

We also found that very good color TV reception is possible if the lens is exposed to noon-day sun for 30 minutes. We believe this is due to the excessive radiation given off by the sun at that time; it seems to have a peculiar effect on the special metals in the glass.

Thanking you for publishing the basic requirements for a Lumistron,
PETER OLSEN
General Electric Co.
Milwaukee, Wis.

I'D LIKE TO SEE

Dear Editor:

In RADIO-ELECTRONICS of May, 1957, you ask for devices or circuits readers might care to see. Hence this request:

A circuit or device that might help me clean the air in my little bungalow. Something all-electronic.

I've noticed many little advertising novelties run by a pendulum and a small electromagnet. This brings to mind an electric clock run in the same manner. E. H. HANSEN
Metuchen, N. J.

(Commercial clocks using the above principle have been made.—*Editor*)
END

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Third, you get the backing of national advertising which sells your *bonded* service as the customers' best buy.

Fourth, you become a member of a national group of service dealers who can feature the national symbol of superior TV-radio service . . . the Raytheon Bonded Decal. *Yet you retain your own independence.*

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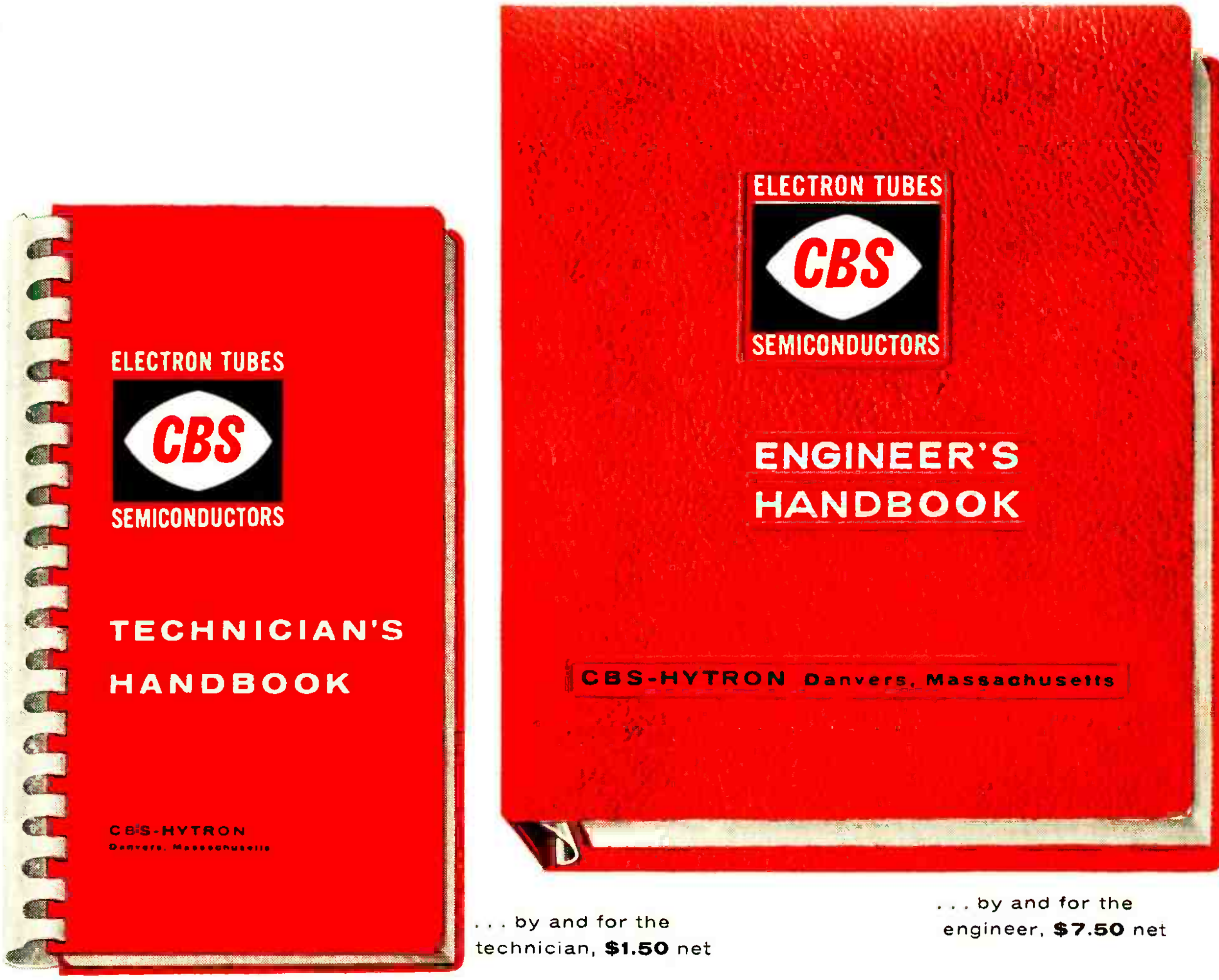

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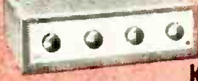

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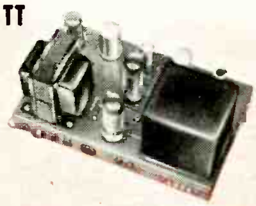
Compact, beautifully packaged & styled. Provides complete "front-end" facilities and true high fidelity performance. Direct tape head & magnetic phono inputs with NARTB (tape) & RIAA (phono) feedback equalizations. 6-tube circuit, dual triode for variable turnover bass & treble feedback-type tone controls. **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. **COMING SOON**

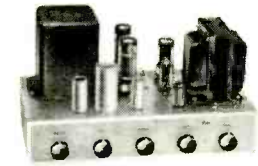
NEW! 50-WATT Ultra-Linear HIGH FIDELITY POWER AMPLIFIER



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.**

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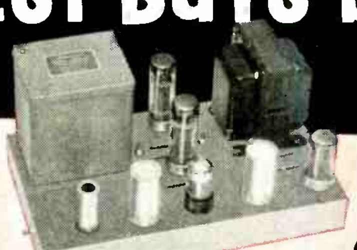
Will not add distortion or detract from the wide-band or transient response of the finest power amplifiers at any control settings. High quality feedback circuitry throughout plus the most complete control & switching facilities. Heavy-gauge solid brushed brass panel, concentric controls, one-piece brown 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: 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.** (½ 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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MEDICAL ELECTRONICS

. . . New Developments in Bio-electronics . . .

FEW branches of electronics are more rewarding than the comparatively recently opened field of biological, or medical, electronics. By "rewarding" we refer, not to pecuniary remuneration, but rather to the far greater rewards attendant on relieving intolerable human suffering, conquering disease and circumventing operative procedures.

The animal body is so constituted that direct access to its innermost sites is difficult, if not impossible in some of its parts. The most intricate machine can be opened up without destroying any of its components. Not so the animal or human machine. During a surgical operation, we must cut through living tissue, muscles, nerves or bones. True, these usually will heal well after a lapse of time, but they will never again be exactly the same. Scar tissue, adhesions, weakened muscles and structural defects remain.

Often, too, explorative operations are necessary because we still have not learned how to view our internal organs *directly*. Often such operations are in vain—the disease may have advanced too far. We have pointed out in the past that once *electronoptics* is achieved—the wedding of ultra-short millimeter waves with light waves—we will then have an instrumentality with which the physician or surgeon can view even the inside of your heart or the marrow in your bones. The medical man can then focus his vision directly on any nerve or blood vessel he selects. Yes, in time we will see these organs in full color, too—not in vague indistinct shadows as with present-day X-rays.

While a prodigious amount of medical research goes on all over the world, it is to be regretted that not a sufficient amount of electronic–biological research is pursued. The reason is that commercial electronic research pays far more. Medical research is usually by grant in various institutions and the monetary reward is often modest. Rarely does a medical research team have an electronic scientist on the staff and, when a particularly knotty problem arises, outside electronic specialists are invited to help solve the difficulty. Likely as not the electronic consultant is not interested in any monetary award—there may not be any. Often the consultant accepts the challenge from purely humanitarian considerations.

Thus, recently, when Dr. John T. Farrar of the Rockefeller Institute and the Veterans Hospital Administration, conceived the idea of a "radio pill" (RADIO-ELECTRONICS, June, 1957), Dr. Vladimir K. Zworykin of TV fame (who is also an honorary vice president of RCA) was consulted. He also happened to be an affiliate in biophysics in the Medical Electronics Center of the Rockefeller Institute. It fell to him to work out the electronic design and problems.

While the electrocardiograph has proved an important tool for the heart doctors, it still leaves much to be desired. The electrocardiograph, as is well known, records the heart impulse electrically. The pulsing heart generates its own current. This the electrocardiograph measures and records on a tape. Even the best modern instruments are difficult to attach to the patient, who must be firmly and positively connected with electrodes strapped to both legs and arms and the region over the heart. This is usually done with a messy conductive salt salve. Even then, the instrument occasionally gives faulty readings. It would seem that, by purely inducto–capacitive means, the sensitivity of the electrocardiograph could be vastly improved. Inasmuch as the heart is in reality an electrical generator, we can imagine two large helical inductances—one strapped to the chest, the other to the patient's back. By means of a special amplifier attached to these inductances, the output of the heart and any irregularities in its action will be recorded by the instrument. Admittedly, a good deal of research must be done before such an inductocardiograph will be perfected.

Heart microphones are becoming more and more refined. A recently perfected one is only about as thick as the lead in a pencil. Such microphones are of great value to the heart surgeon who must know *exactly* where the patient's heart is defective. The heart normally has a number of valves and chambers, any of which might be faulty. Prior to surgery, one must know just *where* and how extensive the defect is. This is done by exploring the heart by feeding a tiny microphone through a vein in the arm and thence directly into the heart. The patient lies over an X-ray tube while a technician watches on the fluoroscope screen the progress of the microphone as it goes into the various heart openings. Another technician listens to the heart noises, which give him the information needed. All the while the patient is conscious and there is little or no pain.

The *electrohysterograph* is another new device coming into use by gynecologists. It throws a great deal of light on the various phases of pregnancy. It was developed by Dr. S. D. Larks, biophysicist of the University of California Medical School. The recordings of the electrohysterograph, compared to those of the electrocardiograph and the electroencephalograph, give characteristic tracings of the electrical activity of the female uterus. To take a recording, electrodes of the device are merely taped on the skin over the uterus. Recently a complete *electrical* record of a birth of a baby from the onset of the labor to delivery was obtained. There also seem to be differences in the electrical patterns of the pregnant and nonpregnant uterus. The electrohysterograph thus may be a new tool to verify pregnancy.

The Electronic Baby was a fanciful essay authored by the writer in the *Digest of Digests* for Christmas, 1946. A mythical Dr. Gagnon first built an ectogenetic–electronic gestation apparatus. Then he extracted an ovum from his wife's ovaries. The egg under the microscope was then fertilized by the professor's own live spermatozöon.

The fertilized egg was now placed in a rubberized elastic bulb. Highly elastic, it could stretch from the size of a pear to a large melon. It was also transparent and the growing child could be watched day and night, so no accidents could occur. The bulb had two rubber hose connections to supply the mother's own blood plasma and dispose of waste fluids. Besides the blood, other necessary chemicals were fed the embryo so that the food supply was exactly like that of a mother during actual pregnancy.

After nine months, the birth itself was an anti-climax. The mother assisted the birth—after all, it was her own flesh and blood. But there was no labor, no birth pains, no illness, no hospitalization—just an electronic machine.

The writer naturally was dumbfounded when several months ago he learned that a New York physician, Dr. Emanuel M. Greenberg, was actually working on an artificial womb! While Greenberg's apparatus will not start with a fertilized egg, like the one described 11 years ago, it closely follows the writer's arrangement. As all obstetricians know, many mothers cannot carry their pregnancies to full term. There are premature births, many so early that they cannot survive even in incubators. Thus in the United States alone, thousands of children die annually.

It is to save these *prematures* that Dr. Greenberg is now working on an artificial womb, which closely parallels the writer's gestation apparatus. He will merely transplant the premature fetus into an elastic rubber container, similar to the one described, until the baby comes to term. —*H. G.*

applying variable damping

Various methods and their relative merits

By NORMAN H. CROWHURST

THE history of variable damping—like that of other innovations in the audio field—has been one of tremendous initial prestige, followed by disillusionment which has driven it into obscurity probably much further than it deserves.

Until I wrote about it before (RADIO-ELECTRONICS, November, 1955, "Variable Damping . . . How Good Is It?"), I thought the basic idea was pretty simple: variable damping just means varying the source resistance of the output amplifier. Correspondence and discussion since then seem to show that I had oversimplified it!

This basic idea can be explained briefly as follows: if an amplifier does not change its output voltage when a load is connected it has zero source resistance, which corresponds to "infinite" damping. (Damping is defined as the reciprocal of the ratio between source resistance and load impedance, and the reciprocal of zero is infinity.) Putting some resistance between this imaginary "zero-resistance" amplifier and the load would produce different damping factors. A resistance equal to the load would give a damping factor of unity (1).

At first infinite damping, or zero resistance, seems to be the limit. But then, quite some time ago, someone pointed out that even with zero resistance the voice coil resistance of the loudspeaker is still in the circuit and provides some damping. To eliminate this, the amplifier should have a *negative* source resistance to cancel out the effect of voice coil resistance. So a source resistance equal to the load (voice coil) resistance (called a damping factor of −1) has been called "ultimate damping."

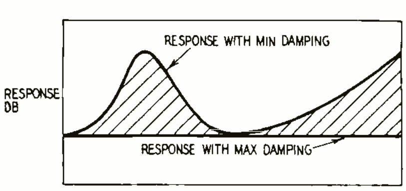


Fig. 1—Variation of amplifier response with adjustment of damping control.

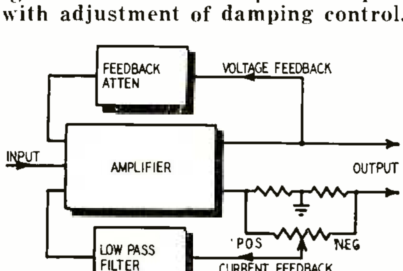


Fig. 2—Block diagram of a damping control used in Bogen amplifiers.

Different opinions

In my earlier article I pointed out that varying the source resistance will vary the frequency response of an amplifier (Fig. 1) because of the speaker's impedance. It has been argued by some that this change in frequency response is not inherently due to different damping. The argument appears to be that we want to hear the change made by damping on transient behavior alone. To isolate this effect the response should be maintained flat under all conditions of damping. This is what the designers of the Bogen amplifier attempted to do. Fig. 2 is a semi-block diagram of their damping circuit and Fig. 3 shows its main features.

The circuit varies the amplifier's behavior only at the low-frequency end because the variable current feedback is bypassed at higher frequencies by the 4-μf capacitor C1. So for the medium and high frequencies the voltage-connected feedback connecting to the top of the 2,200-ohm resistor R1 is the only one effective.

At low frequencies variable current feedback is applied to the bottom end of R1 because of the reactance of C1. Feedback can be varied from positive to negative by the 25-ohm potentiometer R2 connected across the dropping resistors R3 and R4 in the common lead of the voice coil output. With the slider all the way over to the R3 end, the current feedback is entirely positive. When the slider is all the way over to the other end, connected to R4, the current feedback is negative. With the slider in mid-position, there can be no current feedback as it is effectively at ground.

The dashed lines in Figs. 4 and 5 indicate the response of this circuit when operated into a resistance load. The solid lines indicate the amplifier response when operating into a speaker load.

When the current feedback is negative, the increased dynamic impedance of the speaker at its low-frequency resonance (Fig. 1) reduces the feedback and so offsets the reduction in gain over this range of frequencies.

When the current feedback turns over to positive so as to raise the gain at the low-frequency end, the dynamic impedance of the speaker at resonance reduces the amount of current feedback and tends to hold gain nearer level.

When there is no current feedback, the source resistance of the amplifier is entirely determined by the voltage feedback. There is a slight rise in frequency response due to the dynamic impedance of the speaker at this point.

The solid-line curves of Fig. 4 show the variation in frequency response for one particular speaker's impedance characteristic. This one has a marked resonance. In good speakers the resonance should be well damped acoustically, in which case the effect will be much less marked and the range of responses will be closer to that of Fig. 5.

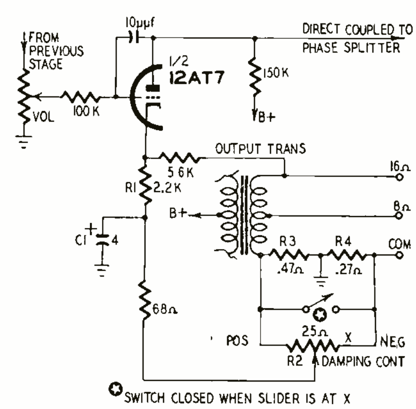


Fig. 3—Partial circuit of Bogen DB20DF, showing essential components of variable damping circuit.

We realize from an examination of the curves in Figs. 4 and 5 that this method does tend to offset the change in frequency response at the low end produced by the change in damping factor in conjunction with the speaker's impedance characteristic. In this way the change in performance will be more nearly that due to damping factor alone, isolated from the change in frequency response effect. However, this method has the disadvantage that its compensation for frequency response variation is fixed by the design of the amplifier and does not automatically adjust according to the impedance characteristic of the speaker.

Another disconcerting factor is that the maximum damping factor (if a point beyond infinity can be called maximum) produced by the maximum positive current feedback results in a considerable rise in gain below the dynamic resonance of the speaker while the opposite condition of minimum damping factor (negative current feedback) results in a rapid rolloff at this point. The former condition can result in excessive amplification of undesirable rumble frequencies and may even cause overloading because the amplifier cannot handle them adequately at this increased amplification.

If a high-quality turntable which does not give rise to any appreciable amount of rumble is used, this aspect of the problem will not be so serious.

Now, to turn to methods of applying variable damping that do not introduce frequency discrimination: any arrangement of this kind will introduce a variation in frequency response, measured as *voltage* across the speaker terminals, like that in Fig. 1.

Is constant power possible

As some manufacturers specify the performance of their variable-damping control in terms of *power* delivered to the speaker, we have to compare the two forms of reference to avoid confusion. In the condition for maximum damping, shown as a straight-line response in Fig. 1, the voltage across the speaker is constant, but as the impedance varies at different frequencies the speaker will not draw constant current. It will take less current where the impedance is higher. This means that the *power* response under maximum damping condition is the inversion of the speaker impedance characteristic shown in Fig. 6.

Going to a condition of minimum damping — where the source impedance is greater than the load impedance — the tendency is to deliver constant current to the speaker, which means that the voltage developed across it will be proportional to its impedance and hence the power curve is the same shape as the impedance curve shown in Fig. 6.

At some intermediate condition there should be a point where the amplifier will deliver *constant* power to the speaker. Some manufacturers make claims that imply this or that their particular circuit does actually achieve constant power drive. As any circuit really produces only an equivalent source resistance in the amplifier, let's briefly analyze what we can expect. Fig. 7 shows the equivalent circuit where R1 is the amplifier source resistance, R2 the resistance component of the speaker impedance and X, it's reactive component.

Assume that we have a speaker whose impedance characteristic is that shown in Fig. 8-a, varying between 16 and 40 ohms. We can use this to determine the power and volt-amp va characteristic delivered to the speaker by using a source resistance of 25 ohms, which is an approximate geometric mean between 16 and 40 ohms.

The speaker will receive equal power and equal va at its minimum and maximum impedances in the vicinity of low-frequency resonance because the impedance at the peak in the impedance characteristic is resistive and hence va and watts will be identical, as at the lowest extremity where the impedance is also resistive.

The 25-ohm speaker impedance is not resistive — only 16 ohms is resistive and the remainder (approximately 19 ohms) is reactive. So for calculating the va we multiply the current taken by the circuit by the voltage across both X and R2, while for calculating the watts delivered to the speaker we multiply the current by the voltage across R2 only. At the high-frequency end, impedance again reaches 40 ohms. This is also not a resistive impedance, but consists of a resistance of approximately 16 ohms with a reactance (at a different phase angle) of about 37 ohms. This means there will be a big discrepancy between the va and the power delivered to the speaker as represented in the curves in Fig. 8-b.

These curves represent the nearest approximation to constant power — or for constant va — that can be delivered to a speaker with this impedance characteristic. Any different value of source resistance will result in even more variation of both va and watts with frequency. From this it is obvious that no circuit can *automatically* provide a speaker with constant power at different frequencies as the impedance varies but, by judicious adjustment of the control, it may be possible to achieve an approach as close as that seen in Fig. 8-b.

Do not assume that this is the optimum condition. It would be such only if the working efficiency of the speaker were uniform at all frequencies. The condition represented in Fig. 8 corresponds with a damping factor of about 0.6, which is much lower than is generally considered optimum. Also the speaker is considered to have the same efficiency at its dynamic resonance where it has a resistive impedance of 40 ohms as it has at a frequency when its impedance is little more than the voice coil resistance.

Most speakers have a considerably improved *power-conversion* efficiency at their dynamic resonance in comparison with that in the region of 400 cycles. This is another way of saying that the damping factor for a speaker with this kind of impedance characteristic will probably be more than 0.6.

Constant-feedback types

Now we will consider ways of applying the damping factor without providing frequency response compensation in the manner of the Bogen circuit. Several circuits have tried to produce true variable damping with a single control. This is possible.

In the Fisher Z-Matic circuit (Fig. 9) this method of control is achieved by placing a potentiometer between a point on a voltage divider across the

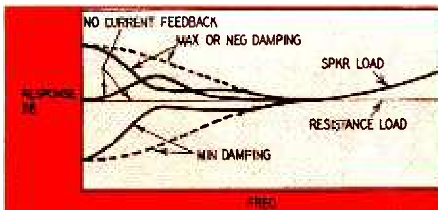


Fig. 4—Amplifier response using the frequency-selective method.

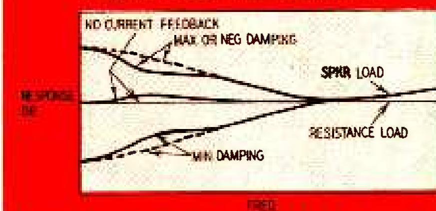


Fig. 5—Same as Fig. 4, using a speaker with a smaller impedance deviation.

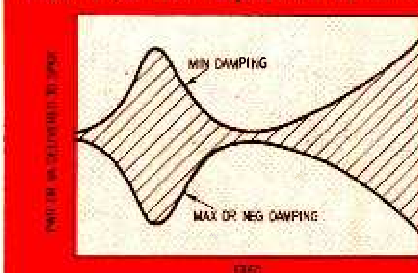
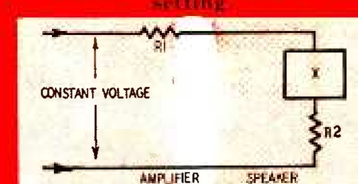


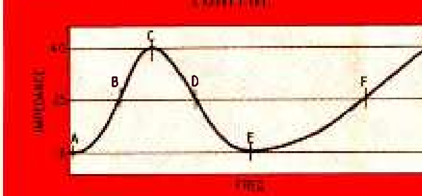
Fig. 6—Variation of speaker power with variation of the damping control setting.



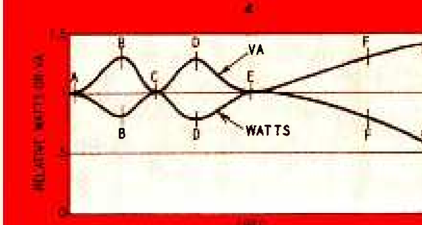
VALUES

FREQ (Fig. 8)	R2	X
A	16	0
B	16	$\sqrt{369} \cong 19$
C	40	0
D	16	$\sqrt{369} \cong 19$
E	16	0
F	16	$\sqrt{369} \cong 19$
G	16	$\sqrt{1344} \cong 37$

Fig. 7—Basic circuit for analysis of power and volt-amps delivered to a speaker with variation of the damping control.



a



b

Fig. 8-a—Impedance characteristic of a typical speaker; b—volt-amps and watts delivered to speaker.

output transformer secondary and the far end of a series resistor in the common lead. The voltage-divider point supplies negative voltage feedback and the series resistor provides current feedback. When the slider is at one end of the potentiometer, the feedback is entirely voltage—at the other end it becomes entirely current feedback.

In this kind of circuit, if the load impedance connected to the amplifier output is correct and resistance values have been correctly chosen, the amount of feedback applied at different points will be constant but the proportions will change from voltage to current according to the position of the slider. An important point to notice is that if the resistor in the common lead for current feedback is correct for one output tapping, it will not be right for the others. In some practical circuits a compromise value is chosen, but the Fisher Z-Matic switches the resistance value when the tap is changed.

Another circuit that does this, but requires two potentiometers, is used in the Fairchild 275 amplifier. Here the controls (Fig. 10), instead of being associated with the output transformer, are at the other end of the feedback network in the cathode circuit of the input stage. To arrange for uniform high-frequency compensation to stabilize the amplifier under all conditions, the voltage feedback employs a 30-$\mu\mu$f capacitor (C1) in shunt with a 47,000-

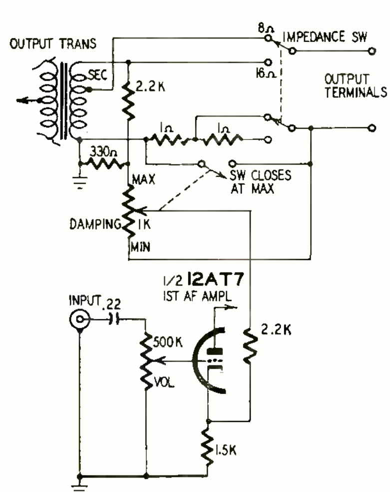


Fig. 9—Fisher Z-Matic circuit applied to model 70-A amplifier.

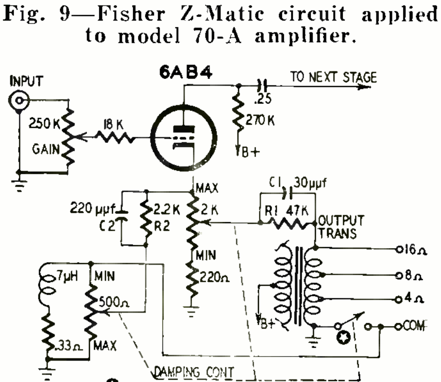


Fig. 10—Partial circuit of Fairchild model 275, showing feedback network with variable damping incorporated.

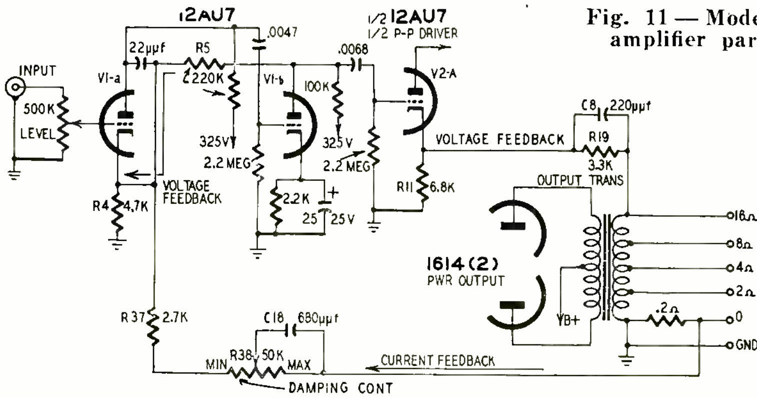


Fig. 11 — Model 232B Scott amplifier partial circuit.

ohm resistor (R1) while the current feedback uses a combined resistance and inductance in addition to the 220-$\mu\mu$f capacitor (C2) shunting the 2,200-ohm resistor (R2). The resistance-inductance combination is actually achieved by winding an air-core inductance with resistance wire.

The Electro-Voice circuit, published in RADIO-ELECTRONICS, March, 1955 ("Variable Damping in Audio Amplifiers," by Robert F. Scott), employs another variant of this arrangement. The Scott 265A amplifier also shown in that issue uses a dual control, the voltage feedback being fed into one side of the phase inverter while the current feedback goes to the cathode of the input stage.

A more recent introduction to the Scott line, the 232B shown in Fig. 11, provides a successful method of variable damping control using only one potentiometer. However, the position of the resistance in the circuit is such that it serves a double function. Its more obvious function is to vary the current feedback from the resistor in series with the output. At the same time, it varies the negative voltage feedback from the plate of the second stage V1-b to the cathode of the first stage V1-a, because the cathode resistance consists of a 4,700-ohm resistor (R4) in parallel with a 2,700-ohm resistor (R37) and the variable 50,000-ohm resistor (R38) in series plus—what is negligible to the cathode circuit—the 0.2-ohm resistor in series with the output.

When R38 is at its zero end, current feedback will be maximum; at the same time voltage feedback from the plate of V1-b to the cathode of V1-a will be minimum because R4 will be shunted down with R37. When R38 is at maximum, the current feedback will be reduced to a minimum and the voltage feedback will be increased to a maximum because R4 will be virtually unshunted.

Beyond-the-infinite damping

Each of the circuits that vary both voltage and current feedback use only *negative* feedback under all circumstances and produce damping factors that are always in the positive region. Some seem to think, following reasoning similar to that of Bogen, that we should carry the damping factor through infinity and some distance into the negative region. They also feel that they would like to keep the circuit as simple as possible and avoid ganged controls. To do this, they vary only the current feedback from positive to negative.

There are two ways to do that. Voltage feedback is invariably provided as well to produce an initially low damping factor as a starting point. Sometimes the voltage feedback is provided over a longer loop than the current feedback, while at other times the current feedback utilizes the longer loop. In each case the voltage feedback tends to stabilize the gain, but the proportion of voltage and current feedback changes with the position of the control so as to vary the source impedance or damping factor. Apart from possible stability problems when a speaker is connected, the fact that the overall amount of feedback changes without changing other circuit constants means that *the frequency response of the amplifier must change* as well, even with a resistance load.

It is somewhat difficult to predict how this change will occur when the voltage feedback is over the longer loop but, if the current feedback is over the longer loop, the predicted kind of response variation — working into a resistance load — is shown in Fig. 12 for a typical case. By careful design, the frequency at which the change in response occurs may be pushed beyond audible limits, but this does not alter the fact that it occurs — it merely minimizes its audible effect and it can still cause drastic effects upon transients, not connected with the effect of the damping on the loudspeaker.

For the reasons last mentioned, I would prefer any of the circuits shown which *do* vary *voltage and current feedback at the same time* to keep approximately *constant total amount of negative feedback*, particularly those of Figs. 9, 10, 11 and the varieties shown in the March, 1955, issue. END

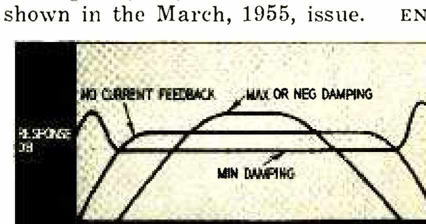
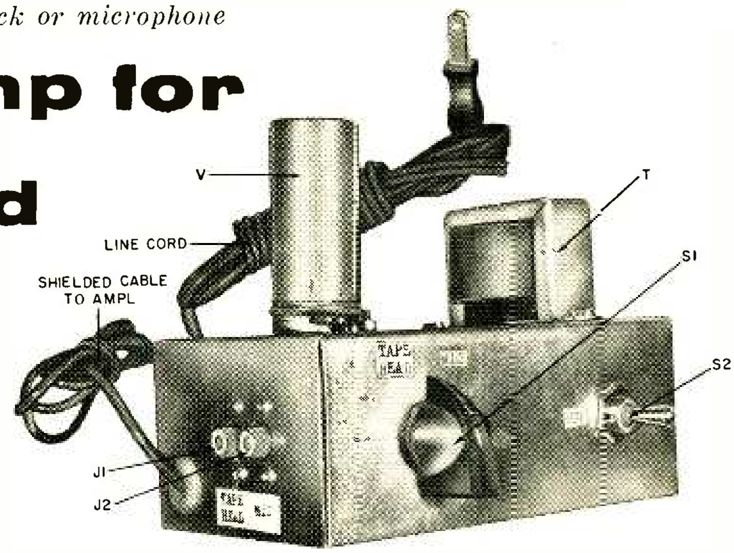


Fig. 12—Variation in overall response as the current feedback is varied.

Use your amplifier with a tape deck or microphone

Simple preamp for TAPE and MIKE



Preamp with self-contained power supply.

By MANNIE HOROWITZ *

HIGH-FIDELITY amplifiers seldom provide for using microphones. Many owners feel that a mike input will not only permit them to put the amplifier to PA use but would make their hi-fi equipment more versatile when recording.

Playback direct from a tape head is not possible with regular amplifiers. The tape-head output must be fed through a properly equalized preamp which is in turn fed to a high-level input of the main amplifier.

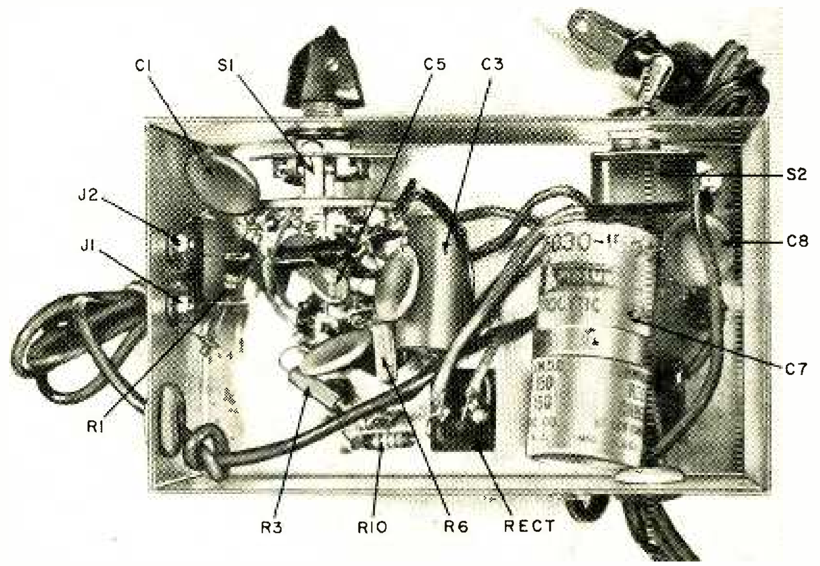
Many people connect the microphone or tape head into phono inputs. Due to the phono equalization, the microphone sounds too bassy or muffled and the tape is improperly reproduced.

This preamp provides properly compensated inputs for both tape head and microphone. The desired input as well as the proper response curve (Fig. 1) is chosen by the four-pole double-throw switch. Two poles on the switch provide equalization, a third selects the input and the fourth shorts the remaining input to ground to avoid cross-talk between channels. Output from this unit is fed to a tape or auxiliary input on the combined amplifier or preamp.

The circuit (Fig. 2) is of the feedback compensation type similar to the one I have used in the phono stage of the Eico HF-20 amplifier and HF-61 preamp. The feedback is from the second plate through the compensating network to the cathode in the first half of the 12AX7. The low output impedance (4,500 ohms) due to feedback makes a cathode-follower output unnecessary. The output cable was kept short and made from low-capacitance shielded wire (less than 80 μμf per foot) to limit any loss of highs.

The unit pictured was built on a home-made chassis 5 x 3 x 2 inches. This limits the size of the components and adds to the difficulty of wiring. I recommend that a standard chassis 6 x 4 x 2 inches, with a bottom plate, be used. This may be made from No. 20 plated steel or aluminum.

* Project engineer, Electronic Instruments Corp. (EICO), Brooklyn, N. Y.



Underchassis parts layout. Everything but tube and transformer goes here.

Construction aids

All parts except the selector switch are mounted in the chassis. When the tube socket is mounted, let pins 1 and 9 face the rear. The power transformer is mounted so the heater and high-voltage leads are toward the center. One single-lug tie point is placed under one mounting screw of the power transformer and the other under one of the mounting screws of the tube socket. Both these lugs are under the component mounting screws that are toward the rear of the chassis. The remaining transformer screw and tube socket mounts get a ground lug each.

The wiring is best done in sections. The power transformer primary, .02-μf line bypass capacitor and an on–off switch are wired according to the schematic. The .02-μf capacitor is soldered to the ground lug at the transformer while the line cord and one side of the primary use the tie lug at the transformer as a junction point.

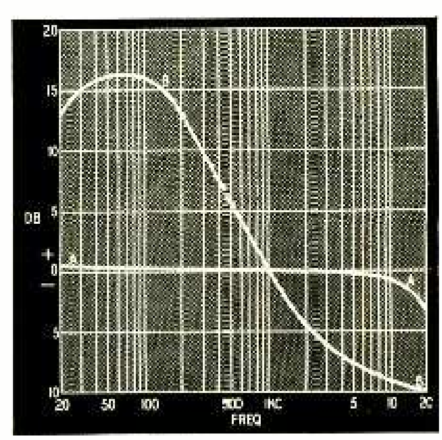


Fig. 1—Response curves of preamp; a—microphone; b—tape head.

The secondary leads of the transformer, the electrolytic capacitor and the vacuum-tube socket are then wired. All ground connections are made to the

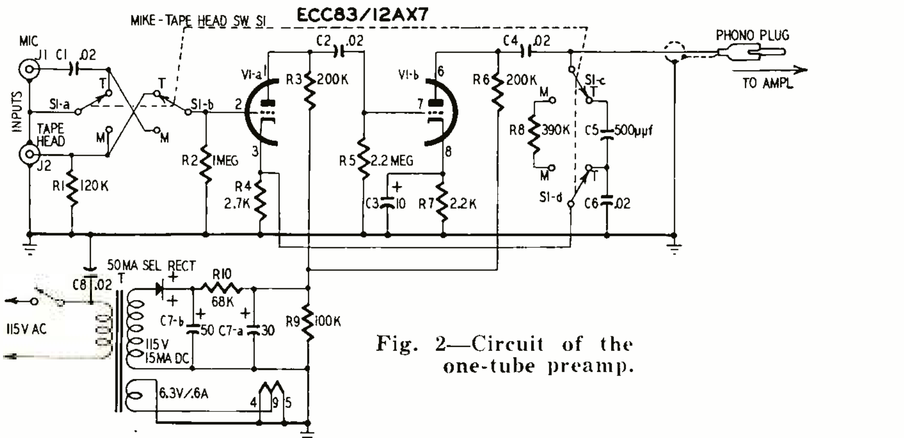


Fig. 2—Circuit of the one-tube preamp.

R1—120,000 ohms
R2—1 megohm
R3, 6—200,000 ohms, carbon deposited
R4—2,700 ohms
R5—2.2 megohms
R7—2,200 ohms
R8—390,000 ohms
R9—100,000 ohms
R10—68,000 ohms
All resistors ½ watt 10% unless indicated otherwise
C1, 2, 4, 6, 8—.02 μf, disc ceramic
C3—10 μf, 6 volts, electrolytic
C5—500 μμf, disc ceramic, 10%
C7—30-50 μf, 150 volts, electrolytic
J1, 2—phono jacks
S1—4-pole double-throw (Centralab PA-1010)
T—Power transformer, primary 115 volts, secondary 115 volts, 15 ma dc; 6.3 volts, 0.6 ma (Triad R54X)
V—ECC83/12AX7
Rectifier—selenium, 50 ma (Sarkes Tarzian model 50)
Chassis—6 x 4 x 2 inches, with bottom plate
Socket—9-pin miniature, shielded, with tube shield
Tie lugs—1 terminal (2)
Switch, spst toggle
Phono plug
Line cord with plug
Miscellaneous hardware

ground lug at the tube socket. The tie lug is used as a B-plus junction point for the 200,000-ohm plate resistors. The 4-inch leads are left hanging free from pins 2 and 3 on the socket. One end of a .02-μf capacitor is left free while the other end is connected to pin 6. These leads and the capacitor are to be connected to the selector switch and are not cut to their final lengths until the switch has been mounted. Do not forget to connect heater pins 4 and 5 to ground at the socket, as well as any shielding mounted on the socket.

The selector switch is very similar to the Centralab type PA-1010. Since that switch is available at the parts jobber's, a drawing (rear view) for prewiring it is shown (see Fig. 3). The resistor and capacitor leads connecting to the switch are ½ inch long. The remaining lead of the components is not cut until the switch is mounted.

When the switch prewiring is completed, mount it with lugs 6 and 7 closest to the chassis. The two resistors from the switch are connected to ground at the input jacks. The tape rolloff capacitor (C6) is grounded at the tube socket. The tape jack is connected to the lead from lug 11 on the switch and the mike jack is connected to the capacitor prewired to the switch.

Connect the lead from pin 2 on the socket to lug 10 on the switch and the pin 3 lead to lug 1. Connect the remaining .02-μf capacitor to lug 4. The shielded lead from the output cable is covered with spaghetti and connected to a ground terminal at the socket while the center wire gets connected to lug 4 on the switch.

Run the output cable through the hole on the side of the chassis and solder a phono plug on the free end.

For a minimum of noise, be certain that all connections are solid and clean. Use your favorite contact cleaner to clean the socket and switch. It is best to use *carbon-deposited resistors*, especially in the plate circuits. The tube used in the experimental model was the Amperex low-noise, low-microphonic ECC83/12AX7.

Hum and noise measured better than 45 db below 0.5-volt output. Experimenting with more filtering, dc filaments and full-wave rectification may improve this. However, Audio League reports seem to indicate that noise levels of this magnitude are negligible.

It should also be noted that the microphone input had a tendency to oscillate when open. About 15 μμf across the input eliminated this. The capacitor was omitted from the circuit since connecting a microphone load automatically puts large capacitances across the input, making the unit completely stable. END

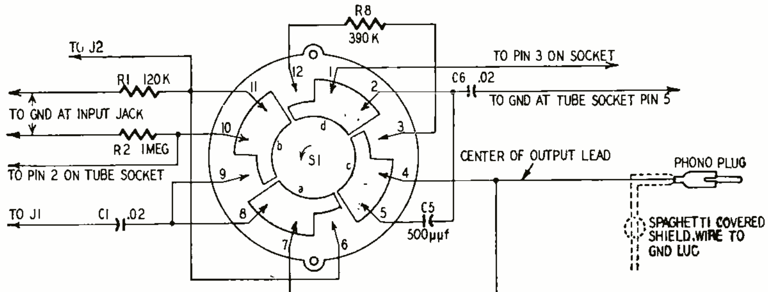


Fig. 3—Prewiring circuit of selector switch S1. Do this wiring before mounting switch.

ELECTRONIC VOICE FOR SILENT CHIEF

By ARTHUR S. GOODWIN

CHIEF Mazeppa, a wooden Indian who has not uttered so much as a grunt in 70 years, now possesses a voice — thanks to electronics.

Chief Mazeppa has stood guard at the door of Greenfield's Smoke Shop in St. Thomas, Ontario, Canada through long weary years. He has always been undaunted by the stares and comments of curious tourists, although it is quite possible he would have liked, on occasion, to talk back to a few.

Jack Greenfield, the present custodian of Chief Mazeppa, has fitted this stolid citizen with an intercommunication unit. The venerable redman can say hello to passersby and even strike up a conversation with startled strangers.

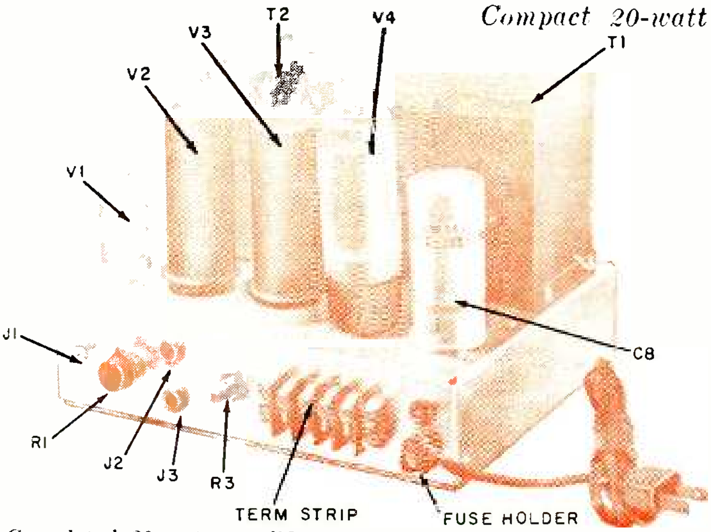
The dusky warrior, a representative of an almost extinct tribe, is rolled inside the shop at night as a precaution against kidnaping.

The first time that the noble chief tried out his voice was a bright Saturday morning. He chided a girl who was having her picture snapped with her arm draped rather lovingly about him.

It took the visitors several moments before they recovered from their surprise and found the source of the Indian's voice. Chief Mazeppa had made more new friends, and Mr. Greenfield was able to welcome them to the city.

The Chief has been silent for 70 years, but with the aid of a tiny loudspeaker tucked under his right arm, he is the only wooden Indian able to catch up with a lifetime of conversation. END

Compact 20-watt hi-fi amplifier is built on 9 x 7 x 2-inch chassis



Completed 20-watt amplifier.

High-Quality Audio Amplifier

By A. Y. C. TANG

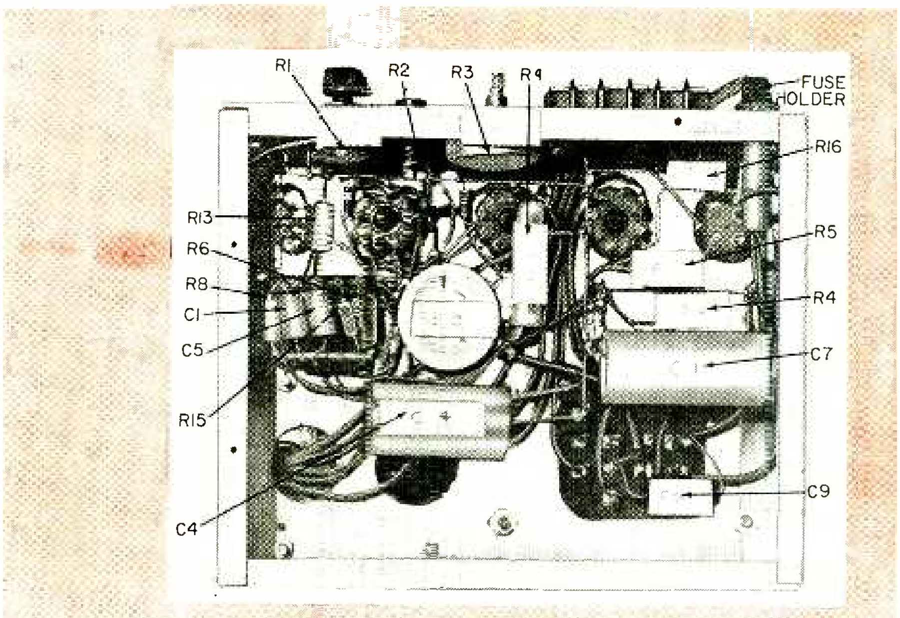
NUMEROUS basic audio amplifier circuits, usually employing complex theories to achieve higher fidelity, have been published. However, only people who have the expensive test equipment, time, patience, money and the ability to solve problems can afford to experiment with such circuits. Sometimes a slight change of electrical components could lead the experimenter into several weeks of misery.

Here we present a basic audio amplifier* which provides 20 watts of audio power with only 1.5% intermodulation distortion at rated output.

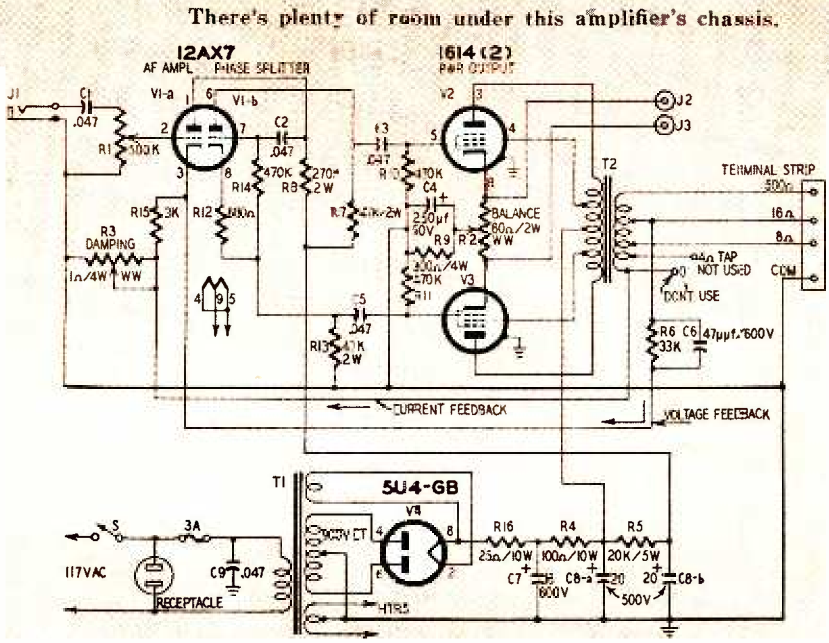
This amplifier can be built on a 9 x 7 x 2-inch chassis because of its simple circuitry. Layout of the components has been tested and proved to be good design.

Let us look at the electronic design (see diagram). Two 1614's are used in push-pull to obtain the required 20-watt output. With cost limitations in mind, a Stancor A-8072 output transformer was used in Ultra-Linear fashion. Overall response of 20–20,000 cycles

* AEI 30W developed by Audio Electronic Laboratories, Cambridge, Mass.



There's plenty of room under this amplifier's chassis.



Circuit of AEL 30W.

R1—pot, 500,000 ohms (Mallory SU-50)
R2—pot, 60 ohms, 2 watts, wirewound (Mallory M-60PK)
R3—pot, 1 ohm, 4 watts, wirewound (Mallory M-1PK)
R4—100 ohms, 10 watts
R5—20,000 ohms, 5 watts
R6—33,000 ohms, ½ watt
R7, 13—47,000 ohms, 2 watts
R8—270,000 ohms, 2 watts
R9—300 ohms, 4 watts
R10, 11, 14—470,000 ohms, ½ watt
R12—680 ohms, ½ watt
R15—3,000 ohms, ½ watt
R16—25 ohms, 10 watts
C1, 2, 3, 5, 9—.047 μf, 600 volts
C4—250 μf, 50 volts, electrolytic
C6—47 μμf, 600 volts
C7—16 μf, 600 volts, electrolytic
C8—20-20 μf, 500 volts, can type electrolytic
J1—phono jack
J2, 3—pin jacks
T1—power transformer, 900 volts ct, 125 ma; 5 volts, 3 amps; 6 volts 3 amps (Chicago PV-200)
T2—output transformer, primary, 9,000 or 10,000 ohms; secondary, 500, 16 and 8 ohms, with 6,000-ohm taps, used for secreen connection (Stancor A-8072; Merit A-3101, UTC CG-19 and UTC S-16)
V1—12AX7
V2, 3—1614
V4—5U4GB or GZ34
switch—spst
Chassis—7 x 9 x 2 inches
Fuse—3 amp (3AG)
Fuse holder—finger type
Miniature socket—9 pin (1) and shield
Octal sockets (3)
Terminal strips (3)—barrier type screw, 4 terminals (Jones No. 141); also Jones No. 2000 terminal strip No. 2005, Jones lug type terminal strip No. 52
Miscellaneous hardware

within 2 db is easily achieved. Further investigation showed that UTC-CG19, Merit A-3101, even UTC-S16 transformers, can be used satisfactorily in the circuit without changes.

The split-load or cathodyne phase inverter is quite linear due to its large amount of inverse feedback. Distortion is very low. The required gain comes from a single 12AX7 triode stage.

Overall negative feedback voltage is taken from the secondary of the output transformer and applied to the first triode stage. To compensate individual speakers we incorporated variable-current feedback which can be turned off if desired. Through a listening test one can determine what the optimum amount of current feedback should be.

The power supply is conventional, using an R-C filter circuit. The requirement is a power transformer capable of supplying 450 volts at 120 ma. A Chicago PV-200 is recommended. The rectifier is a 5U4-GB used for its slender shape and good heat dissipation construction. A current-limiting resistor saves the first electrolytic capacitor, which should be a high-quality unit.

The layout of the chassis has been carefully designed. Use a 7 x 9 x 2-inch chassis. (A larger chassis may be necessary due to variations in transformer size. Measure the transformers you obtain and determine the chassis size.—*Editor*) Drill all the holes in the side. Then proceed to drill holes for mounting capacitor and tube sockets, also for the terminal strips and the test jacks. Mount the power transformer beside the audio output transformer, then all other components.

Study the circuit again and get ready to solder. See photo for placement of resistors and capacitors. Layout of hookup wires is not critical. A common ground bus should start at the phono socket which contacts the chassis. If there are other ground points on the chassis, hum might be introduced from the ground loops.

Check the finished amplifier, making sure everything agrees with the circuit diagram. Make sure there are no visible shorts between wires or wire and chassis. Insert the fuse and connect the speaker to the proper impedance of the output transformer. Plug in the line cord and turn the unit on.

If the amplifier oscillates, unplug the line cord and check the schematic again. If no error is found, reverse the primary leads of the output transformer to the plates of the 1614's. Reverse the leads to the screen grids of the 1614's.

Before using the amplifier in a system, balance the pair of 1614 tubes. Use a dc voltmeter between the test sockets. Rotate potentiometer R2 until there is no voltage difference between these points.

With the amplifier in an audio system, tune in a program and adjust current feedback control for best listening.

There should be no problem of overheating. The operating temperature of the chassis should be around 130°F.

END

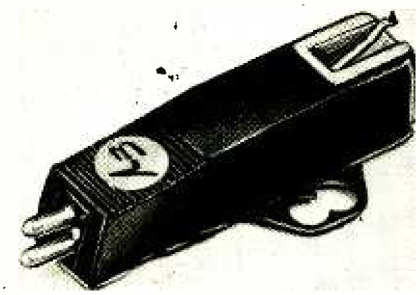
modern phonograph cartridges

Amplitude-responding cartridges

Part IV

By JULIAN D. HIRSCH

Above—Sonotone series 3 cartridge. Below—Electro-Voice model 84.



In the preceding articles we described a number of magnetic cartridges. Despite their constructional differences, the operating principle of all these units is the same. They deliver an output voltage proportional to the velocity of stylus motion imparted by the record groove.

In this concluding article, we describe a few *amplitude-responding* types. The output of these cartridges depends only on the amplitude of stylus displacement.

An examination of the RIAA recording characteristic (see Fig. 1) shows the reason for one of the major advantages of amplitude-responding pickups. The solid line in Fig. 1 shows the actual recorded velocity of the record when RIAA equalization is used. The dashed line shows the response of the playback equalizer required to deliver a flat output from such a record with a true velocity-responding pickup.

Fig. 2 shows the recorded amplitude of the same RIAA record. Below approximately 500 cycles these records are, roughly speaking, recorded with constant amplitude. Between 500 and 2,500 cycles a constant-velocity characteristic is used and above 2,500 cycles a pre-emphasis in recording converts the response to constant amplitude.

A perfect amplitude-responding pickup would give a reasonably flat output from such a recording. With a slight modification of the mid-frequency response (usually accomplished in the mechanical design of the cartridge) the better constant-amplitude cartridges deliver an output flat within ±2 or 3 db over the entire recorded range when playing an RIAA equalized recording.

Most amplitude-responding cartridges are the piezoelectric type. These make use of the fact that, when a crystal of Rochelle salt or a small piece of barium titanate ceramic which has been properly treated is bent or twisted, a potential is developed between its opposing surfaces. Although Rochelle salt crystals have been used for many years in low-cost phono cartridges, they are subject to deterioration from heat and humidity. Ceramic cartridges, on the other hand, are virtually indestructible in normal use and practically all the better amplitude-responding cartridges have ceramic elements.

Sonotone series 3 ceramic cartridge

The Sonotone series 3 cartridge (see photo) is the latest and finest of ceramics developed by the Sonotone Corp. Fig. 3 is a sketch of its internal construction. The ceramic element is approximately ½ x 1/16 x 1/64 inch. One end is clamped between rubber blocks which serve as damping elements and hold the electrical contacts against

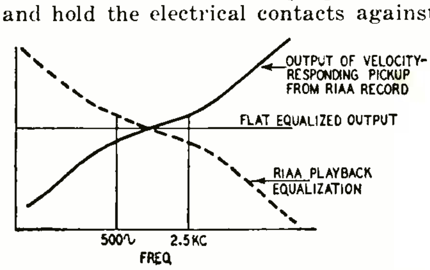
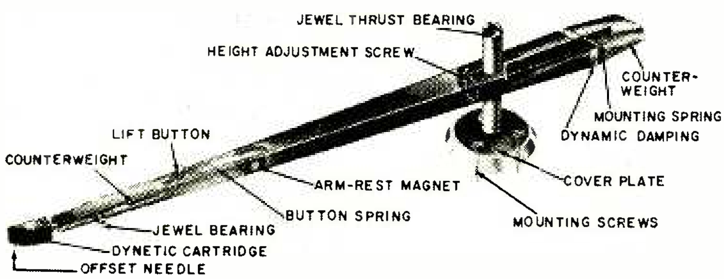
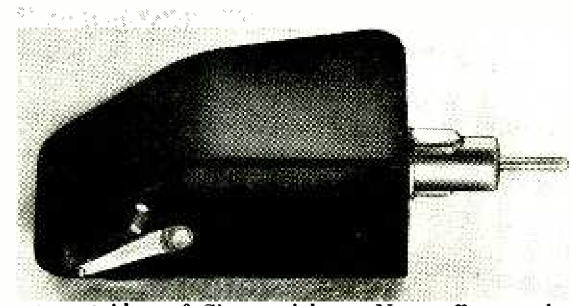


Fig. 1—RIAA recording characteristic and complementary playback equalization curve.



Above—Shure Studio Dynetic pickup.



Right—Moving-magnet cartridge of Shure pickup. Note offset stylus.

the silver-coated surface of the ceramic. Near the element's other end another rubberlike damping block positions the element and provides some damping and vertical compliance. At one end of the element a short, stiff metal strut is firmly fastened. At the other end of this strut is a forklike depression. Up to this point the series 3 cartridge is very similar to Sonotone's lower-priced series 2 and generally quite similar to most other low-cost ceramic cartridges. Two unique features of the series 3 are the damping vane and the special hollow stylus arm.

As seen in Fig. 3, the damping vane is attached to the lever arm which bends the end of the ceramic element. The region surrounding this vane is filled with a special damping grease. The grease offers resistance to any rapid motion of the vane and thus damps mechanical resonances in the moving system of the cartridge.

Earlier Sonotone ceramic cartridges used a stylus mounting generally similar to the one in series 3 cartridges. The stylus jewel is located at the end of a metal arm, the other end of which is fastened to a damping material. The forklike end of the driving arm which protrudes from the cartridge body engages the stylus arm approximately at its mid-point.

In the turnover cartridge, model 3T, the entire stylus arm may be rotated 180° by flipping the stylus lever from one side of the cartridge to the other. The stylus assembly is mounted at a slight upward angle so that the stylus arm is always being pressed against the driving arm. There is enough flexing at the base of the stylus arm to allow the stylus assembly to be rotated.

Although the series 3 stylus looks like the series 2, it is actually a hollow tube of light metal. In earlier types of Sonotone cartridges, a solid stylus arm was used. The hollow arm, of course, has lower mass and therefore improves high-frequency response.

The output of the Sonotone series 3 cartridge is approximately 0.5 volt from a normal LP record. It has a compliance comparable to that of many magnetic cartridges (2×10^{-6} cm/dyne). The stylus mass is only 6 milligrams. The normal tracking force is 4–6 grams in a good professional tone arm or 6–8 grams in a record changer.

In common with all ceramic cartridges, the Sonotone series 3 requires a rather high terminating resistance if proper bass response is to be realized. At least a 2-megohm resistance should be used. Higher values will slightly emphasize the bass, while lower values will give a thinner bass. To use this cartridge with a preamplifier that is equalized for magnetic cartridges, a simple R-C network (see Fig. 4) will convert the amplitude response of the cartridge to velocity response. The values shown in Fig. 4 will result in a response flat within 1.5 db from 20–12,000 cycles on a velocity basis. The value of R determines the voltage appearing at the preamp input and should be in the region of 10,000–47,000 ohms. Incidentally, this network will perform a similar function for any amplitude-responding cartridge though the smoothness of the final response will naturally depend on the quality of the cartridge.

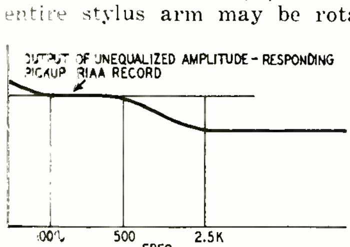


Fig. 2—Output of unequalized amplitude-responding pickup from a RIAA record.

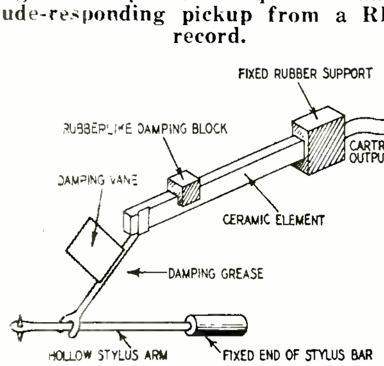


Fig. 3—Internal construction of Sonotone 3T cartridge.

Electro-Voice model 84

The E-V model 84 cartridge is a ceramic type designed to cover an audio range of 20–15,000 cycles with a response flat within ± 2.5 db when terminated in 3 megohms or more. Like the Sonotone cartridge, its output is approximately 0.5 volt. The lateral compliance is high (1.2×10^{-6} cm/dyne) and most of the general statements made about amplitude-responding cartridges apply to it.

The E-V model 84 is normally supplied as a single-stylus cartridge, with a choice of 1- or 3-mil sapphire or diamond styli. A turnover version is also available, which consists of two cartridges mounted back to back in a yoke. The internal structure of the E-V 84 is different from that of other ceramic cartridges. Fig. 5 is a sketch of its moving system.

The lateral compliance is largely obtained from the short, thin metal strip marked "compliance arm". One end of this strip is firmly clamped to the body of the cartridge case and the other is driven by the stylus. The stylus arm is long (about ½ inch) so that the lateral compliance at the stylus tip is high despite the relatively stiff metal section.

The ceramic element is driven from the point where the stylus arm joins the compliance arm. It makes an angle of approximately 20° with the stylus arm. The fixed end of the ceramic element is supported in a block of rubberlike damping material. The electrical connections are made at this end. The vertical compliance of this cartridge is obtained largely through the use of a long stylus arm of thin cross-section. The lateral compliance arm is rather stiff in the vertical plane.

E-V obtains smooth, wide-range response by a novel damping system. The entire body of the cartridge—including the complete ceramic element, the compliance arm and the portions of the stylus arm within the cartridge—is enclosed in a damping grease, apparently a silicone, with the appearance and consistency of cold cream. The nonreplaceable portion of the stylus arm protrudes from the cartridge body through a rub-

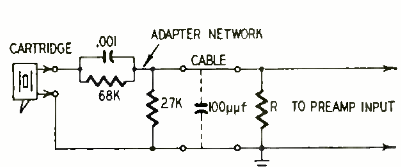


Fig. 4—Adapter network converts amplitude response to velocity response.

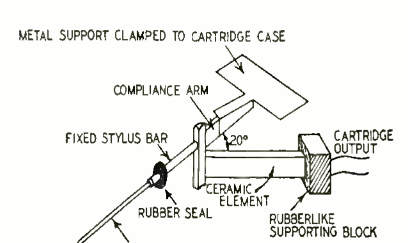
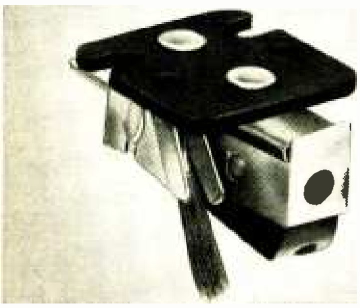


Fig. 5 (Right)—Mounting of ceramic element in Electro-Voice model 84.

ber seal. It is a hollow tube of rectangular cross-section, into which a replaceable stylus is inserted.

The mid-range response of the E-V 84 is slightly modified from a true amplitude response to give a more nearly flat response to an RIAA equalized record. E-V also sells an adapter unit which converts the response of its cartridges to a velocity characteristic for use with magnetic preamplifiers. This is essentially the same sort of



Weathers F-M capacitance cartridge.

network described with the Sonotone cartridge.

An interesting variation of the model 84 is the 84-M, designed to drive a magnetic preamplifier input stage having a 47,000-ohm input resistance. It delivers a flat response from a constant-velocity signal with about 30 millivolts output from an LP record. Presumably the inherent response of the 84-M is an unmodified constant-amplitude response in contrast to the internally modified response of the standard model 84. When converted to a velocity characteristic by simply using a low-resistance termination, the response is flatter than would be obtained from the usual ceramic cartridge connected thus.

Although the E-V 84 is somewhat different in physical form than most other high-quality cartridges, a complete kit of adapting bushings and screws is supplied for installing it in most tone arms and changers.

Weathers FM capacitance pickup

The Weathers FM capacitance pickup, though an amplitude-responding device, has little in common with the ceramic cartridges previously described or with any other cartridge for that matter. It is characterized by the highest compliance (14×10^{-6} cm/dyne), the lowest moving mass (1 milligram) and the lowest stylus tracking force (1 gram) of any pickup available.

This has been achieved by using a pickup structure in which lateral stylus displacement varies the capacitance in the grid circuit of a rf oscillator. This frequency - modulates the oscillator, which operates in the vicinity of 20 mc. A simple but ingenious circuit utilizes the small variation in plate current of the oscillator as its frequency is varied to develop an audio voltage output proportional to the amplitude of the stylus displacement. The output of the oscillator unit is at a high-impedance level so the length of shielded cable connecting it to the amplifier should not exceed 4 feet.

Due to the unusually low stylus force and high compliance of this cartridge, it is recommended for use only in the special Weathers arm designed for it. The arm is made of light wood and in its current version uses viscous damping in both lateral and vertical planes.

Another unusual feature of the pickup is the small sable brush which is mounted on the side of the cartridge. This brush serves a dual purpose: It prevents lint from accumulating on the stylus and interfering with its proper operation and it absorbs most of the downward force of the arm. This actual downward force is about 3 grams, yet only 1 gram is effective as stylus force. The Weathers stylus-force gauge shows that only 1 gram of upward force is needed to lift the stylus out of the record groove, yet 3 grams is required to lift the brush completely from the record surface. This makes the pickup much easier to handle since there is a strong tendency for a 1-gram pickup to float out of the user's hand.

Fig. 6 is a sketch of the Weathers pickup system. The stylus is electrically a part of the outer shell of the cartridge while the inner or stationary electrode is insulated from the cartridge shell. Inside the plastic body of the cartridge is a small stepup autotransformer. Its output is fed through a 4-foot length of special flexible shielded wire to an oscillator. Since this lead forms a part of

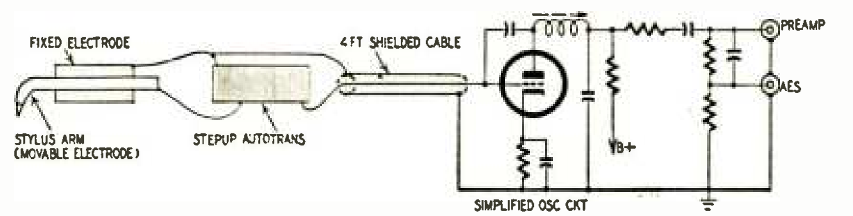


Fig. 6—Weathers FM pickup has built-in stepup transformer, oscillator circuit.

the oscillator's tuned circuit, it must be used in the length supplied. and not shortened nor extended.

Oscillator adjustment is simple and, once made, remains relatively unchanged. The oscillator unit has two optional outputs: One, marked AES, provides an output equalized for the AES recording characteristic. This may be fed directly to the input of a power amplifier. The second output is marked PREAMP and is a constant-amplitude response output. An adapter unit is available which converts this constant-amplitude response to a velocity response. When it is used, the system may be plugged into the magnetic input of a conventional preamplifier.

The stylus is mounted on a plate which may be easily slid in or out of the cartridge without tools. Both 1- and 3-mil styli are available and a turnover model of this cartridge has two cartridges back to back in a yoke.

Shure Studio Dynetic pickup

In the first article of this series a statement was made that no moving magnet pickups are currently on the market. Since then, a moving magnet pickup has been announced by Shure Brothers, Inc. Dubbed the Studio Dynetic, it is sold only as a complete system with pickup and matching arm.

The pickup offers several unique features. The cartridge itself is very small and plugs into a special fitting on the arm. The horizontal pivot is close to the stylus. An adjustable counterweight permits setting stylus force between 1 and 2 grams. The arm itself does not move in the vertical plane. A small plastic button on the top of the arm is depressed to raise the stylus from the record surface. It is not possible to damage the stylus or the record accidentally. Jewel bearings are used for both lateral and vertical pivots. A novel damping system, described as "dynamic damping," which does not affect the tracking of even severely warped or eccentric records, is used in the arm.

A closup of the cartridge shows the required offset angle built into the stylus shoe. The arm is straight and the stylus is replaceable.

Fig. 7 illustrates the internal construction of the Dynetic cartridge. Two identical coils are mounted symmetrically with respect to the permanent-magnet rod attached to the stylus shoe. Lateral motion of the stylus rotates the magnet about its long axis and alters the balance of magnetic flux entering the cores of the two coils. This generates a voltage in the coils proportional to stylus velocity. Due to the symmetrical coil structure, hum pickup from external magnetic fields is minimized. A high-permeability shield is also incorporated in the pickup. The magnet does not exert a significant attraction to a steel turntable.

The lateral compliance of the Dynetic pickup is greater than 6×10^{-6} cm/dyne, and the effective mass at the stylus tip is 1.5 milligrams. In spite of these high-performance parameters, the stylus is replaceable by the user without difficulty. The output of this cartridge is of the order of 5 to 6 millivolts and its impedance is sufficiently low so that considerable lengths of shielded cable may be connected to it without adversely affecting its high-frequency response. END

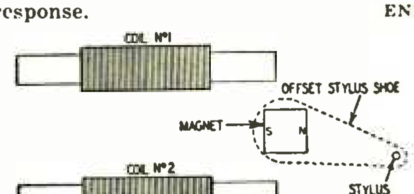


Fig. 7—Construction of Shure Studio Dynetic pickup, a moving magnet cartridge.

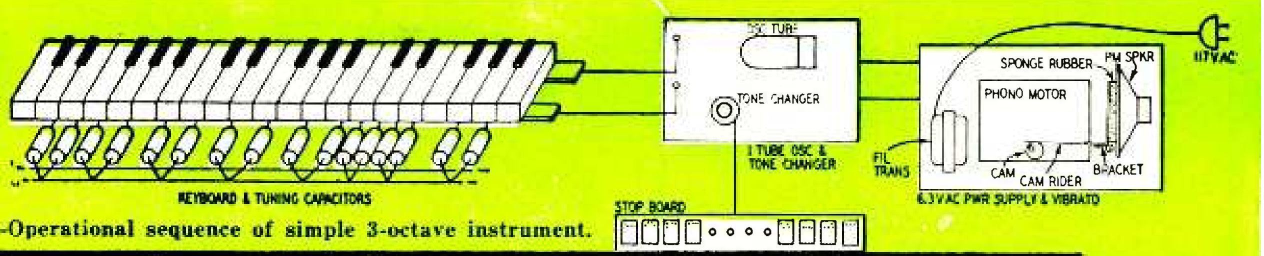


Fig. 1—**Operational sequence of simple 3-octave instrument.**

Simplest Electronic Organ

By HAROLD C. HUBBARD

A monophonic electronic organ featuring an unusual oscillator that operates without plate or grid voltage supplies

SINCE the development of the vacuum-tube audio oscilator and the early days of the Trautonium and Theremin, radio technicians and experimenters have dreamed of making a simple musical instrument that would have a selection of tone qualities, be easy to play and inexpensive and easy to build. Here is such an instrument. This electronic organ uses a new type of one-tube oscillator and a tone changer that produces reed, string and flute tones, plugs into the mike jack of an existing amplifier and *operates without a B-supply.*

Other monophonic instruments developed in the past were rather complicated when we consider that they produced only one note at a time. Constructing these instruments meant much work and a considerable outlay of cash, and then the result was too often a novelty instead of a musical instrument.

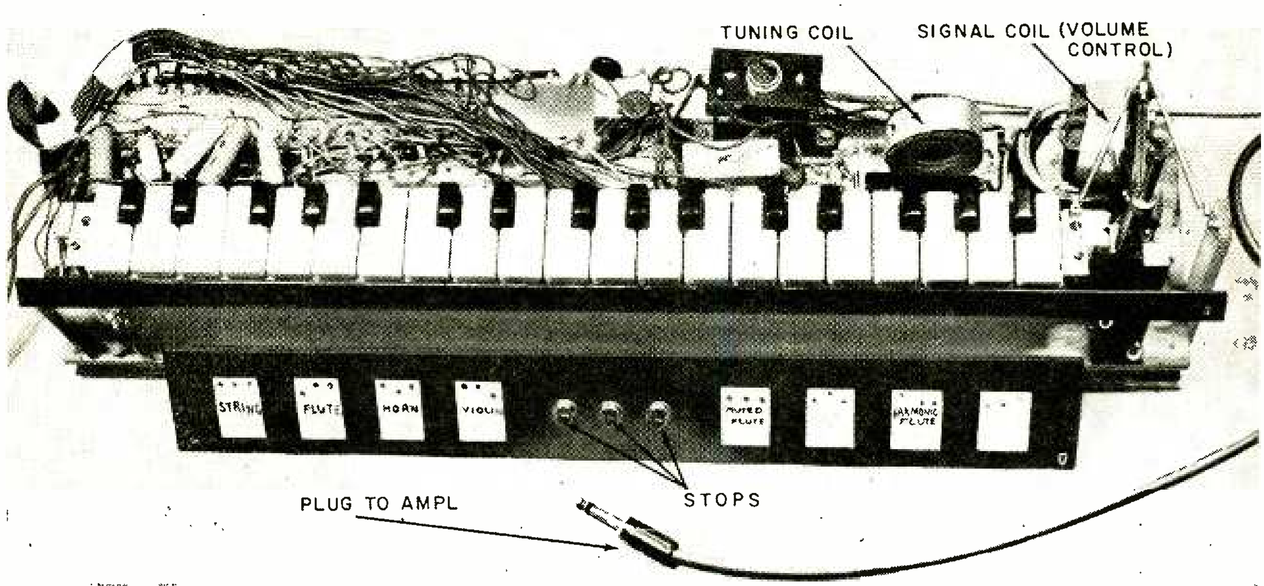
It would seem that a solo (single note at a time) musical instrument would be easy to design, but this has not been the case heretofore. While frequency stability is not as important as in polyphonic instruments, it should be such that the instrument is in tune without any adjustments each time it is plugged in. Ordinarily this means a well-regulated power supply which increases the cost. If the device is really simple, it lacks musical quality—sounding either monotonous as a producer of sine waves or, if relaxation oscillators were used, the low notes were a semimusical buzz.

A unique oscillator

This article tells how to build a simple electronic musical instrument using the Hubbard oscillator upon which patents will soon be issued. It can be built in a few evenings at a cost of only a few dollars. Yet it will not sound like a musical code oscillator and key-click filters are not needed. More than one flute quality can be had and it will be a little more than a sine wave. Also, a string tone can be produced with precise proportions of harmonics with fundamental so that the composite will have body in the medium-low register like a bass viol and not like an electronic squawker.

It may be well to point out to experimenters who are beginners in electronic music that the fundamental is absent in the lowest register of many instruments generally since the body of column of that instrument will not resonate at such a low frequency. In this case, just as in the instance of musical output from a small speaker, the ear supplies the fundamental. If a heavy fundamental is added at this low fundamental frequency and if the act of the ear supplying the fundamental is part of the characteristic of a certain instrument, then the simulated tone will not sound like the true instrument.

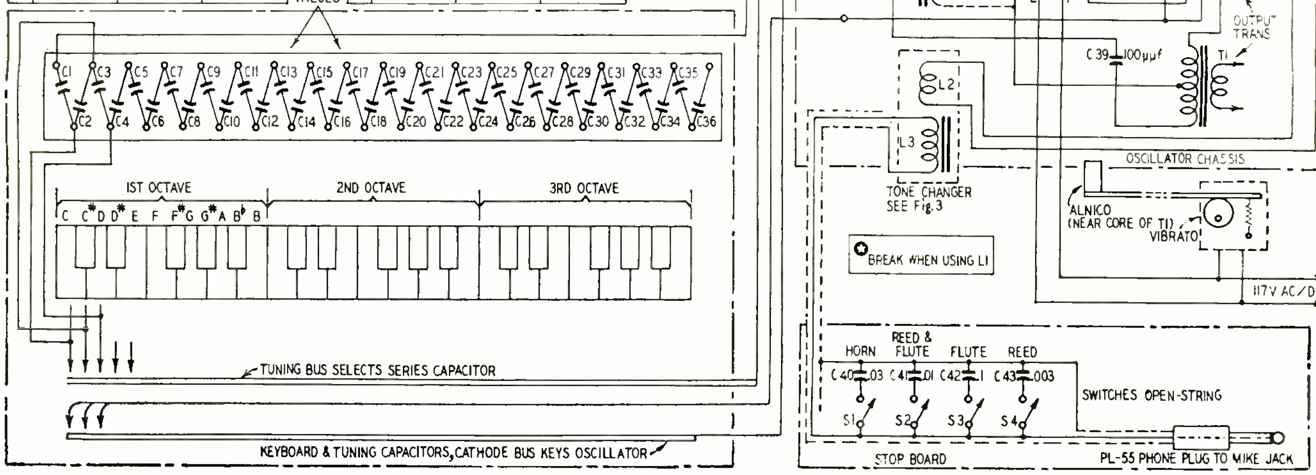
In this instrument, it was decided where either a string or reed tone was desired, the harmonic content at different frequencies would be a function of a resonating circuit, that circuit being a "resonator" or "sound box," thus producing more natural music. Also, it makes it possible to



The organ with cover removed. Only three stop switches are on these models. Circuits shown provide wider range of tone coloring with four switches.

	1ST OCT	2ND OCT	3RD OCT
C	C1 .056	C13 .1	C25 .024
C#	C2 .35	C14 .107	C26 .022
D	C3 .4	C15 .09	C27 .013
D#	C4 .34	C16 .07	C28 .013
E	C5 .25	C17 .065	C29 .013
F	C6 .2	C18 .06	C30 .009

	1ST OCT	2ND OCT	3RD OCT
E#	C7 .28	C19 .04	C31 .008
G	C8 .2	C20 .05	C32 .0058
G#	C9 .19	C21 .042	C33 .006
A	C10 .15	C22 .03	C34 .0045
B♭	C11 .14	C23 .03	C35 .004
B	C12 .13	C24 .021	C36 .004

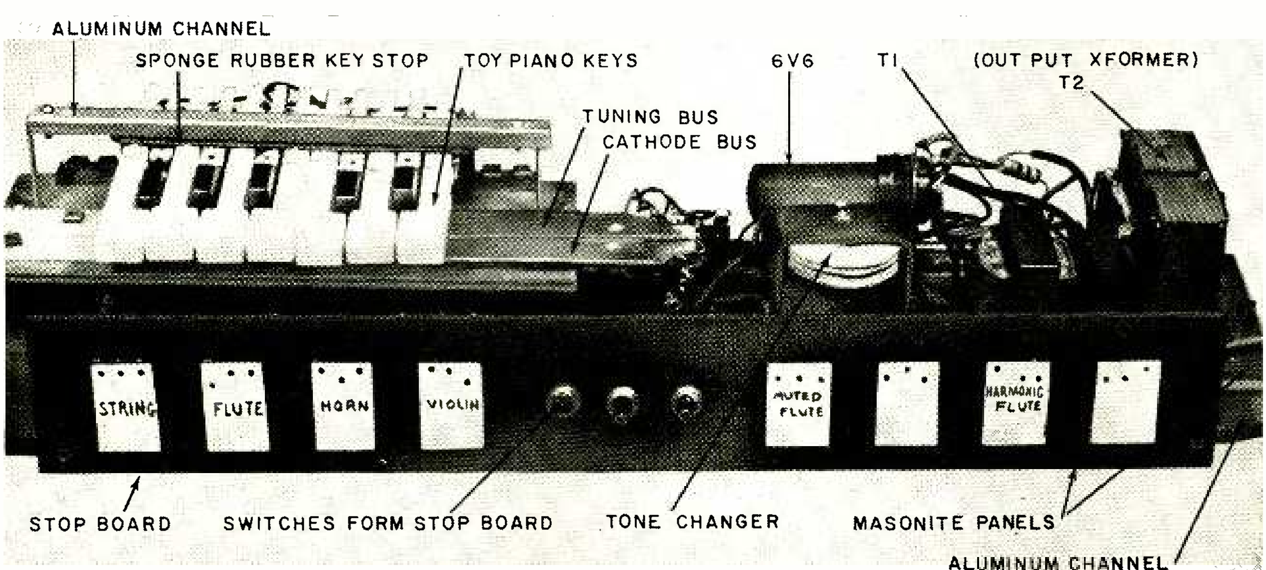


C1—.056 μf
C2—0.35 μf
C3—0.4 μf
C4—0.34 μf
C5—0.25 μf
C6, 8—0.2 μf
C7—0.28 μf
C9—0.19 μf
C10—0.15 μf
C11—0.14 μf
C12—0.13 μf
C13, 42—0.1 μf
C14—0.107 μf
C15—.09 μf
C16—.07 μf
C17—.065 μf
C18—.06 μf
C19—.04 μf
C20—.05 μf
C21—.042 μf
C22, 23—.03 μf
C24—.021 μf
C25—.024 μf
C26—.022 μf
C27, 28, 29—.013 μf
C30—.009 μf
C31—.008 μf
C32—.0058 μf
C33—.006 μf
C34—.0045 μf
C35, 36—.004 μf
C37—400 μμf
C38—.02 μf
C39—100 μμf
C40—.03 μf
C41—.01 μf
C43—.003 μf
All capacitors, paper, mica or ceramic, 100 volts or higher. C1 through C36 should be selected from an assortment of standard values and padded where necessary for proper tuning.
R1—750,000 ohms, ½ watt or larger
R2—1,000 ohms, ½ watt or larger
T1—audio output transformer, 50,000 ohms plate-to-plate primary, 3–6 ohms secondary (Chicago RO-113 or equivalent) secondary not used
T2—audio output transformer, 14,000 ohms plate-to-plate primary, 16 ohms secondary (Chicago Standard RO-111 or equivalent)
L1—see text Part 2
L2—2,000 turns No. 26 dcc wire (see Fig. 3)
L3—Waldom 1,500-ohm universal replacement speaker field coil
V—117L7-GT, 6V6, 6Y6 etc., see text
S1, 2, 3, 4—spst switch, toggle or equivalent
Terminal strips, mounting boards, keyboard from toy piano, see text
Parts for vibrato, see text

Fig. 2—Schematic diagram of the organ using a 117L7-GT. Power line supplies only the heater.

have as high as 10 tone colors of around 15 *cents* each. (At an octave relationship of 1 to 2 there are 1,200 cents in an octave—100 cents between two related semitones.) The actual construction and wiring are so simple a schematic and a few hints are all that are necessary. The device is built in four parts as shown in Fig. 1: the oscillator, keyboard and tuning capacitors, stop board and vibrato. The original instrument (Fig. 2) uses a 117L7-GT. A second model, used in some photographic illustrations, has a 6V6 connected as in Fig. 3.

The choice of tubes is left to you. Most tubes will work when connected as triodes. A power amplifier tube is recommended for the oscillator because its cathode emission is higher than in voltage amplifier types. The 117L7-GT seems to be less susceptible to line-voltage drops of long duration, but many of these tubes have high leakage and will not operate in this circuit. The 6V6 fed by a 6.3-volt filament transformer will reflect line drops of



One of many models. This one is shown with 1-octave keyboard. Dots on "tabs" show switch positions for different tone colors.

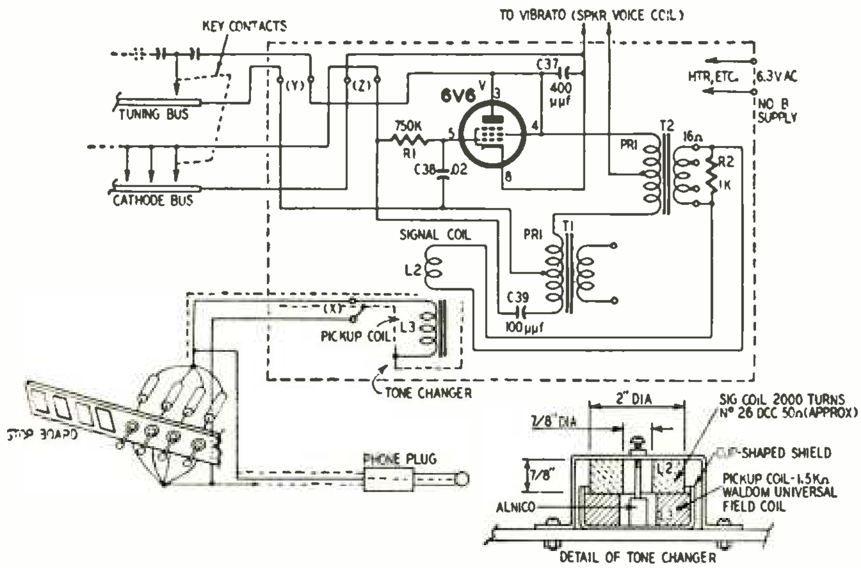


Fig. 3—Diagram of the 6V6 oscillator and tone-changer details. The 6.3-volt input is the sole power supply.

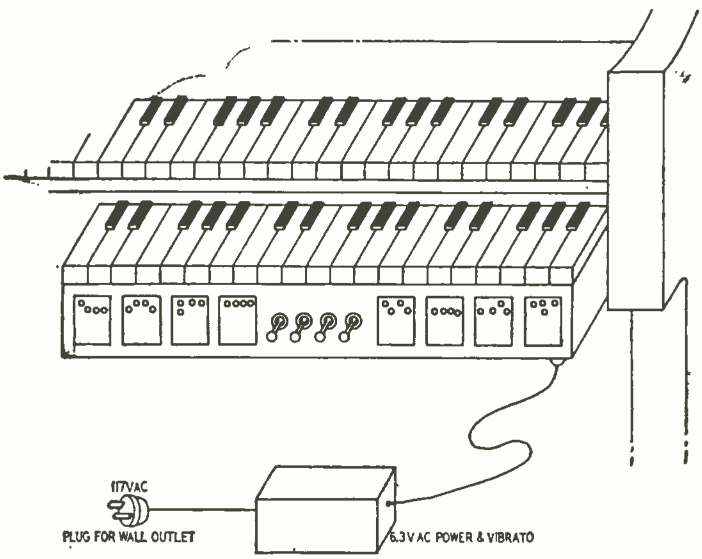


Fig. 4—One setup for organ.

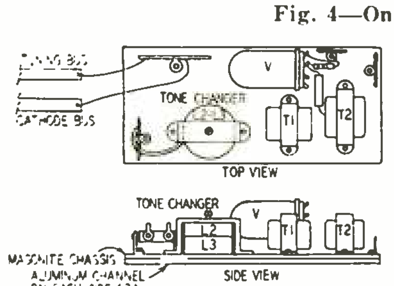


Fig. 5—Parts layout for oscillator.

long duration, but not enough to be serious. This type of tube must also be hand-picked for oscillation. Most 6L6's and 6Y6's are excellent in this circuit. As many as eight 6Y6's have been tried in the same chassis with the frequency varying only about ½ cycle. If the instrument is moved around into locations of low line voltage, it can be tuned either by inductance in the grid circuit or by varying slightly the resistance across the secondary of the output transformer. These voltage problems are not common in most localities and should not be confused with surges and fluctuations of short duration which are of no consequence in this device.

Parts placement, shielding

Placement of parts is not critical except for the vibrato motor and the filament transformer (if a 6V6 is used). These must be kept 2 feet or more from the oscillator, if unshielded. Slight 60-cycle beats can spoil a sweet cutting string tone. For this reason, the filament transformer and vibrato were mounted as shown in Fig. 4, put into a case and left as a power supply near the 117-volt outlet.

If it is desired for some reason to mount the transformer near the oscillator, then the oscillator must be mounted in a box made of ¼-inch steel.

Either the 117L7-GT or 6V6 model oscillator parts can be mounted as shown in Fig. 5. Use a Masonite panel, do not use metal chassis or shields unless the whole unit is shielded. Metal chassis and partial shields merely act as sensitive probes for 60-cycle pickup.

The stop-board panel is a piece of Masonite trimmed to dimensions to suit the case you select. No finished size is given because some builders will want the oscillator chassis mounted at the end of the keyboard, others the arrangement used on the 117L7 model.

The holes for the switches are drilled, then the panel is sprayed flat black. Color spray paint in pressure cans may be used if desired. When dry, masking tape is used, just leaving the "stop tabs" to be sprayed white right over the flat black. See photos. This dressed the stop board up more than the switches could do, and it is a good way to indicate which tone colors you may have by showing the switch positions.

It is recommended the oscillator chassis be built first. Plug it into an amplifier and try different tubes. Remember the B-plus "power supply" is the electron space charge of the tube and a good tube will cover a much greater range than a poor one. Spend a few minutes here trying different tubes even though the first one produces amazing results.

During this procedure, hook different values of capacitors between points X in Fig. 3. Also, short across tie points marked "to vibrato." Cement or solder a small Alnico bar magnet (the type glued to many novelties) onto a thin 6-inch steel ruler (the kind sold in dime stores). Let the Alnico slug vibrate or oscillate near the core of T1 while holding the opposite end of the scale between thumb and forefinger. By changing values of capacitors at points X in Fig. 3 you can enjoy the tone colors possible while producing different frequencies. A decade or substitution box will be a handy item here as well as later in final tuning. A switch across points Z serves as a key during this test.

The oscillator chassis can be wired and assembled in very short order and, outside of added keyboard capacitors, is the generator for all frequencies and shaper for all tones. Once you see how simple it is and listen to it experimentally you will have all the inspiration needed to build the keyboard and vibrato to be described in the conclusion of this article.

(Before writing us and quoting oscillator and vacuum-tube theory as proof of the impossibility of this circuit, we suggest that you give it a try. Parts can be found in the average junkbox. We know it works. We've tested a simple 4-note oscillator and have heard tape recordings made with a 3-octave instrument.

The transformers that work best at lower frequencies are those with a high inductance and low resistance. Power transformers with the high-voltage secondary as the oscillator coil and the 117-volt primary as the output coil have been made to work as low as 25 cycles. Tubes that will not work as a triode alone can be made to oscillate by cascoding as in the 117L7 circuit where the pentode cathode is returned to the plate of the diode section.—*Editor*)

TO BE CONTINUED

Three test instruments that speed servicing these difficult circuits

FLYBACK and SWEEP-CIRCUIT TESTERS

By ROBERT F. SCOTT

OBSCURE troubles in horizontal deflection circuits are often hard to localize, particularly when failure of one component causes others to change value or break down. When such troubles occur, the technician must locate and replace all defective components before applying power to the set for more than a few seconds at a time.

Failure to locate all faults can damage expensive components just replaced. For example, an open cathode resistor in the horizontal oscillator may leave the output tube without excitation. This, in turn, can cause the output tube to go gassy and may burn out the flyback transformer. If a technician spots a defective flyback transformer and replaces it without determining the cause of the trouble, subsequent tests with power applied to the set can damage the transformer just replaced.

Test-equipment manufacturers have recognized the need for speedy and complete testing in deflection circuits and have developed a number of new instruments for this purpose.

Dynamic sweep analyzer

The Win-Tronix model 820 Dynamic Sweep Circuit Analyzer is a signal-substitution type instrument for localizing trouble in sync, sweep oscillator and output circuits, output transformers, yokes, and picture and damper tubes. Its circuit is shown in Fig. 1.

When the FUNCTION switch is thrown to SIGNAL SUBSTITUTE, V1-a oscillates at approximately 15,734 cycles and applies a sawtooth signal to the HORIZONTAL GRID DRIVE output jack and the grid of V2, the built-in horizontal output stage. This setup localizes trouble in horizontal deflection circuits.

In a set with no raster, the oscillator tube is pulled or the grid coupling capacitor is cut loose from the horizontal output grid. If the raster returns when the 15-kc signal is applied to the output grid, the trouble is somewhere in the oscillator circuit. No raster indicates output circuit trouble.

Next, the test leads are connected between the output jack at the plate of V2 and the output plate cap on the primary of the flyback transformer. A raster on the screen accompanied by a dim glow on the OVERLOAD indicator shows that the defect is between the grid and plate circuits of the set's horizontal output stage. It can now be pin-pointed by measuring the dc voltages on the horizontal output tube's screen and cathode.

If the raster does not appear when the transformer is driven by the analyzer or if the OVERLOAD lamp glows brightly, there is a defect in the yoke, flyback, width coil, damper tube or associated components. One by one, disconnect the width coil, keyed agc connections, R-C network across the horizontal yoke windings and all other components not absolutely needed for high voltage and deflection. A component or network is defective if a raster is obtained and the OVERLOAD lamp drops to normal brilliance when it is disconnected from the circuit. If the

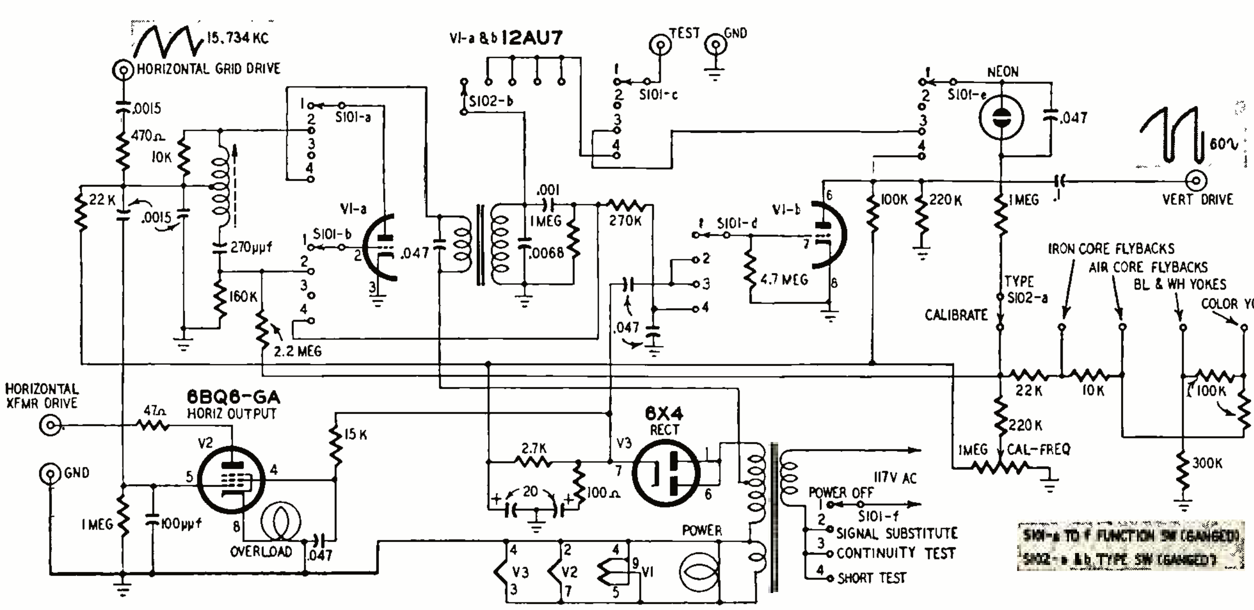


Fig. 1—Circuit of the model 820 Dynamic Sweep Analyzer.

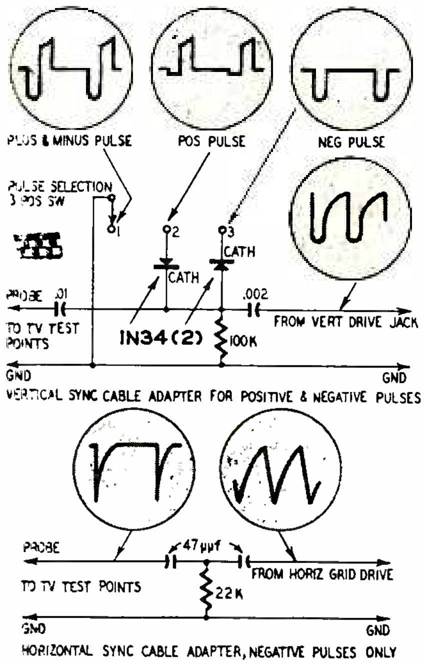
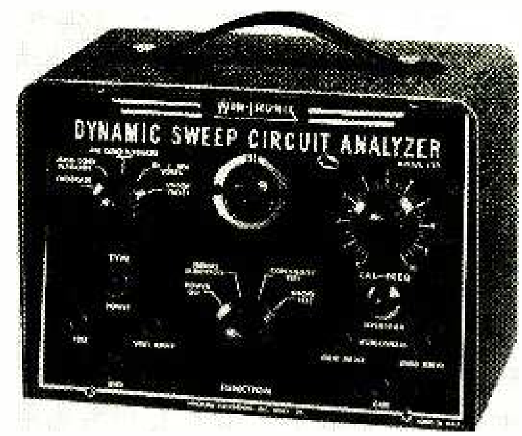


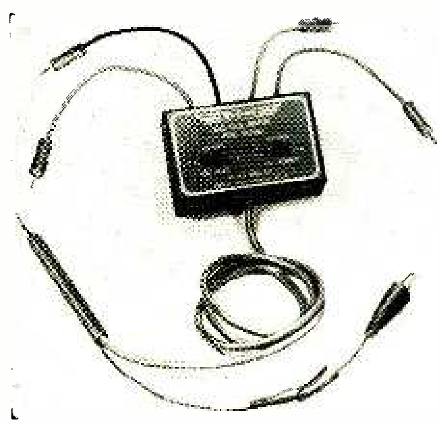
Fig. 2—Cable adapters used with the 820 produce sync pulses.

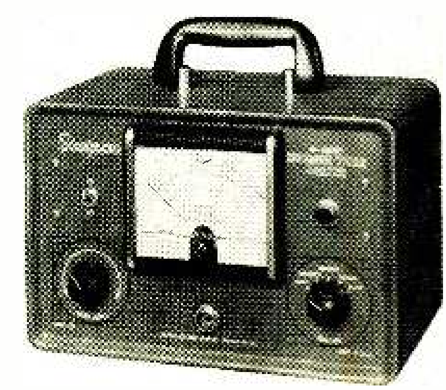


Right — Win-Tronix Dynamic Sweep Circuit Analyzer.

Below left — Sync pulse adapter for the Win-Tronix model 820.

Below right—Model 382 In-Circuit Horizontal System Analyzer made by Simpson.





overload still exists, look for a short in the flyback transformer.

Failure of the overload indicator to light at all shows an open circuit in the output section. Check or replace the damper tube and fuse in the boosted B-plus circuit and check the primary and high-voltage windings of the flyback with an ohmmeter or the continuity-test circuit in the analyzer.

Test for shorted turns

Throwing the function selector to SHORT TEST sets up the analyzer for detecting shorted turns in flyback transformers and yokes. V1-a is converted to a blocking oscillator operating at around 500 cycles. Its grid is tied to the grid of V1-b through a 270,000-ohm resistor. Now, V1-b operates as a dc amplifier with a 100,000-ohm plate load resistor shunted by a neon lamp in a voltage-divider network. The TYPE selector switch is thrown to CALIBRATE and the calibrate-frequency (CAL-FREQ) is adjusted so the neon indicator flickers slowly and steadily with the test leads open.

The TYPE selector is then thrown to the position specified for the type of flyback transformer being tested. The plate cap is removed from the output tube, the damper and high-voltage rectifier tubes are removed, the yoke plug is pulled or the hot lead disconnected and one lead of the width coil is broken. The test leads from the analyzer are then connected across the flyback terminals specified in the manual. If the neon lamp continues to flicker, the flyback is not shorted and should now be tested for continuity and leakage between windings.

The test procedure for yokes is basically the same as for flybacks. They are disconnected from the flyback and the damping resistors are cut loose from the vertical winding.

The first step in checking the vertical deflection circuit is to disconnect the output grid coupling capacitor from the oscillator or discharge tube and apply a 60-cycle sawtooth from the VERT DRIVE jack to the output grid. If vertical deflection returns, the trouble is at some point ahead of the output grid. The test lead is then moved back step by step toward the oscillator until the defective stage or component is located.

If deflection does not return with the drive signal applied to the output grid, the trouble is in the vertical output transformer or the yoke. If the yoke checks good, the trouble is in the output transformer and its replacement is necessary.

Continuity tests

Circuit continuity is tested with the selector switches set to CONTINUITY TEST and CALIBRATE and the CAL-FREQ control turned fully clockwise so the neon indicator lights when the test leads are shorted. A continuous and steady glow of the indicator shows continuity when the test leads are connected across yoke windings, coils on flybacks and other transformers, speaker voice coils, resistors and tube heaters and filaments.

Test for leakage

Leakage resistance up to 300 megohms between windings or between a winding and core is tested with the 820 adjusted for continuity tests and the test leads connected to separate windings or to a winding and the core. A component with no appreciable leakage will cause the indicator lamp to go out. If it flashes, leakage resistance in megohms is approximately equal to 50 times the interval between flashes in seconds. For example, one flash every 6 seconds shows leakage resistance of 300 megohms or so and one every 3 seconds indicates leakage of approximately 150 megohms.

Sync troubleshooting

Vertical roll and horizontal pulling are often caused by an open circuit, short or other defect that prevents an adequate sync signal from reaching the deflection oscillators. These defects can be localized by signal substitution with the 820. Fig. 2 shows simple adapters that can be used to convert the sawtooth signals available at the VERT DRIVE and HORIZONTAL GRID DRIVE jacks into sync pulses.

The vertical sync adapter provides signals with positive- and negative-


Knight-kit Flyback Checker.

going pulses or negative and positive pulses alone. This enables the technician to duplicate the normal vertical sync signal at any point in the sync chain. The horizontal sync adapter provides negative pulses only.

The model 915/960 Sync Pulse Adapter (see photo) is available for use with the 820. It provides both negative- and positive-polarity vertical and horizontal sync pulses.

Simpson 382

This instrument is called the In-Circuit Horizontal System Analyzer because it permits initial tests for shorts in the output transformer and its associated components without disturbing the receiver circuitry. It tests flyback transformers, yokes, width and linearity coils and measures capacitance from 10 $\mu\mu$f to 0.1 μf in three ranges. The circuit is shown in Fig. 3.

When testing for shorts, the 6K6-GT operates as a 1-kc oscillator with feedback supplied through the grid winding of the oscillator transformer. It is keyed on and off at a 60-cycle rate by the ac plate voltage from the 116-volt tap on the power transformer. Strength of oscillation is indicated by a 60-μa meter with a full-wave rectifier connected across 68,000 ohms of the 268-000-ohm grid leak. The in-circuit test is made with one test lead clipped to the horizontal output plate lead and the other to ground.

This effectively places the entire horizontal output circuit in parallel with the grid winding of the oscillator transformer. A shorted turn anywhere in the horizontal output system reduces the circuit Q to the point where the voltage developed across the 68,000-ohm resistor causes the meter to read REPLACE.

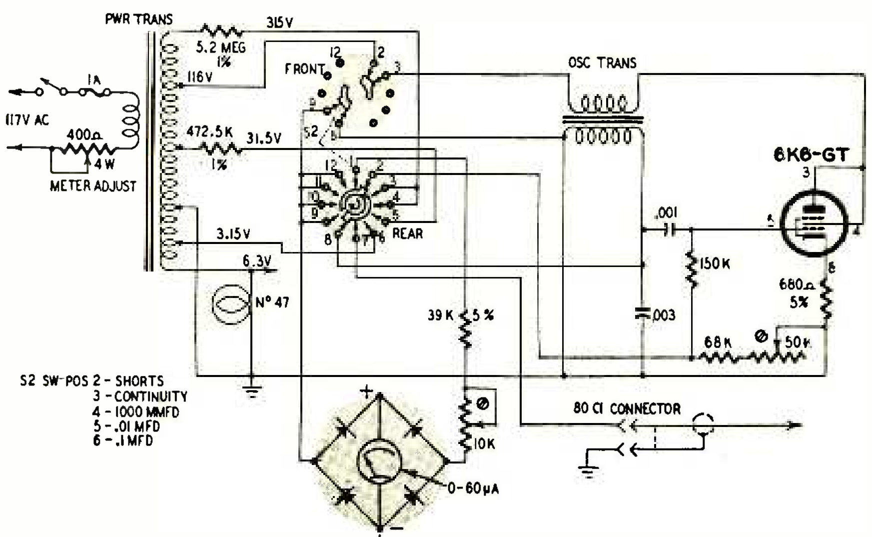


Fig. 3—Simpson model 382 In-Circuit Horizontal System Tester circuit.

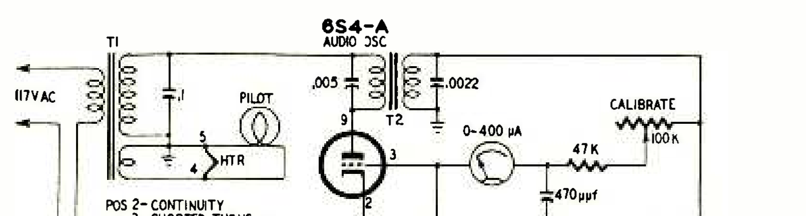


Fig. 4—Circuit of the 1-tube Knight Flyback Checker.

Open circuits do not load the test oscillator so when you have an inoperative circuit that tests GOOD, check the continuity of the yoke, linearity and width coils and the individual windings of the flyback transformer.

When the FUNCTION switch is turned to CONTINUITY, the meter and its rectifier are in series with the test leads across the 315-volt section of the power transformer. The circuit then operates as an ac ohmmeter, indicating continuity by reading in the GOOD area of the bottom scale and an open circuit by reading REPLACE.

The capacitance ranges use an ac ohmmeter circuit with the scales calibrated in capacitance units. The meter deflection is determined by the range and the ac reactance of the capacitor under test. Approximately 315 volts is applied to the test leads on the 10–1,000-$\mu\mu$f range, 31.5 volts for capacitors up to .01 μf and 3.15 volts for values to 0.1 μf.

Knight-kit flyback checker

Allied Radio's flyback checker kit is similar in its basic operation to the Simpson 382 and most of those currently available. It checks for shorted turns in flyback transformers, yokes, width and linearity coils and other inductors with a Q of 1 or higher and inductance between 3 mh and 2 henries. Continuity checks can be made in any circuit or component with resistance from 0 to 500,000 ohms.

The circuit of the Knight-kit checker is shown in Fig. 4. The tube is an audio oscillator with feedback from plate to grid supplied through transformer T2. Power transformer T1 supplies 60-cycle ac to the plate so the circuit oscillates only on that portion of the input cycle that makes the plate positive with respect to the cathode. The grid returns to ground through the CALIBRATE control, the 47,000-ohm resistor and one winding of T2. The strength of oscillation is indicated on a 400-μa meter in series with the grid.

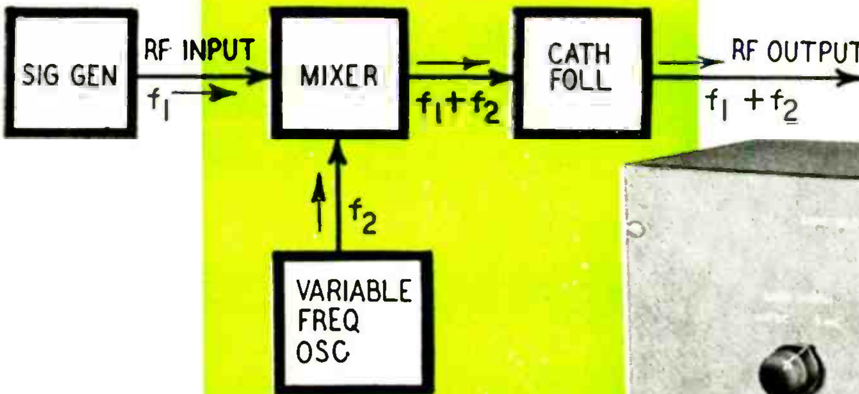
The component being tested for shorts is connected in parallel with the grid winding of T2 through the test leads. The added inductance raises the oscillator frequency and increases grid current causing the meter to read in the GOOD area of the scale. If the inductor has one or more shorted turns, it absorbs power from the feedback circuit and the meter pointer falls to zero or some point in the SHORTED TURNS section of the scale.

Continuity tests are made with the element or circuit under test connected directly between the oscillator grid and ground. If the circuit resistance is less than ½ megohm, the grid current drops and the meter indicates that continuity is OK. An open circuit or one with resistance above 500,000 ohms or so will not affect the oscillator's operation and the meter reads OPEN. END

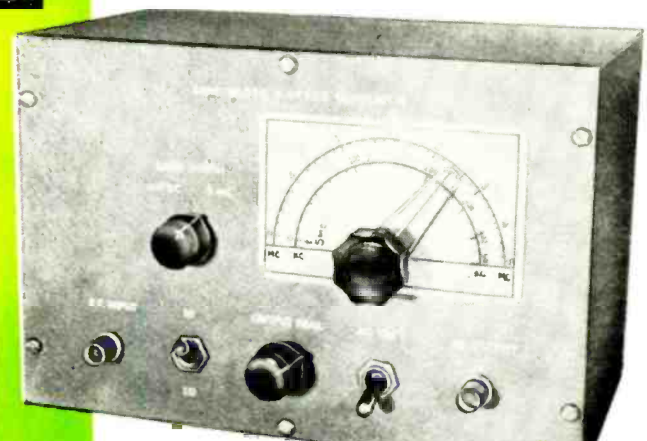
NEXT MONTH

By Robert F. Scott

Inexpensive Instruments as Service Aids



Adapt your signal generator to measure intermediate-frequency bandwidths



Bandwidth Marker Generator

By RICHARD GRAHAM

THE typical radio–TV signal generator is a paradoxical piece of equipment. It is usually required to cover a frequency range of 125 kc to 215 mc, a frequency ratio of 1,700 to 1. On the other hand, it must be accurate enough to serve as a marker generator for TV and FM receiver alignment.

These two requirements are incongruous. The wide frequency range covered in five or six bands always results in insufficient bandspread for marker purposes. Any technician or experimenter who has tried to measure the bandwidth of an FM or TV if strip accurately by using a servicing type of signal generator will attest to that.

It is generally agreed that the accuracy of most signal generators is adequate for alignment purposes. Actually it makes little difference if, for example, the center frequency of an FM if is 10.5 mc instead of 10.7.

We can say that, while the accuracy of the usual signal generator is acceptable, the differential accuracy necessary for bandwidth measurements or marker purposes is poor because of poor bandspread.

This situation is easily corrected with the accessory unit described here. The bandwidth marker generator is used with a signal generator and acts as an electronic bandspreader at any frequency of the signal generator.

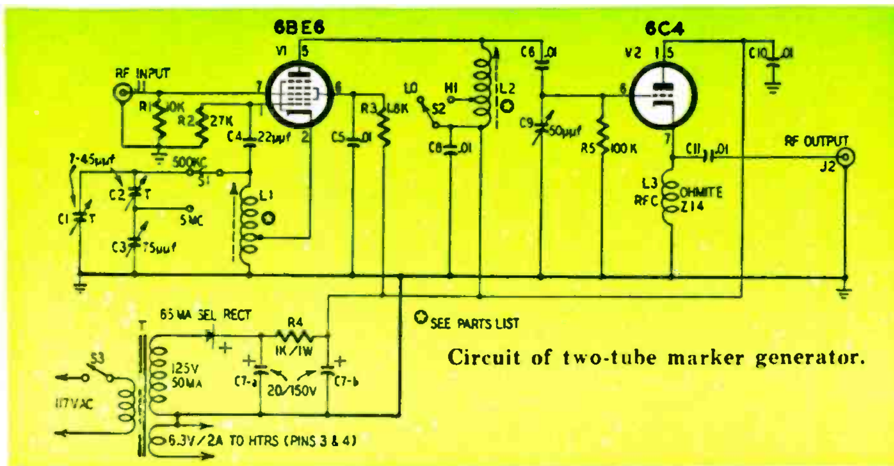
The block diagram of the marker generator is shown above and the schematic at the right. The signal generator's output is fed to a frequency mixer in the marker generator. The output of a vfo in the bandwidth marker is also fed to this mixer. The mixer's output is four frequencies which correspond to the sum and difference of the two input frequencies as well as the two mixer input frequencies. A parallel-tuned circuit in the output of the mixer selects the desired sum frequency. This output appears across a high-impedance parallel-tuned circuit and is transformed to a low impedance by a cathode follower.

The vfo is designed to cover two bands of frequencies. The oscillator covers 5.0 to 5.5 mc or a frequency change of 500 kc in one range and 5 to 10 mc in the second. Effectively the signal generator output can be shifted within 500 kc or 5 mc.

Using the marker generator

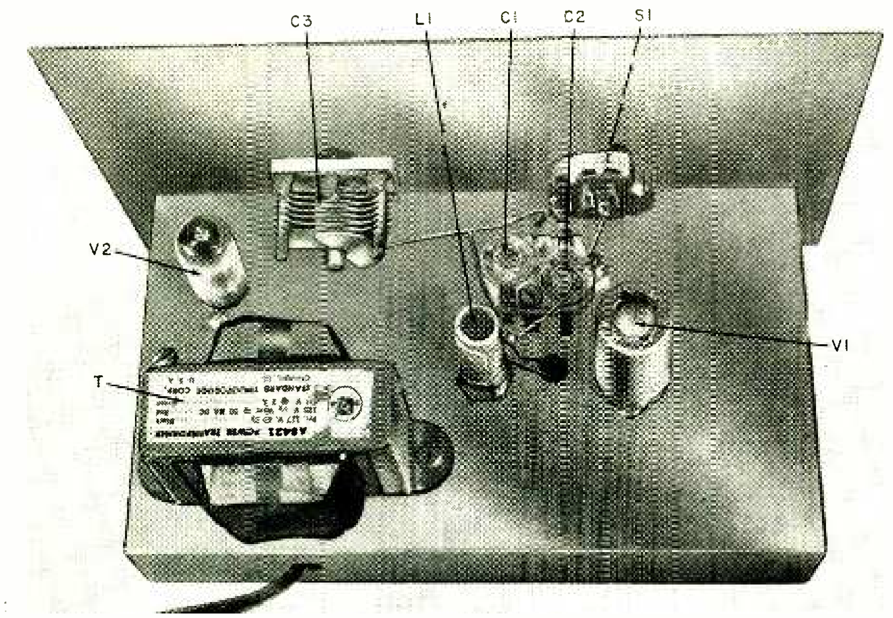
Suppose we wish to align an FM tuner and want to tell accurately when the if bandwidth is 200 kc at the 3-db points. If the response is made much wider than this, the sensitivity of the tuner will suffer; if it is made narrower, the audio quality deteriorates to an obvious extent.

Now, if the vfo in the bandwidth marker generator is made to operate over a frequency range of 5.0 to 5.5 mc and the signal generator is set at 5.4 mc, the mixer output, which will be the sum of these two frequencies, can be varied over a range of 10.4 to 10.9 mc. This frequency change at 10.7 mc of only 500 kc is accomplished by adjusting the marker generator's calibrated oscillator. The result is a max-

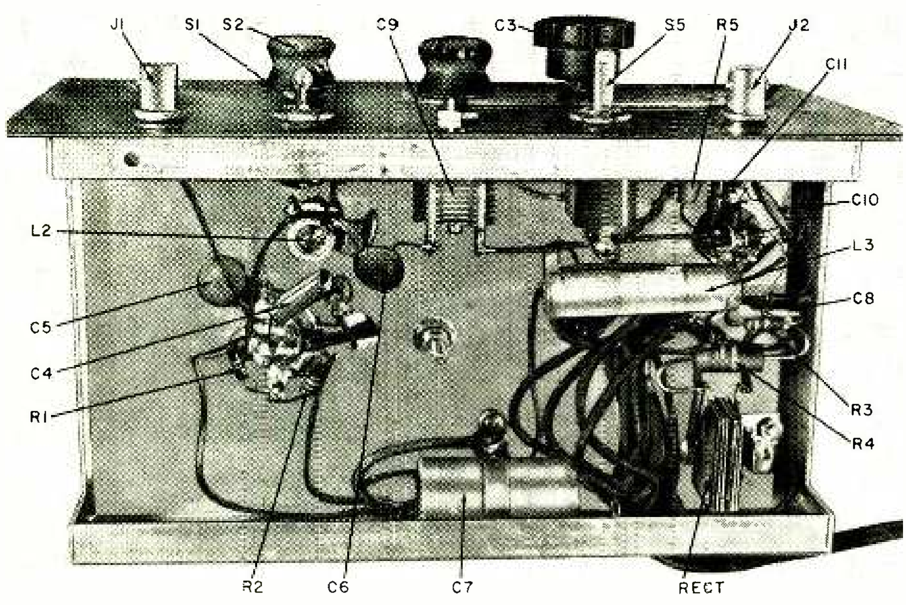


Circuit of two-tube marker generator.

R1—10,000 ohms
R2—27,000 ohms
R3—1,800 ohms
R4—1,000 ohms, 1 watt
R5—100,000 ohms
All resistors ½ watt unless noted
C1, 2—7-45-μμf ceramic trimmers
C3—75 μμf, air variable
C4—22 μμf, 500 volts, mica
C5, 6, 8, 10, 11—.01 μf, 600 volts, disk ceramic
C7—20-20 μf, 150 volts, electrolytic
C9—50 μμf, air variable
J1, 2—coax connectors
L1—36 turns, tapped 10 turns from bottom end, No. 30 silk-covered wire, CTC LS4 ½-inch-diameter slug-tuned form.
L2—15 turns, tapped 8 turns from bottom end, No. 30 silk-covered wire, CTC LS3 ⅜-inch-diameter slug-tuned form.
L3—rf choke (Ohmite Z14)
S1—spdt rotary
S2, 3—spst toggle
T—power transformer, primary 117 volts; secondary 125 volts, 50 ma, 6 volts 2 amps
V1—6BE6
V2—6C4
Selenium rectifier—65 ma
Sockets (2), 7-pin miniature
Tube shield
Chassis—4½ x 8 x 1½ inches
Cabinet—6 x 5 x 9 inches
Knobs
Miscellaneous hardware



Top-chassis view shows layout of major components.



Space no problem under chassis of this marker generator.

imum of 500 kc of frequency change at 10.7 mc with a bandspread of 180° on the marker generator's dial.

While the 500-kc frequency change is ideal for FM tuner alignment, it is too narrow for TV work. Here is where the 5–10-mc range comes in. It will give a calibrated frequency change up to 5 mc in the same manner as in the previous example.

The bandwidth marker uses two tubes. Mixer and oscillator are combined in one 6BE6. The cathode follower output is a 6C4.

The two oscillator ranges are selected by switching variable trimmer capacitors C1 and C2 in series and shunt with C3, the main oscillator tuning capacitor.

The tuning of the mixer output covers 10 to 25 and 23 to 48 mc in two ranges. Switch S2 shorts out part of the mixer plate coil (L2) to change the tuning range. This frequency range covers the common FM and TV intermediate frequencies.

The unit is housed in a 6 x 5 x 9-inch aluminum utility box. Construction is straightforward. Details can be seen in the photographs. It is advisable to mount L2 and S2 close together. This prevents additional capacitance that can cause a dead spot in the output tuning when switch S2 is closed.

Alignment procedure

This requires a receiver capable of tuning 5–10-mc range.

The first step in alignment is to set trimmers C1 and C2 at approximately mid-capacitance. Set the main variable tuning capacitor C3 for maximum capacitance. Set S1 to the 5-mc position. Tune the receiver to 5 mc. Place the receiver antenna near the generator. Adjust coil L1 until the oscillator carrier is heard. Now set S1 to the 500-kc position. Adjust C2 until the oscillator carrier is heard at 5 mc in the receiver. Tune the receiver to 5.5 mc. Set C3 for minimum capacitance. Adjust C1 until the oscillator carrier is heard at 5.5 mc. Repeat adjustments of C1 and C2 several times since each will affect the other. It also may be necessary to set S1 back in the 5-mc position and readjust L1.

This procedure will automatically insure that the oscillator will reach 10 mc when S1 is in the 0–5-mc position and C3 is rotated to minimum capacitance. However, it might be better to check this point by setting the receiver to 10 mc with the antenna near L1 and rotating C3 toward minimum capacitance. A strong carrier should be noted at some position of C3, at or near minimum capacitance. If it isn't, repeat the alignment of L1, C1 and C2.

When the frequency extremes of the oscillator are set on both ranges, it is necessary only to set the receiver to the intermediate frequencies to obtain the remaining calibration points. When the calibration is completed, it's a good idea to coat the cardboard scale with colorless nail polish or Polystyrene Q dope to give it a hard surface.

L2 can be adjusted by setting the receiver to 10 mc. Place the antenna near the cathode-follower output. Set a signal generator feeding into the rf input connector on the front panel to 5 mc. With the internal oscillator at 5 mc, S2 open and C9 at maximum capacitance, adjust L2 for maximum output in the receiver. This adjustment can also be made in the initial use of the instrument as an oscilloscope frequency marker. At this time C9 is set at slightly less than maximum capacitance and L2 adjusted for maximum marker height on the scope.

To use the bandwidth marker generator it is always necessary to remember that the output frequency will differ from the signal generator frequency by 5 mc. If the desired output frequency is 10.7 mc, the signal generator is set for either 5.7 or 15.7 mc. The lower frequencies usually have more bandspread on most signal generators —hence greater accuracy. Therefore it is usually better to use the lower frequency. Switch S2 is set for the frequency output range and C9 is adjusted for maximum output. This is done during the visual alignment of the if under test. Simply adjust C9 for maximum marker pulse height.

The bandwidth marker generator is applied to circuits and alignment problems in precisely the same manner as the signal generator was when used alone. Except now, of course, the marker generator frequency dial is adjusted to give specific frequency changes called for in alignment procedures. END

BUILD a versatile probe set

Part II: Construction and application of low-frequency detector and low-capacitance probes

By EARL T. HANSEN

LAST month we described the construction and application of direct-alignment, isolation and high-frequency probes. We continue with another probe that any oscilloscope owner will find valuable for extending the usefulness of his instrument, the low-frequency detector probe (Fig. 1).

This is a half-wave shunt type crystal demodulator probe for general use in rf circuits where wide-band audio (or video) output is not required. The low frequency referred to is the modulated signal range and not the rf under observation. The useful rf range is approximately 100 kc to 250 mc. The audio output range is from dc to about 10 kc. The input capacitance is 2.5 μμf and causes very little loading or detuning in critical circuits. Resistor R2 in Fig. 1 isolates the cable from the rf source and consequently eliminates cable resonance.

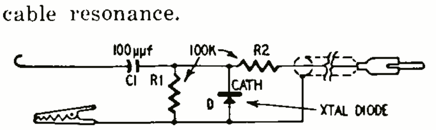


Fig. 1—Low-frequency detector probe.

The probe can be used for signal tracing in the tuner and if strip of a TV set although the horizontal sync will be attenuated and distorted. If the technician is interested only in the presence of the signal and is not concerned with sync clipping, ac ripple, etc., this probe is quite satisfactory. It is recommended for use in radio rf and if circuits. On local AM broadcast stations a signal can probably be observed on the loop antenna and followed through the receiver to the detector.

This is the probe for observing the response curve or aligning a single video if stage. To view the response curve of a single stage, the properly terminated sweep generator output cable is connected to the grid of the preceding stage. The low impedance of the cable swamps out the grid tuned circuit and prevents it from influencing the curve. The detector probe is connected to the plate of the following stage (Fig. 2). To prevent T3 from influencing the curve and being detuned by the probe, the coil must be shunted with a swamping resistor; 200 ohms is a typical value. With this arrangement the response curve of T2 and its trap is presented on the scope. Any regeneration in the stage would show up as a sharp peak. Do not overload the stage; it would cause a distorted response curve.

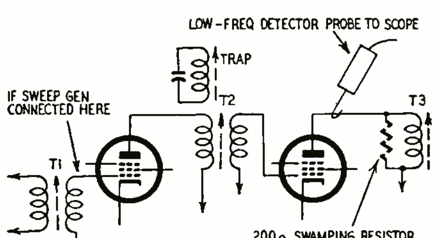


Fig. 2—How if response of a single stage is observed.

The 200-ohm swamping resistor could be included in the probe but this would limit its use. Connect the resistor as close to the tuned circuit as possible. This avoids long leads in a resonant loop, as would be the case if the resistor were in the probe.

Video amplifier bandwidth can be checked by connecting the detector probe to the grid or cathode of the picture tube, whichever the signal is applied to. A video sweep generator is then connected to the grid of the video amplifier tube. Its frequency sweep must range from 0 to 5 mc. The horizontal input to the scope is connected to a 60-cycle variable-phase ac source, as in other response-curve presentations. Some scopes have this source built in; others must use the source provided by the sweep generator. The observed curve will be similar to Fig. 3 in a normal video amplifier.

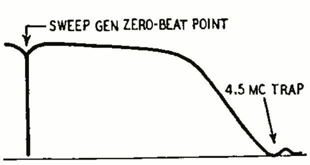


Fig. 3—Video response curve, as shown by the low-frequency detector probe.

Another important use for this probe is sweep-checking the bandwidth of chrominance amplifiers in color receivers. This applies to chroma circuits ahead of the demodulators as well as I and Q bandpass amplifiers after synchronous demodulation. The setup is very similar to that described for video amplifiers. The sweep generator (0–5 mc) is again connected to the grid of the video amplifier. The probe is applied to any luminance or chrominance circuit up to the picture tube and the cumulative response curve at that point seen on the scope. Adjust the chroma gain and generator output to give sufficient amplitude but do not distort the signal by overloading. Markers may be injected by lightly coupling a signal generator to the video amplifier grid.

Both the high- and low-frequency detector probes can also be used with a vtvm to indicate relative values of rf and can be calibrated to give accurate readings up to the voltage limitations of the diode crystals used.

The builder may prefer to call this probe "rf demodulator," which may be more descriptive of its general-purpose use.

Low-capacitance probe

This is probably the most widely used probe in the group, particularly in TV servicing (Fig. 4). It is also known as the high-impedance probe. The bandwidth is more than adequate and exceeds that of most scopes, being flat from dc to over 10 mc. Resistive and capacitive loading are only one-tenth of that with the direct probe. The only disadvantage is the 10-to-1 attenuation. However, this is inconsequential because of reserve oscilloscope gain and the high-amplitude signals usually encountered in TV circuits.

This probe is used when it is desired to observe a signal waveform with a minimum of circuit loading. This would apply to the video detector and all the circuitry beyond it, including the sync section, sweep oscillator and amplifiers, blanking, horizontal afc, chroma bandpass, color apc, synchronous demodulators, power supply and audio. The exception is the high-voltage pulse at the flyback transformer. A special high-voltage capacitive divider probe is best for this application. Nevertheless, the low-capacitance probe can be used to get an accurate picture of the waveform if the tip is held an inch or two away from the point to be tested. This would present the waveform on the scope but it would be difficult to measure the peak-to-peak value by this method.

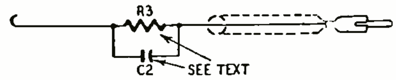


Fig. 4—Low-capacitance probe.

This probe is the only one in the group which requires adjustment when built. It must be adjusted to give equal attenuation at all frequencies. First make sure the input step attenuator in the scope is properly compensated.

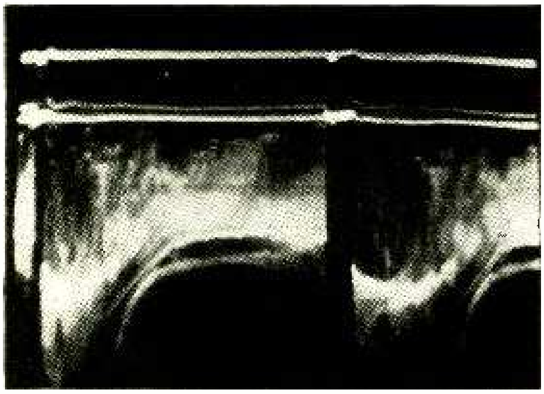


Fig. 5—Composite video signal at output of video amplifier, as seen with the low-capacitance probe. Sweep rate 30 cycles.

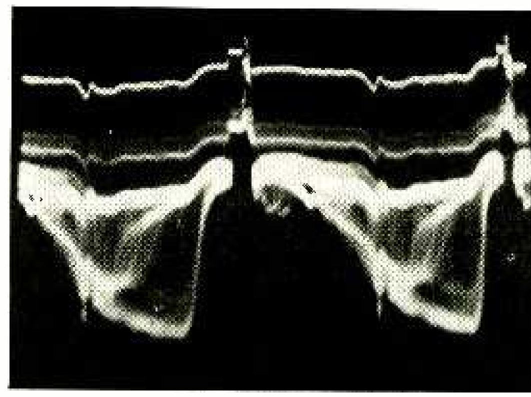


Fig. 7—Video through the low-capacitance probe when there is insufficient compensation.

To do this, use the direct probe and view the composite video signal on the video detector load resistor of a normally operating TV chassis. Use a 30-cycle scope sweep. The presentation should be similar to that of Fig. 5. It will probably be inverted—the important point is to make sure the vertical and horizontal sync pulse tips have the same apparent amplitude.

Should the image be similar to that of Fig. 6 or 7, refer to the scope instruction manual for adjustment procedure. Make this check at all settings of the attenuator switch. If the amplitude is not sufficient at the high attenuation position, move the direct probe to the video amplifier output for greater deflection. If the scope does not have an input attenuator switch, these checks can be disregarded if a waveform similar to Fig. 5 can be seen on the scope.

If the signal shown is similar to Fig. 7 and no means of adjustable compensation is included in the scope, the instrument should be considered inadequate for any TV service work except alignment and response-curve checks.

The next step is to determine the value of the scope input resistance so that the proper value of R3 (Fig. 4) can be determined. If the scope has response to dc, turn the input switch to the dc position and measure the input resistance from the vertical terminal to ground, with the scope off. Input resistance of a non-dc scope can be measured as in Fig. 8. A 60-cycle ac voltage (6.3 volts is satisfactory) is applied to the vertical input of the scope and the vertical amplitude adjusted to show a large deflection covering a certain number of divisions. A variable resistance (0 to 5 megohms) is placed in series with the 60-cycle voltage source and the vertical input terminal. This resistance is varied until the screen image indicates one-half the previous amplitude. The variable resistance is removed and measured with an ohmmeter. This is equal to the scope input resistance R5 (Fig. 9).

To make the probe's 10-to-1 attenuation correct, the value of R3 must be nine times the resistance of R5. Example: R5 is 0.5 megohm. Then R3 equals 0.5 × 9, or 4.5 megohms. A 4.7-megohm ½-watt resistor would be satisfactory.

This resistor determines the low-frequency attenuation ratio. The high-frequency attenuation or compensation is determined by the ratio of C2 in Fig. 4 to C5 in Fig. 9, the latter being the total cable and scope input capacitances. C2 must be one-ninth the value of C6. Since C5 is not known or easily measured, it is simpler and more accurate to estimate the capacitance and adjust it to an exact value, using a video signal. Since the input capacitance C5 to the scope and cable will be somewhere between 55 and 125 $\mu\mu$f, an approximation of C2 would be 8 or 10 $\mu\mu$f. This value can be tried and a signal from the video amplifier observed.

If the value is exactly correct, the horizontal and vertical sync pulses will be at the same level, as in Fig. 5. If the vertical pulse extends beyond the edge of the horizontal portion as in Fig. 7, capacitor C2 is too low and should be increased by a twisted wire gimmick or by substituting a capacitor of slightly greater value. If the vertical pulse group is depressed in the horizontal as in Fig. 6, capacitor C2 is too large. This can be changed to one of lower capacitance or a variable trimmer (3–30 $\mu\mu$f) can be added to the input of the scope and adjusted to accomplish the same effect. The amount of input capacitance added to the scope by this variable trimmer is negligible and it is a very accurate method of adjusting probe compensation.

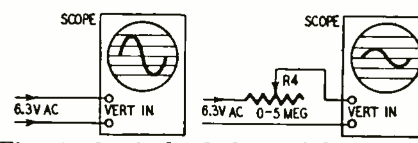


Fig. 8—Method of determining scope input resistance. See text.

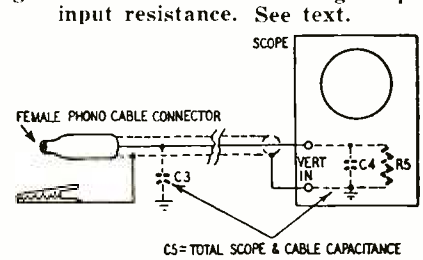


Fig. 9—Breakdown of total scope and cable capacitances.

Many low-capacitance probes have a variable capacitor in the probe itself. This necessitates a larger and bulkier housing. A little extra effort in adjusting the probe during construction allows a light streamlined job to do all the larger ones will, and do it more conveniently.

It is interesting to note that Figs. 6 and 8 indicate that, when the probe is

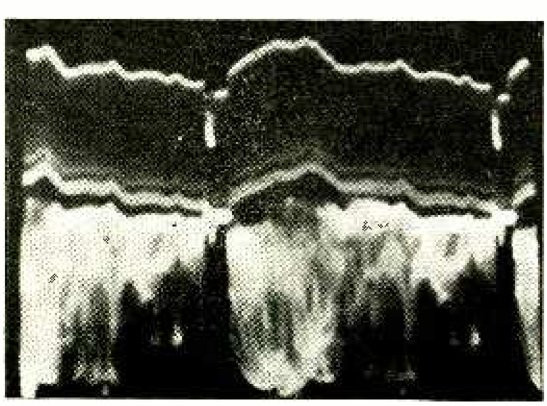


Fig. 6—Video signal as seen with the low-capacitance probe when it is overcompensated. Sweep rate 30 cycles.

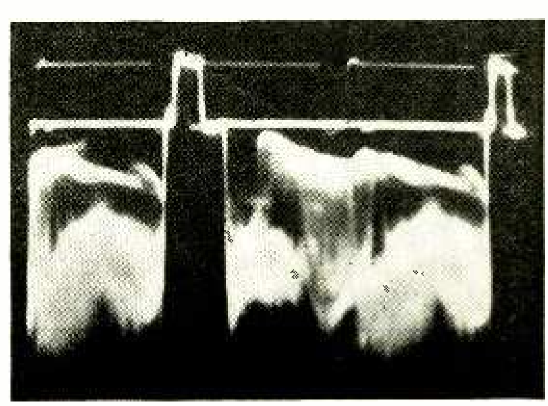


Fig. 10—Same signal as Fig. 5 with the scope sweep rate changed to 7,875 cycles.

improperly compensated, the picture information modulates the amplitude of the sync pulse tips. An open agc bypass capacitor in a TV set can cause a similar effect (Fig. 6 especially).

On some scopes probe compensation holds entirely correct at only one setting of the scope input attenuator. This is because the scope input capacitance changes slightly when the attenuator is switched. Little can be done about this without considerable modification to the scope. Therefore the probe should be adjusted to the most often used setting of the attenuator. The changes in compensation caused by switching are usually very slight and are mentioned only in explanation of effects that might be temporarily puzzling.

When using this probe with scopes that have built-in peak-to-peak voltage calibrators, keep in mind that the presentation on the scope tube will be one-tenth that actually in the circuit under test.

Figs. 4, 10, 11 and 12 show video signals at the output of the video amplifier with a properly adjusted low-capacitance probe. Fig. 11 shows hum modulation causing poor sync and improper shading of the TV picture. The cause in this case was an oscillator mixer tube (5J6) with heater-to-grid leakage. Fig. 12 indicates horizontal sync pulse distortion causing horizontal and vertical jitters. The cause was an ungrounded picture-tube coating and two missing tuner-tube shields, allowing the high-voltage pulses to be radiated into the tuner circuits.

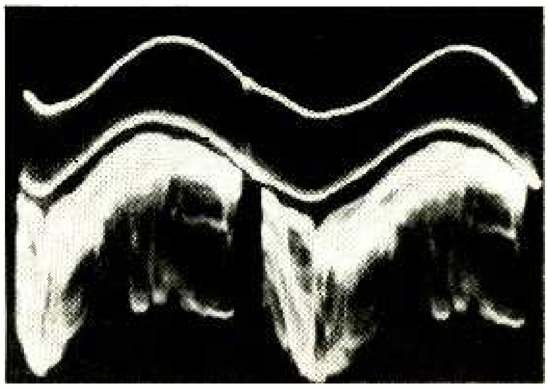


Fig. 11—Video with excessive 60-cycle ac. Video amplifier output through low-capacitance probe. Sweep rate 30 cycles.

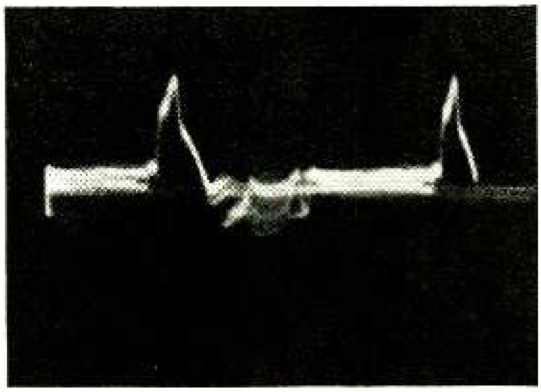


Fig. 12—Video signal with distorted sync pulses. Low-capacitance probe at video-amplifier output. Sweep rate 7,875 cycles.

To summarize, the direct probe is used for audio or other signals where some circuit loading will not be objectionable. The alignment isolation probe is used at the video detector load resistor or tuner check point when the response curve is to be viewed. The high-frequency detector probe (video if) is used for signal tracing in the if section of a TV chassis. The low-frequency detector (rf demodulator) probe is used for general signal tracing in rf-if circuits and for bandwidth checks in video and chroma circuits. The low-capacitance probe is used in all other applications, especially when minimum loading of the circuit under test is desired. Pleasant probing! END

Parts List

R1, 2—100,000 ohms
R3—To be determined, see text
R4—5-meg pot
R5—input resistance of scope
C1—100 μμf
C2—To be determined, see text
C3, 4, 5—Distributed capacitances in probe and scope
D—CK706, 1N295, 1N34 crystal diode or equivalent, see text

Primer for Tube Buyers

Q I sometimes see tubes advertised for sale at prices much lower than list. How come?

A Not all tubes are of the same quality. Some dealers offer seconds, rejects or otherwise less than perfect tubes at lower prices.

Q Isn't that illegal?

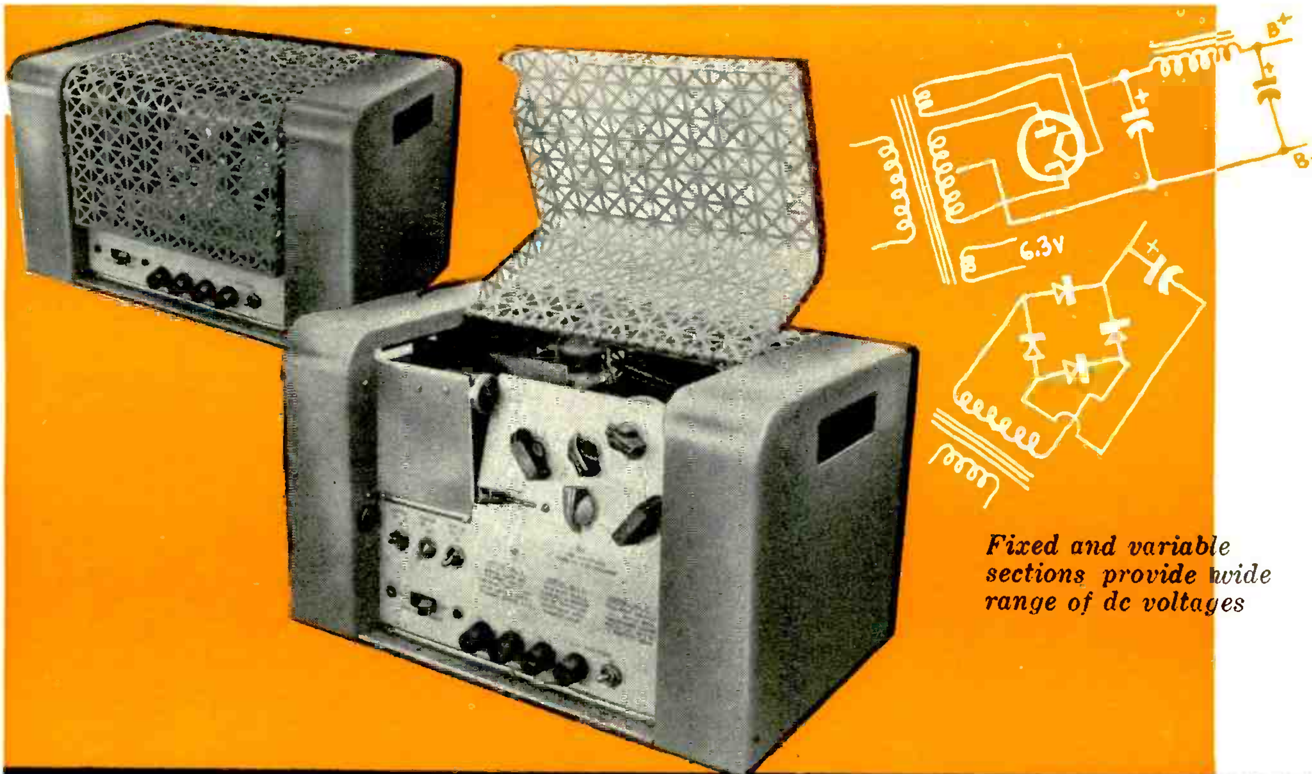
A No! Unethical—Yes, since the reader has the right to expect that unless otherwise stated the tubes offered for sale are new and unused.

Q Well, why do you permit such advertising?

A RADIO-ELECTRONICS doesn't. Maybe we're old fashioned, but the publishers of RADIO-ELECTRONICS insist that their readers be told what kind of tubes they are being offered. Since January 1956 we have demanded that mail-order tube advertisers state specifically that the tubes advertised are new and unused, not rejects or rebranded merchandise. If the tubes do not meet those standards, the advertisers must say so.

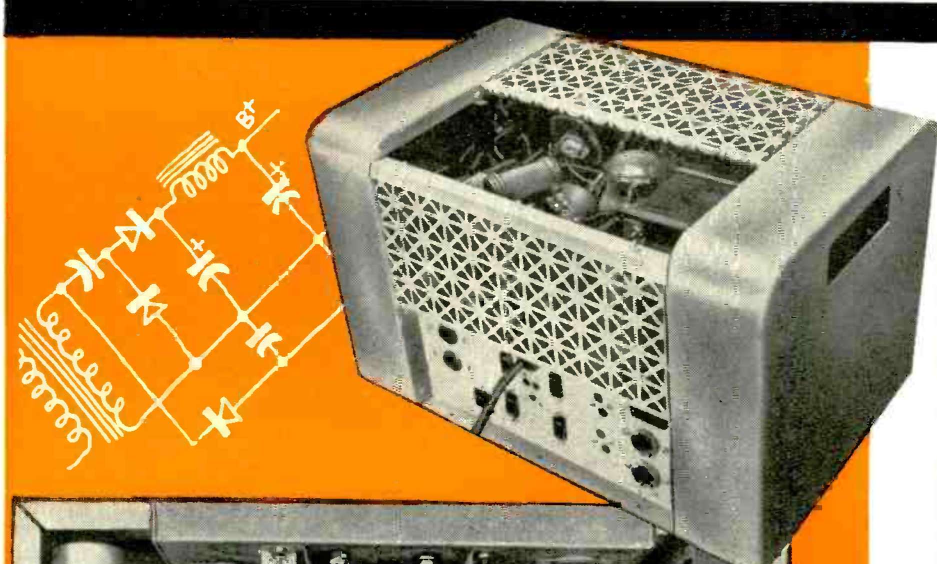
Q Well what do you gain out of that?

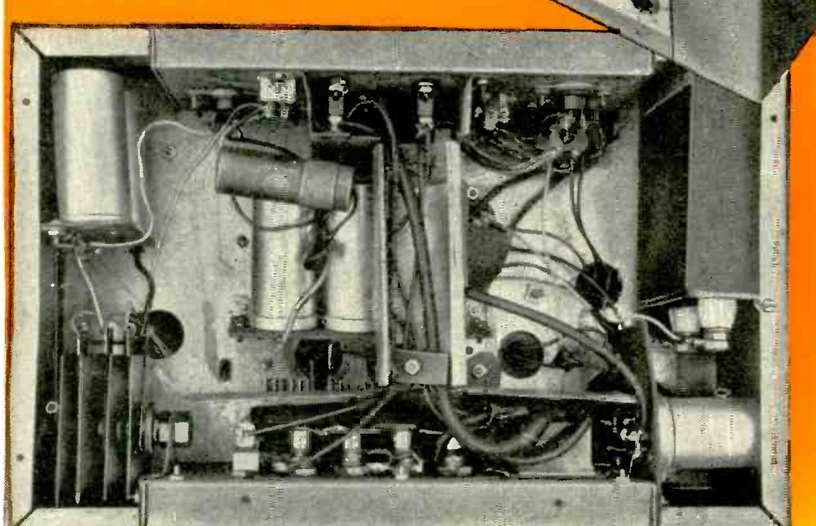
A Financially, if that's what you mean, we gain nothing! In fact, if you check back over issues prior to January 1956, you'll find we've lost some of this advertising. But we are protecting our readers—and our advertisers. And since we're not in business for just the fun of it, we feel that that will help build our circulation—and our advertising income.



Fixed and variable sections provide wide range of dc voltages

EXPERIMENTER'S POWER SUPPLY





By THOMAS R. HUGHES

THIS power supply is designed for operating two or three pieces of equipment at one time for testing and developing receivers, power amplifiers, etc. It consists of three separate sections: a main plate supply providing a fixed dc voltage; a supply of 0–350 volts dc, variable, for fixed bias or other purposes; a supply of 0–24 volts dc, variable, at 3 amperes for a filament supply of low-level stages or other low-voltage needs.

Each section (Fig. 1) is completely isolated from the line and other sections by its own isolating transformer, preventing feedback or crossover within circuits being fed. Aside from the doorbell transformer and 26-volt 3-ampere selenium rectifier used in section 3, and the 1-to-1 ratio isolating transformer used in section 2, all major components can be bought at stores dealing in war and manufacturer's surplus stocks.

Section 1 is a standard power pack fed from a TV plate and filament transformer rated at 800 volts center-tapped and 225 milliamperes. One 6.3-volt winding delivers 10 amperes, one 1.5 amperes and one 5-volt winding 3 amperes. The B-plus output of this section can be

Top — The completed experimenter's power supply; with cover lifted all controls are exposed. Center—Rear view shows the output connections. Bottom —Underchassis wiring and parts layout.

jumped from around 350 volts to over 400 by switching a 10-μf heavy-duty, oil-filled shunting capacitor ahead of the first smoothing choke.

This supply is well filtered by two 10-henry chokes and 40-μf shunting capacitors with a variable voltage-divider resistance load. No voltage regulation is used in any of the three sections because they are well under-rated for normal use.

The second section is a selenium rectifier voltage-tripler circuit, using a four-deck selector switch to change from a single half-wave to a doubler and then to a tripler connection, giving a selection of three voltage ranges.

At these ranges the voltage can be gradually faded toward zero by a rheostat in the 117-volt line ahead of T2. In this way it is not necessary to sacrifice any dc power by I^2R loss in voltage dividers or fixed resistors.

This supply contains a 10-henry smoothing choke and 16-μf capacitor, to iron out ripple. All components are rated for at least 200 ma.

The third section consists of a 3-ampere full-wave selenium rectifier fed from the secondaries of a heavy duty doorbell ringing transformer. With a two-deck selector switch, the secondary taps of this transformer can be reconnected from 8 to 16 or 24 volts. The output is filtered by 8,000 μf.

Here again, the secondary voltage is lowered by a rheostat and resistors on the line side of the transformer and the I^2R loss avoided on the dc side. A selector switch inserts additional resistors in series with the rheostats if the load is too light to produce the required voltage dropping within the rheostat winding. A double-throw tap switch determines whether the resistor bank will be used with section 2 or 3.

Design of Chassis

The chassis was laid out to shield the filtered sections from the ac components and conductors and separate the selenium rectifiers and capacitors from all heat-producing parts. An aluminum plate was used for the deck to which all transformers and chokes were bolted, thus, there could be no magnetic path from one to another through it. All cores were rotated 90° from adjoining units.

The aluminum plate was mounted approximately 4 inches high to give plenty of room for mounting capacitors and rectifiers underneath. The heat-producing parts were mounted above the deck where plenty of air circulation is permitted by cane-metal covers (See photos).

To protect the controls on the front and the plugs to be inserted on the rear from mechanical injury, both the front control and rear terminal panels are recessed.

The front half of the cane-metal cover is hinged and tilts back over the rear. The rear half of the top can be lifted off pegs without removing any screws but the back vertical section of the screen is screwed in place because the same screws and nuts hold some chokes and transformers in place.

The two ends of the chassis were made from 20-gauge galvanized sheet steel and the front panel and rear terminal board and bottom cover plate were made from remnants of 24-gauge galvanized sheet steel.

Fig. No. 2 shows how the material was cut and bent to make the two ends. In each position that tinsnips could not reach, a row of four small holes was drilled for starting a saw and a fine-tooth hacksaw blade (pointed like a keyhole saw) was used to saw along the line. Bends were made by clamping between pieces of angle iron in a 4-inch vise and creasing with a light hammer.

The drum-shaped rolls at the top corners were made, after all bends were complete, by clamping a section of 2-inch-diameter metal shafting at the place and bending the top extension down over it to meet the front part. Where there was overlapping, the edge was trimmed off with a hacksaw. Small, aluminum countersunk head rivets were used to fasten a small patch of sheet metal inside this joint. The joint was filled with acid-core solder and then the rivet heads and solder were

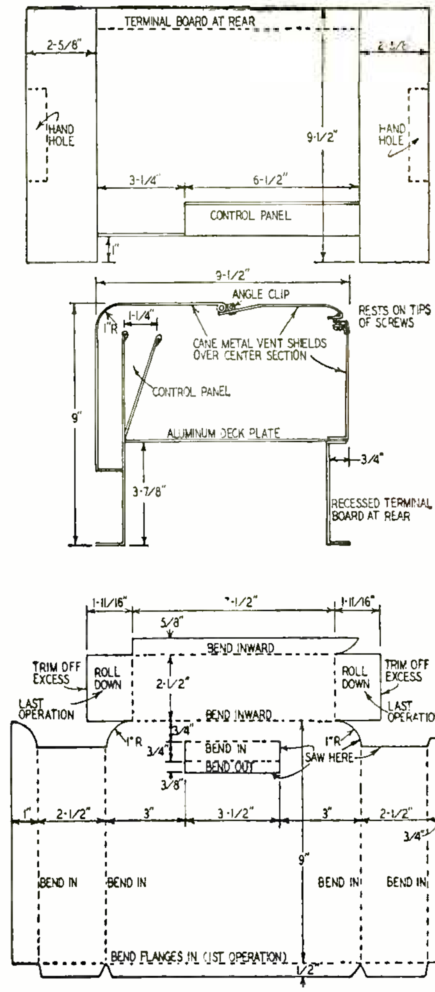
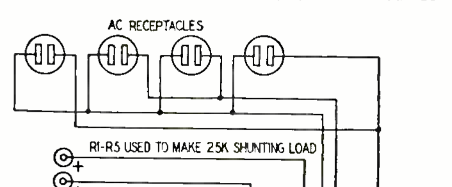
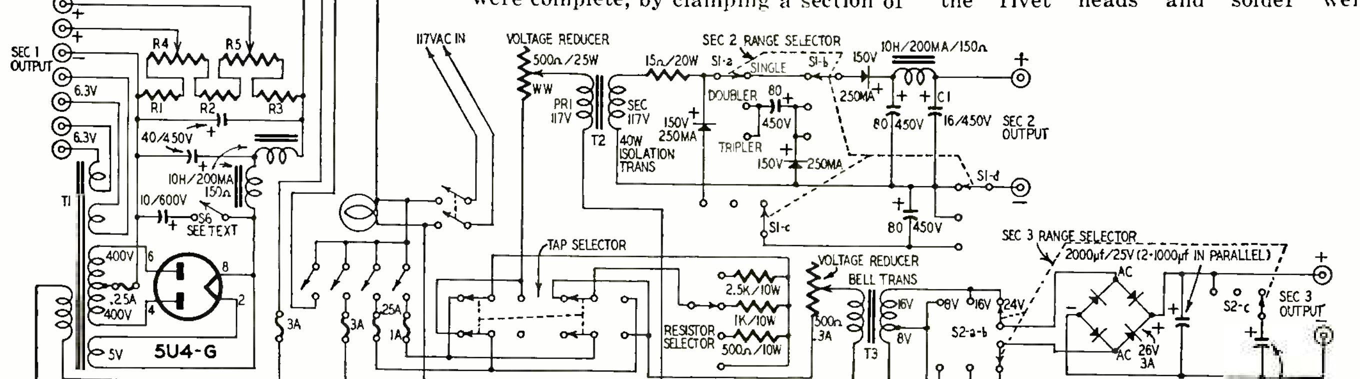


Fig. 2—Layout for construction of the power-supply cabinet.

Resistors: 1—500, 1—1,000, 1—2,500 ohms, 10 watts; R1-5 (see text): 1—15 ohms, 20 watts; 1—500-ohm 0.3-ampere wirewound rheostat; 1—500-ohm 25-watt wirewound rheostat.
Capacitors: 1—10 µf, 600 volts, oil filled, paper; 1—16 µf, 2—40 µf, 3—80 µf, 450 volts, electrolytics; 2—1,000 µf, 25 volts, electrolytics; 3—2,000 µf, 6 volts, electrolytics.
Switches: 1—4-pole double-throw selector switch (contacts on 2 decks); 1—3-pole 3-position 3-deck selector switch; 1—4-pole 3-position selector switch; 4—spst; 1—dpst, 10 amperes.
Transformers and chokes: 1—shielded transformer, 800 volts ct at 225 ma, 6.3 volts at 10 amp, 6.3 volts at 1.5 amp, 5 volts at 3 amp; 1—isolation transformer, 40 watts; 1—bell transformer, 117 volts to 8, 16, 24 volts at 3 amp; 2—10-henry 200-ma, 150-ohm shielded smoothing choke.
Miscellaneous: 1—selenium rectifier, 26-volt, 3-amp, full-wave bridge type; 3—selenium rectifiers, 150-volt, 250-ma, half-wave type; 2—3-amp fuses and holders; 1—0.25-amp fuse and holder; 1—1-amp fuse and holder; 1—high-voltage fuse and holder; 1—0.25-amp Slo-Blo fuse and holder; 1—5U4G and socket; 1—117-volt pilot lamp and assembly; 1—chassis and cabinet (see text); 1—line cord; knobs, output terminals.

Fig. 1—The experimenter's power supply is actually three independent systems.

smoothed down flush with the outer surface.

The chassis sections are bolted together with 6-32 machine screws and nuts and the bottom cover plate attached at blind flanges by sheet-metal screws.

Because the cover tips back over the top, there was no logical way of mounting a handle in the center for carrying the chassis. The outfit weighs around 40 pounds and any handle must be substantial. The 1⅛x3½-inch sections were bent in near the top in each end to provide flush hand holes. Thus, both hands are used to carry the set and the handles provide a smooth surface for distribution of pressure on all fingers. In addition, a certain amount of ventilation is provided at these locations for transformers located in the ends.

Ventilating covers

Cane metal is intended for ventilating panels in doors of water-heater cabinets, etc., in kitchens or service porches and can be bought in sheets at hardware stores or cabinet shops. Along the edges and running through its pattern are strips of solid metal about 1/8 or 3/16-inch wide. I always lay out covers so that solid strips are along the edges to give a finished appearance. If this is not possible, fold the sharp ends of the lattice work back over a piece of soft iron wire (any gauge from 16 to 10) to form a neat rolled edge.

At the sides of the front cover that tips back to expose the controls, ¾-inch flanges were bent over to give it strength. Where it was bent to conform to the 1-inch radius rolls at the top corners of end pieces, the lattice-work sections were carefully trimmed out of the flanges, with diagonal cutters, to meet after the roll was made. These tips were joined by soldering (with acid-core solder) to make the side flange continuous around the bend.

For the hinge, the back edge of this cover was rolled over a 3/16-inch rod; it doesn't matter where the lattice work is cut off. Fig. 2 shows a ⅝-inch flange bent down at the inside top edge of the end pieces. A hole was drilled in this flange at each end to receive the hinge rod. The rod is cut to extend past the flanges and can be slid endwise while inserting in one end and then slid back through the hole in the other end.

The cane-metal section above the terminal board at the rear was flanged at the bottom for bolting in place and along the sides for finishing. At the top corners things didn't jibe for securing it by bolts through the flanges. So, to finish and strengthen the top edge and fasten it to the chassis ends, two small angles were bent from 24-gauge sheet steel. These were fitted together, one inside the other, with ears on the ends of one for bolting to the chassis end sections.

These angles were clamped over the edge of the cane-metal back piece by three 4-36 machine screws with the nuts topside. The top cover that mates with this section had the flange bent under so that openings in the cane metal would seat over these three screw tips and hold it in place. Some small angle clips were bolted to the end sections, just back of the hinge, to hold the front edge of this section.

Angle clips were bolted to the front control panel and riveted to the end sections for supporting the aluminum deck section. Soft ⅛-inch tinner's rivets were used on the ends, with the heads inside. The holes were countersunk from the outside so that after the rivet ends were peened into the flared holes they could be smoothed down flush with the outer surface of sheet metal.

The top edge of the control panel was doubled over to leave a finished edge. A sheet of .012-inch Lucite was crimped under this folded edge with a piece of 1-inch medical tape folded over the Lucite and extending past the edge of the metal to keep from cutting the Lucite. Before the controls were finally installed, the Lucite was pulled down over the front of the panel and held in place with pieces of small chrome auto-molding and 4-36 screws and nuts.

A razor blade was used to cut out the Lucite at the holes for control shafts. Then a piece of white paper was placed behind the Lucite and holes cut through it also. I typed labels and instructions on this paper. Then the controls were ready for installing. Locknuts were used front and back on the shafts of all controls. The front nut was adjusted for the desired length of the shaft and tightening was done by the rear nut so that the Lucite would not be damaged.

Fuses and controls

Since this unit is to feed various equipment, all sections are fused. Three fuses are in the transformer primaries and a fourth is used for all four ac line plugs. The fuse in the center-tap lead of the plate supply is mounted in a clip inside the chassis, above the aluminum deck.

Since the contacts of the voltage-range selector switches short adjoining clips as they are rotated, it is well to de-energize the primary while shifting to the next range.

The section-2 range selector (upper left-hand corner of panel) controls the four decks of contactors (S1-a–d). The control to the right of it is the section-2 voltage reducer.

When section 2 is connected to a load requiring its full rated 200 ma, this rheostat will fade the voltage down to 30%, or less, of full range. However, when it is connected to a lighter load, additional 10-watt resistors are connected in series with the rheostat. The control directly below the voltage reducer is the resistor selector.

To the right of the section-2 voltage reducer is the section-3 reducer. It controls a 500-ohm 0.3-ampere rheostat. This rheostat will also need resistors inserted in series with it for controlling light loads.

Below the section-2 range selector, at the left of the panel, is the handle of a 2-deck tap selector. This switch transfers the resistor selector from one rheostat to the other and leaves the remaining rheostat connected straight through.

To the lower right hand of the other control knobs is the section-3 range selector. It controls a three-deck selector switch (S2-a–c), with S2-c switching in a capacitor.

Since I could obtain only two 1,000-μf capacitors at 25 volts from surplus stocks but could get plenty of 2,000-μf units at 6 volts, I use the third deck to switch in three 2,000-μf capacitors in parallel on the 8-volt range. I need the 6.3 volts mostly and this satisfactorily clips ripple.

Assembling

Before assembling, I painted the inside of the end sections, the aluminum deck and the cane-metal grilles with some tough auto enamel which was left over from another job. These parts were baked in the sun for a week before assembly.

All capacitors except C1 were of the aluminum-can twistlock variety, mounted in groups on sections of 3/32-inch electrical fiberboard by drilling holes in the fiber for the tabs to extend through and crimping the tabs. They were mounted so no cans touched any part of the chassis as the chassis was not used for any ground path.

The three selenium rectifiers were mounted in a row by passing an ⅛-inch rod through the brass tubes in their centers. The ends of the rod were threaded with a 6-32 die for nuts to mount brackets at the ends and keep the rectifiers from rotating.

Holes were made through the aluminum deck with a 1 1/16-inch knockout punch at locations where groups of wires had to pass through. Switch S1 was mounted on the aluminum deck by a bracket at its rear.

Since the most complicated wiring was in the connections between this control and the rectifiers and capacitors of the section-2 tripler circuit, a start was made with these parts mounted on the aluminum deck. After all connections were made between the rectifiers and capacitors below deck and the selector switch above, the final leads were extended for connecting to other components as assembly proceeded.

The double-throw tap selector switch, which mounts snugly below S1, was wired next and mounted in its slot on the control panel with leads brought out for connecting to surrounding controls. Pieces of white medical tape were used to stick tabs on the leads and they were identified by writing on the tabs with a lead pencil.

In assembling the chassis, the flanges

at the sides of the control panel lock behind the flanges of the end sections to conceal their edges. While these flanges were hooked together and the end sections spread apart, the aluminum deck was inserted into the end sections. The deck was then lowered onto its supporting clips as the ends were swung into position and the shaft of S1 was inserted through its hole in the front panel.

The other selector switches were wired and leads brought out before mounting in place on the panel because the controls fit together too snugly for wiring in place.

Only a fair mechanic who has done a little shaping of sheet metal should tackle the construction of the chassis.

Terminal board

Some of the rear plugs are not readily available but were sorted out of surplus odd lots in supply houses. So-called battery plugs were used for some of the low-voltage connectors although such are not normally intended for use as convenience outlets. They are not provided with a large enough fiber insulating plate that they can be mounted in an opening through the sheet metal. Instead, I drilled a ¼-inch hole in the sheet metal where each connecting pin reaches through, allowing a clearance all around the pins of at least 1/16 inch from the metal. The plug receptacles were then mounted back of these holes by two 4-36 screws and nuts.

By having a different type of plug for each voltage or class of supply, no one will make a mistake and damage some equipment by plugging it into the wrong outlet.

A four-prong Jones plug was used for supply from section 2 although only two prongs are of any value. There are two plugs of the same type connected in parallel for each of the classes of supply normally used. This is so that two pieces of equipment can be furnished plate or filament voltage at the same time. And, of course, all plugs are polarized.

The plugs and switches of the ac line were shielded as much as possible from the rest of the chassis. All line wires pass from the front to the rear through the trough raceway. These shields were made from scraps of thin metal.

It is possible that this shielding was unnecessary but I took every precaution possible to prevent hum pickup. I even fed the indicator light at the top of the control panel by a two-conductor shielded cable from below.

Shielded feeders are brought up from the filtered B plus of section 1 to a terminal plate in the top of the chassis. Various resistors can be grouped at this terminal plate for a shunting load or voltage dividers (R1–5). Resistors R1–3 are chosen to add with R4 and R5 (if needed) for making up a usual shunting load of 25,000 ohms. END

Re: FM-3 AFC Conversion

Had trouble adding agc to your Heathkit FM-3 or 3A tuner? Try these suggestions

WE have received inquiries from readers who did not get satisfactory performance after adding afc to their Heathkit FM-3 tuners as described in the January 1957 issue. Heath Company engineers had previously successfully modified several tuners and report, on inquiry, that the main difficulty seems to be in the germanium afc diode.

Two diodes of the same type may have conductance curves that vary widely. Optimum performance is usually obtained when the diode is operated on the knee of the curve. The best operating point for your diode can be obtained by varying the cathode voltage of the 6C4 until the afc action is most positive or until a fairly strong station covers the widest possible tuning spread.

If the afc does not work the 6C4 operating voltages are incorrect, the diode is reversed or one of the newly installed components is defective. To change the operating point of the diode, try a different value of resistance for the 6C4 plate load resistor, cathode resistor or by loading the grid with a fairly high resistance to ground. This applies only to the modification where the 6C4 cathode supplies bias and actuating voltage for the diode as in Fig. 3 of the article.

When it is impossible to obtain correct calibration after conversion, it will probably be necessary to replace the 10- or 14-μμf N750 temperature compensating capacitor (across the oscillator coil on the tuning assembly) with a lower value. Try a 4.7-μμf N750 unit.

A substantial improvement was made in two of the tuners by increasing the size of the capacitor (10 μμf) in series with the diode and the oscillator grid. A value of around 20 μμf worked nicely. In some cases, this larger coupling capacitor may affect calibration and necessitate a reduction in the temperature-compensating capacitor mentioned above.

This afc circuit is sensitive to signal strength. Control action is usually good on strong and medium signals but may be slight or non-existant on weak ones. The if alignment must be good or the set will respond only to very strong signals.

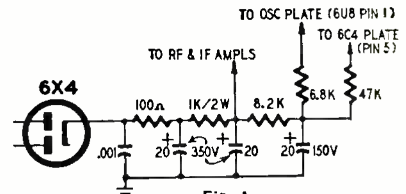


Fig. 1

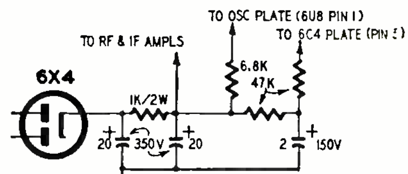


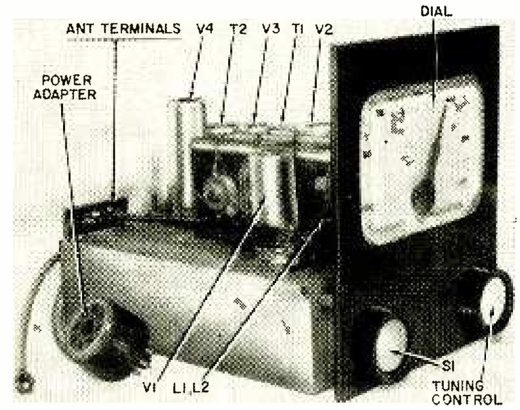
Fig. 2

Modifying the FM-3A. Most of the circuit differences in the FM-3 and FM-3A are at points involved in the afc modification. In the FM-3 the 6C4 alone is decoupled from all other circuits by a 47,000-ohm resister and 2-μf capacitor as in Fig. 1. The diagram of comparative circuits in the FM-3A (Fig. 2) shows the oscillator and 6C4 decoupled from the remaining circuits by an 8,200-ohm resistor and 20-μf capacitor. If your tuner is a model FM-3A, change its circuit to agree with that of the FM-3 before modifying for afc. END

easy-to-align FM tuner

This FM tuner is also easy to construct

By ROBERT ABBATECOLA



Tuner with adapter for power connection to amplifier.

ONE of the major drawbacks in the construction of an FM tuner is the problem of alignment after it is built. The tuner described in this article is designed to overcome this obstacle by using a 6BN6 gated-beam limiter–detector tube, a type used in many modern television receivers.

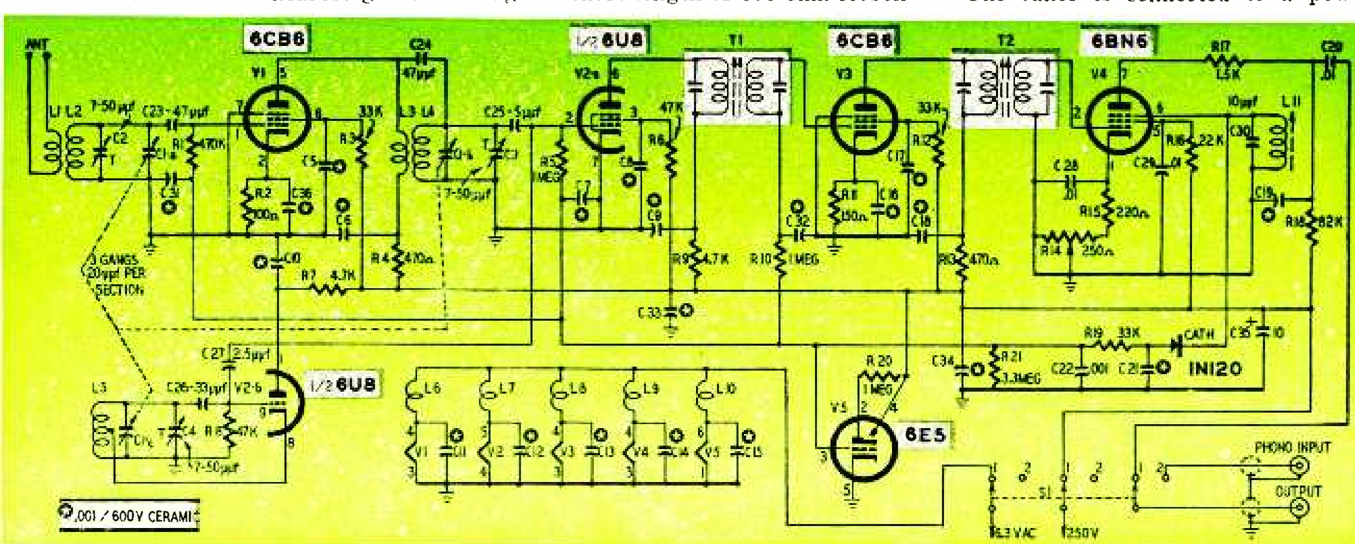
The tuner is constructed on a 5 x 7 x 2-inch chassis although it could also be built on a smaller one. Only standard, easily obtained components are used. The construction itself will present no problems if all the usual precautions for building a vhf tuner of this kind are taken. For instance, keep all component leads and wiring as short as possible and use a separate ground tie point for each individual tube and its components. To help prevent oscillation, connect the center ground post of each tube socket to the nearest ground point. Use ceramic or mica-filled sockets.

This tuner has only four high-gain tubes (Fig. 1). A 6CB6 pentode is used for the rf amplifier, feeding the pentode section of a 6U8, used as a rf mixer. The 6U8 triode section acts as a Hartley oscillator. From the 6U8 mixer, the signal is fed to the 6CB6 10.7-mc if amplifier. The last tube is a 6BN6 limiter–detector. This tube also provides agc for the tuner, through a 1N120 diode connected to the quadrature grid and coil. Fig. 2 shows the top of the chassis, illustrating the parts layout. It will help keep component leads short. The tuning capacitor is mounted in the center of the chassis. The 6CB6 rf amplifier is mounted to the right of the front section of the variable capacitor with antenna coils L1 and L2 directly in front of the tube at the top of the chassis to isolate them from the rf stage. A short length of 300-ohm ribbon line is run to the antenna terminal.

The 6U8 is mounted on the left side, opposite the middle section of the tuning capacitor. The rf coil is under the chassis (Fig. 3) directly below the middle section of the tuning capacitor. The last section of the tuning capacitor is used as the local oscillator, and the oscillator coil is mounted under the chassis, 90° out of line with the rf coil to help prevent mutual coupling. A small copper shield is mounted on the chassis to shield the rf coil from the oscillator coil. Next in line is T1, then the 6CB6 if amplifier, then T2 with the 6BN6 last. No volume control is included in the design of the tuner because most amplifiers already have one.

After the photographs were taken, a 6E5 was added to aid in tuning. Although not essential, the 6E5 can be used in aligning the tuner.

The tuner is connected to a power



C1-a, -b, -c—3-gang 20-μμf-per-section variable
C2, 3, 4—7-50 μμf ceramic trimmer
C5 to C19, C21, C31 to 34—.001-μf 600-volt ceramic
C20, 28, 29—.01-μf ceramic
C22—.001 μf
C23, 24—47-μμf mica
C25—5-μμf mica
C26—33-μμf mica
C27—2.5-μμf mica
C30—10-μμf mica
C35—10-μf 450-volt electrolytic
C36—.001-μf 600-volt ceramic
All resistors ½ watt
R1—470,000 ohms
R2—100 ohms
R3, 12, 19—33,000 ohms
R4, 13—470 ohms
R5, 10, 20—1 megohm
R6, 8—47,000 ohms
R7, 9—4,700 ohms
R11—150 ohms
R14—250-ohm *carbon* potentiometer
R15—220 ohms
R16—22,000 ohms
R17—1,500 ohms
R18—82,000 ohms
R21—3.3 megohms
L1—1 turn No. 16 enamel wire, ¼ inch ID, spaced close to ground end of L2
L2—3½ turns No. 16 enamel wire, ¼ inch ID, ⅜ inch long
L3, 6, 7, 8, 9, 10—14 turns No. 22 enamel wire, 3/16-inch ID, closewound
L4—3 turns No. 16 enamel wire, ¼ inch, ID, ⅜ inch long
L5—3½ turns No. 16 enamel wire, ¼ inch ID, 5/16 inch long, tapped ½ turn from ground end
L11—34 turns No. 30 enamel wire on ⅜-inch-diameter iron core, slug-tuned coil form (Cambridge Thermionic Corp. LS3 or equivalent).
D1—1N120 crystal diode
T1, 2—10.7-mc FM if transformer (J. W. Miller 1463 or equivalent)
S1—3-pole 2-position rotary switch (Mallory 3242J or equivalent)
V1, 3—6CB6
V2—6U8
V4—6BN6
V5—6E5
Chassis, output connectors, knobs, assorted hardware.

Fig. 1—Schematic diagram of the FM tuner.

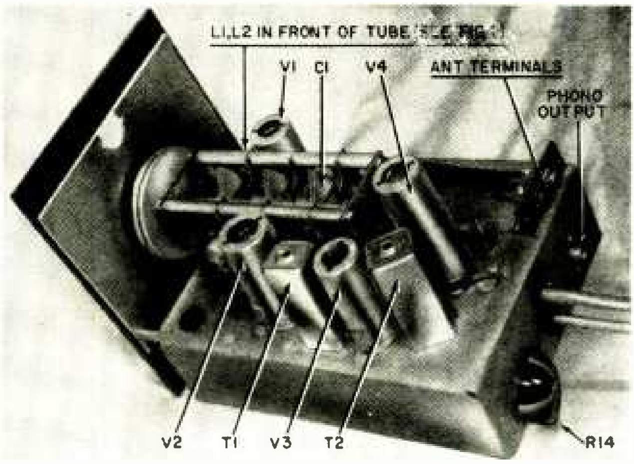


Fig. 2—Top chassis view, indicating layout of large components.

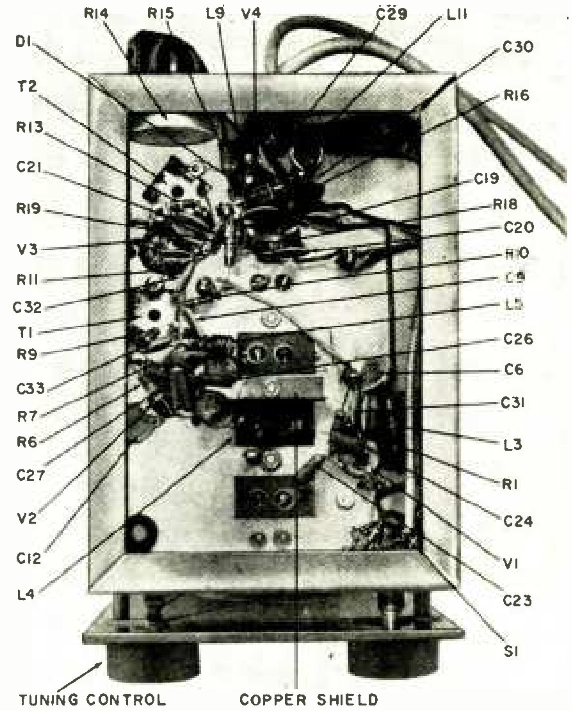


Fig.3—Small parts layout as seen under the chassis.

supply delivering 250 volts at 40 ma, or power can be taken from the amplifier, since little current is needed.

We made an adapter from an old tube base and an octal socket (see photo at the head of the article) to allow taking power from the amplifier without installing an additional socket in the power supply. The adapter is plugged into one of the output tube sockets and the tube plugged into the socket on the adapter. To wire the adapter we soldered wires to all the pins on the socket. Then, using a four-conductor cable we connected leads to the screen grid terminal, filament terminals and the ground terminal, bringing the cable out through a hole drilled in the tube base. Next we brought the wires from the socket down through the respective tube pins and soldered.

Alignment procedure

To align the tuner all that is required is a rf signal generator and a vtvm. If a 6E5 eye tube is used, it will be connected to the agc line at the junction of R1, R5, R10, R19, and the chassis ground measuring the agc voltage. Therefore, while it would be handy to connect a vtvm at this point, it is not entirely necessary. With the tuner turned on, check the eye tube or vtvm. The eye should be fully open and the voltmeter should read less than 1 volt. If the eye is not fully open or the voltmeter reads more than 1 volt, the tuner is probably oscillating. Take some .001-μf ceramic capacitors and connect them at different points in the circuit to see if the oscillation will stop. Any point in the circuit can be bypassed with the .001-μf capacitors except control grids or plates. In our tuner, we found that, by substituting a .01-μf capacitor in place of a .001-μf cathode bypass on the 6CB6 if amplifier, we were able to eliminate the oscillations. Each tuner presents a different problem and the above solution will not apply in every case.

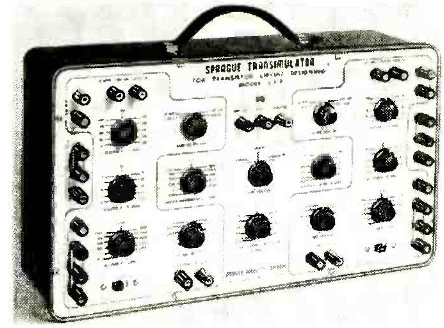
After checking the tuner for oscillations, connect an rf signal generator through a .001-μf capacitor to the control grid, pin 2, of the 6U8 and ground. Turn the tuning capacitor until its plates are fully intermeshed. With the signal generator adjusted for a 10.7-mc unmodulated signal and with the vtvm or eye tube connected as described above, adjust if transformers T1 and T2 and quadrature grid coil L11 for maximum voltage or a minimum shadow on the 6E5. Reduce the output of the signal generator as the agc voltage increases, repeating the adjustments on T1 and T2 and L11 each time. The next step is to align the rf section. The signal generator should be tuned to about 106 mc and connected to the antenna input terminals of the tuner. The tuning capacitor is tuned for an indication on the vtvm or the 6E5. If there is none, try adjusting oscillator trimmer capacitor C4 to get a signal with the tuning capacitor near its minimum capacitance. Then adjust the rf and antenna trimmer capacitors C2 and C3 for maximum indication.

If your signal generator does not cover the FM band (88–108 mc), connect an antenna to the tuner and see if an FM station can be received. Knowing the frequency of the station, adjust the oscillator trimmer capacitor, bringing the station to about the proper position of the tuning capacitor. Peak the rf and antenna trimmer capacitors for maximum indication. Adjust the tuner to receive a station toward the high end of the band and readjust the oscillator trimmer if necessary. Also, repeak the rf and antenna trimmers for maximum agc voltage. Next, tune to a station at the low end of the band. Should the FM band go beyond the full range of the tuning capacitor, spread the oscillator coil out slightly and readjust the oscillator trimmer capacitor. If the band is covered by a small portion of the tuning range, squeeze the oscillator coil slightly and realign. Now for the tracking of the rf and antenna coils. Tune to a station at the high end of the band and adjust the rf trimmer for maximum agc voltage. Then tune to a signal at the low end of the band and retune the rf trimmer capacitor for maximum voltage or eye closure, noting whether the trimmer has to be increased or decreased in capacitance. If its capacitance has to be decreased, separate the turns of rf coil L4 slightly. If an increase is necessary, squeeze the turns of the coil L4 together slightly. Repeat this procedure until there is no change of the trimmer capacitor either at the high or low end of the band. The tuning capacitor will then be tracking across the whole band. The above steps also apply to antenna coil L2.

With the tuner connected to a suitable amplifier, tune in the weakest receivable station and adjust the 6BN6 cathode potentiometer R14 for the best quality and minimum hash, not for maximum gain. You will notice that hash and distortion will increase on either side of this point. Once this is done readjustment will not be necessary for a long time or until the 6BN6 is replaced. Use a *carbon* potentiometer.

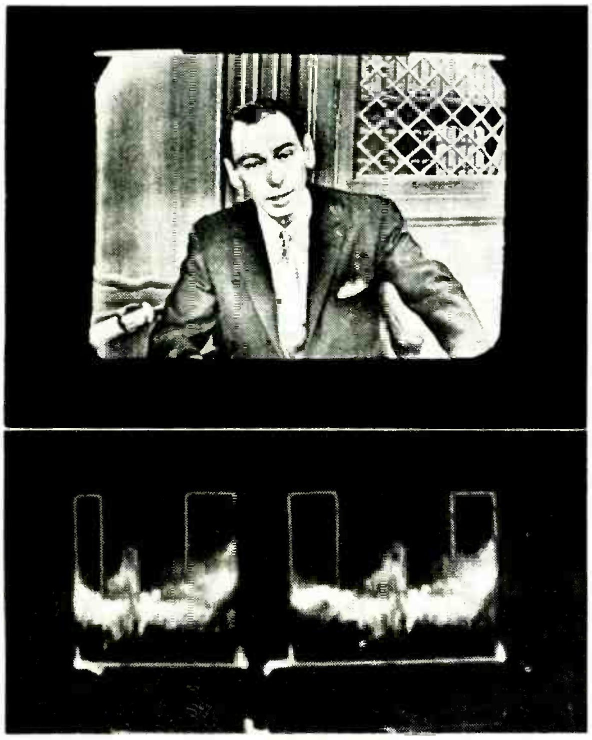
In the off position switch S1 disconnects the heater, B plus and output of the tuner, connecting a phonograph to the amplifier. In the on position, heater and B-plus voltages are supplied to the tuner, the phonograph is removed from the input of the amplifier and the tuner is connected. We used a TV antenna coupler on our regular television antenna to receive both the television and FM signals. A folded dipole on the tuner will work well for local stations, or a regular FM antenna can be installed to obtain more distant stations. END

what's new?



END OF THE BREADBOARD

and research kits is foreshadowed by this Transimulator, with the help of which practically any transistor circuit can be designed without arranging components, cutting wires or making Fahnestock clip connections. It is made by Sprague Products Co. "for transistor circuit designing." Short of high power, the manufacturer states, any ac or direct-coupled amplifier stage, multivibrator, switching, phasing or push-pull circuit can be simulated with any desired type of transistor. Everything for resistance-coupled stages is built in, with voltages, biases and loads continuously variable. Almost any desired external connection, including extra voltage supply, meters, degeneration, bypass, various types of coupling and, of course, signal input and output can be made at the five-way binding posts on the panel of the Transimulator.



QUALITY CONTROL

signals for maintaining TV picture quality are now being transmitted by the ABC television network. They appear on the viewer's screen as two bright horizontal lines in the "vertical interval" shown here at the top of the screen. They would normally be blocked out by the receiver mask. The viewer may get a correct picture by rolling the bar down a little with the hold control and setting the brightness till the gray portion between the two bright lines just becomes black.

The signals are even more valuable to engineers at network stations, who watch the square waves on their waveform monitors (shown at left). The signal is referred to as an Amplitude Reference Signal and takes 4 of the 525 scanning lines. Its height sets the level. Bottom of the pulses is the black, top the white reference. Distortion or misshaping of the square waves indicates corresponding distortion of the signal. Thus ringing, peaking, loss of frequencies at either end of the video spectrum can be recognized and identified immediately.

ELECTRONIC DRIVE operates this new hi-fi turntable at four speeds without mechanical switching. Not only is more precise and trouble-free speed control claimed than with mechanical speed-change systems, but it works on 50-cycle or other non-standard current. The drive circuit powers a hysteresis motor with 30-, 60-, 81- or 141-cycle ac. In effect, the motor becomes a four-speed unit.

The belt-driven turntable, introduced by Fairchild, uses five tubes in the drive unit. A 12BH7 double triode in a Wien bridge oscillator circuit supplies voltage of the desired frequency to a 12BH7 push-pull preamplifier, which feeds another 12BH7 driver. This is cathode-coupled to a pair of push-pull class-B 25BQ6-GA's, which supply the motor through a matching output transformer.

SOLID, OPAQUE METAL

windows and lenses made from a silicon material have been developed by Raytheon. The new optical material, purified to 1 part impurity in 100 million, allows invisible heat rays from subzero targets to reach a supersensitive infra-red detector. Use of this material may make it possible to detect enemy planes, ships and missiles from longer distances in total darkness without revealing the observer's position. The silicon optical parts could also be used as prisms, lenses and windows in devices to analyze petroleum products and help chemists to identify new compounds needed for better plastics and other synthetic materials.

JERRY KASS

THE use of printed circuitry in television receivers is increasing rapidly, and service technicians must adopt special techniques in repairing this relatively new type of wiring. These techniques do not consist of any new approach to servicing or troubleshooting procedure—basically, this need not change. However, certain new tools and methods are required and should be used in the recommended manner.

"Printed" circuits in various branches of electronics are of many types. Two are used predominantly in television receivers — etched circuits, using a photoengraving process, and plated circuits, used for the past few years by Motorola. Of the two, the etched circuit is the most popular and is easily distinguished by certain characteristics. The conductor pattern is noticeably raised over the face of the insulating board by as much as .003 inch. The edges of the conductors are not as smooth as those of plated circuits. This can be seen easily with a magnifying glass. Finally, the back of the etched conductor is extremely rough.

An etched circuit is made from a laminated plastic board having a sheet of thin copper foil bonded to one side. A layout diagram of the desired circuit is made, and then a photographic negative is made of the drawing. The copper foil is then coated with a material that makes it photosensitive.

A contact print of the negative is made on the copper foil, which is then photographically developed. Finally, after developing, the phenolic board is immersed in an etching solution. In the etching process the unexposed portions of the copper foil are eaten away, leaving a precise copper reproduction of the desired circuit bonded to the board. Using this process, line width of as little as .01 inch can be reproduced accurately. Holes are then punched in the board, into which the leads of the various components are inserted. These are mounted on the side opposite the copper wiring. When all the parts are mounted and mechanically tightened, the entire wiring side of the board is dipped into molten solder to make all connections simultaneously. In this process the copper wiring is also tinned. The last step consists of applying a coating of silicone resin varnish to the wiring to prevent short circuits due to dust and moisture.

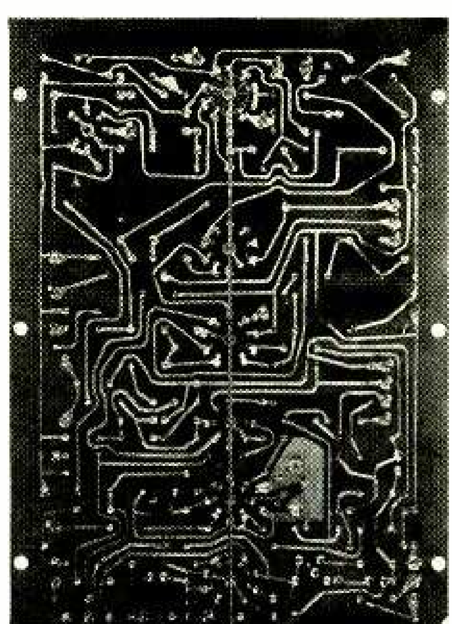
In working with these etched circuits, the technician can work on the top side of the board and still see the printed circuit by placing a lamp of about 50 watts under the board. (Some of the early printed circuits were not translucent.—*Editor*) Do not use a lamp of more than 75 watts as overheating can easily damage the copper foil and the laminate board.

On the subject of heat, a low-wattage soldering iron is desirable. Although a 100-watt iron can be used with care, a smaller unit of 35 to 50 watts is advisable. Only in extreme emergencies or after considerable experience with etched circuits should a soldering gun be used. In keeping with the low-heat approach, a low-temperature rosin-core solder (60% tin and 40% lead) should be used. Shorts from excess solder form easily and are difficult to find. Thus, use solder sparingly to keep it from spreading.

Broken wiring

In general, standard components are used in printed-circuit boards. However, in continuity checking extreme care must be used in checking for breaks in the foil. Many technicians have found it profitable to invest in a magnifying glass. Breaks in the wiring are sometimes hairline thin and easily overlooked.

If the break is very small—just a crack—it can be fixed by flowing some molten solder into it. If the separation is large—1/32 inch or so—the break should be jumped with a piece of solid hookup wire, allowing some slight overlap on each side. Pigtail trimmings from resistors and capacitors are splendid for this purpose. In comparatively rare cases, when the break is very large and the jumper wire may cause a short, use an insulated wire.



Early model etched circuit board.

If the copper foil becomes raised from the board due to excessive heat or mechanical prying, cut off the raised portion and treat the separation simply as a large break in the wiring.

Should it be necessary to remove a printed-circuit board, do so with caution. (Normally this will be done only when the entire board is to be replaced. Under these conditions damage to the board is of no consequence.—*Editor*) In some cases the slightest flexing of the board will cause the foil and mounting lugs to loosen. Thus, before removing the mechanical binding devices that hold the board, clear any wiring or mechanical obstructions around it.

In sets using wire-wrap connections on the board where the connection has been opened, do not wrap the wire back onto the original terminal after the repair has been made. A good procedure is to cut the wiring to the board (where necessary), leaving about ⅛ inch of the color coded wire as a reference point for reconnection—made by *soldering* to the wire-wrap lug.

When printed-circuit boards are mounted to the chassis by lances to which they are soldered, removal requires a specific procedure. To prevent bending the board, apply heat to the point where the eyelet of the etched board is soldered to the lance, and simultaneously apply pressure to the back of the board through the board hole in the chassis. When the solder melts, gently force the board forward to the point where the lance is flush with the eyelet. Then let the junction cool. Do not try to clear the eyelet from the lance in one operation. Continue this procedure at all lances holding the board. Then when each lance is flush with its eyelet, follow the same procedure a second time to clear each eyelet from its lance and free the board from the chassis.

While flexing the printed-circuit board should be avoided, in some stubborn cases of intermittent circuitry

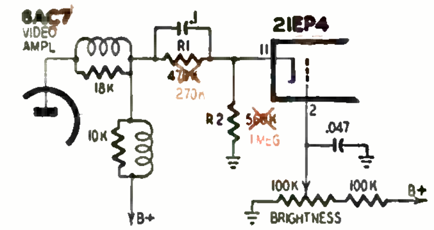


Fig. 1—Brightness control modification in Admiral 22C2 chassis.

it may be helpful. A slight flexing of the board sometimes aids in localizing a trouble such as an intermittent break in the wiring.

In probing printed circuitry, it is often necessary to remove the silicone resin on the wiring. This can best be done by using a silicone solvent, such as Xylene. Almost as effective, depending upon the resin, is lacquer thinner or denatured alcohol. Where work has been completed and the wiring is to be re-covered, clear lacquer can be applied with a brush. Krylon spray also serves this purpose extremely well.

The precise approach to servicing printed circuits depends upon the particular set and trouble. The above, however, is a general outline to be used on all such sets.

Excessive brightness

I have a peculiar case of too much minimum brightness on an Admiral chassis 22C2. With the brightness control set to its maximum counterclockwise position, instead of the picture tube being cut off, the brightness just diminishes slightly and bright retrace lines can be seen. I have experimented with a vertical retrace blanking circuit but this only affects the retrace lines. The brightness potentiometer has been replaced, along with all other components in the cathode and control grid circuits of the picture tube. I have noticed trouble similar to this on other sets of this type, but none quite so bad. I would appreciate some type of blanking circuit or other change that might correct this condition.—T. R., Detroit, Mich.

The solution to this problem can be stated rather exactly since this is a common trouble in the Admiral 22C2 and similar chasses. Fig. 1 shows the brightness control circuit of this model. As can be seen, the voltage on the control grid can be varied from ground potential to some B-plus value. The voltage on the cathode is relatively fixed, being determined largely by the voltage divider formed by resistors R1 and R2. What has happened is that the voltage on the cathode is not sufficiently positive so that, even with the control grid at ground potential, the bias on the 21EP4 is not enough to bring the tube to cutoff.

The solution, therefore, is simple. It consists of varying R1 and R2 so as to place a higher voltage on the cathode of the 21EP4. This can be done by decreasing the value of R1 and increasing the value of R2. A wide range of values can be used, but these shown (R1, 270,000 ohms; R2, 1 megohm) have been tried in numerous sets and provide excellent brightness operation, with the tube going into cutoff when the brightness control is turned counterclockwise.

Parasitic oscillations

The raster on a Westinghouse chassis V-2342 is covered with sharp horizontal streaks and has a scalloped effect from top to bottom. This trouble takes place whether or not a station is tuned in and in some instances the condition gets so bad that the picture breaks up and tears.

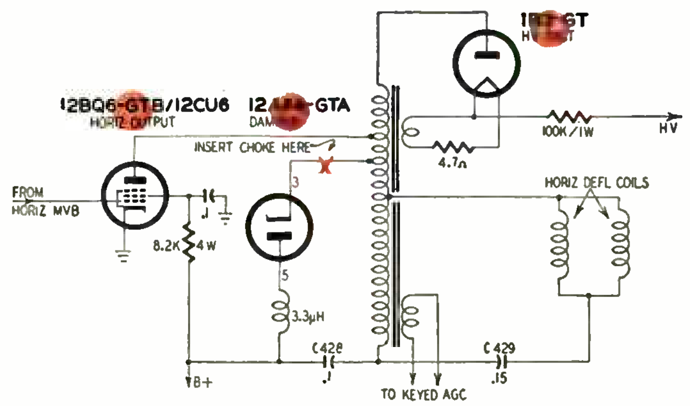


Fig. 2—Stop parasitic oscillations in a Westinghouse V-2342.

I noticed something that may give a clue to the trouble. When the brightness is decreased, the amount of streaking and scalloping increases. When the brightness is increased, the trouble is almost eliminated and there is a normal picture. The setting of the horizontal hold control has some effect on the trouble, but not much. The trouble appears almost certain to be in the horizontal sweep circuit. I have checked as best I can, but have not been able to come up with a solution. I have replaced the horizontal oscillator and output tubes, the damper and the high-voltage rectifier. All these check good, as do all components in these circuits.—F. N., Olympia, Wash.

Trouble such as streaking and scalloping can be caused by a great many defects, but occurring together and with the effect that the brightness control has, this seems almost certainly a case of some sort of parasitic oscillation. The principal effect of varying the brightness is to vary the load on the high-voltage power supply, and thus vary the high voltage. In cases of parasitic oscillations in the horizontal output circuit, the solution is usually in loading down the troublesome individual circuit. In this case it appears very much like the fault lies in the damper circuit.

Since you have changed the tube, first try placing a 3.3-µh choke in the cathode lead of the 12AX4 damper (Fig. 2). If this does not help, short out C429 from the horizontal deflection yoke circuit. This will load down or dampen the entire output circuit by placing the horizontal deflection coils directly in parallel with the flyback winding and the damper circuit. If this does not completely cure the trouble, change the value of capacitor C428 from 0.1 µf to approximately .047 µf. The higher capacitive reactance will help squelch parasitic oscillations.

Power transformer hum

A very annoying case of hum has developed in an Olympic DA chassis after the set has been in operation for 2 hours or so. The hum appears to be coming from the power transformer. This unit is a peculiar box type transformer and the only temporary solution I have come up with is to hit it. But then the hum reappears hours later. Since the set works perfectly well, and I cannot find an exact replacement transformer, I would like to know of some way to reduce or eliminate the hum. Any suggestions would be appreciated—T. M., Columbus, Ohio.

You apparently have a very early model of this chassis since every recent one appears to be of the standard variety. However, other manufacturers have had considerable trouble with hum in this type of unit and the general cure in the field has been to dent or dimple the top and sides of the transformer with a few taps from a hammer. The units are pretty rugged, and you can hit them hard.

Another solution to this problem is to open the transformer and place wood wedges around the sides on the inside. Make these wedges good and tight. If denting and wedging do not help, replace the transformer with one of standard construction. If you can't find an exact replacement, use one of slightly higher ratings, and use dropping resistors to get the proper B voltages. END

MORE about PRINTED CIRCUITS in next month's TV Clinic

Servicing modern damper circuits

The workings of typical flyback systems and how to troubleshoot them

By **MATTHEW MANDL**
TELEVISION CONSULTANT

MANY troubles in the high-voltage and horizontal-deflection systems of television receivers originate in the critical damper circuit. When the damper tube or associated components become defective, symptoms can include raster ripple, light vertical bars, poor linearity, incorrect brightness, loss of high voltage, fuse blowing or other troubles.

The damper tube conducts during the second transient alternation developed by the collapsing magnetic field of the horizontal deflection coils. Fig. 1 indicates the sweep waveform and the dotted lines show the transient voltage which would normally be developed in the absence of a damper tube. The transient produces one or more white vertical bars near the left of the screen since it occurs during the initial portion of the horizontal scan. When a transient voltage builds up, the beam moves forward more rapidly; when it declines, the beam reverses direction and moves toward the left of the screen (Fig. 2). This periodic forward-and-back movement of the beam at one particular place along the horizontal scan produces the white vertical line indicative of insufficient damping.

The first alternation of the transient (caused by the collapse of the field around the deflection coils) does not cause the damper tube to conduct since it places a negative potential on the plate of the damper. This negative alternation develops the flyback voltage which is stepped up in the horizontal output transformer and then rectified, producing the high voltage for the second anode of the picture tube. The second (positive) alternation of the transient causes the damper tube to conduct but, instead of the energy being wasted by having it dissipate through the resistance of the network, it is utilized for two important purposes:

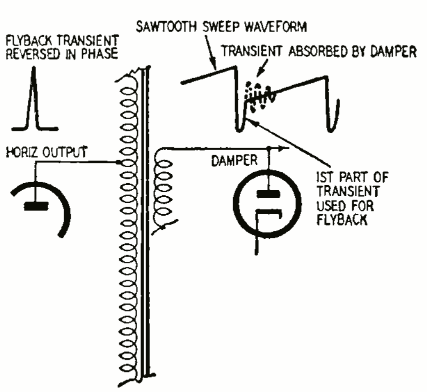


Fig. 1—Dotted waveforms are oscillations in circuit not using damper tube.

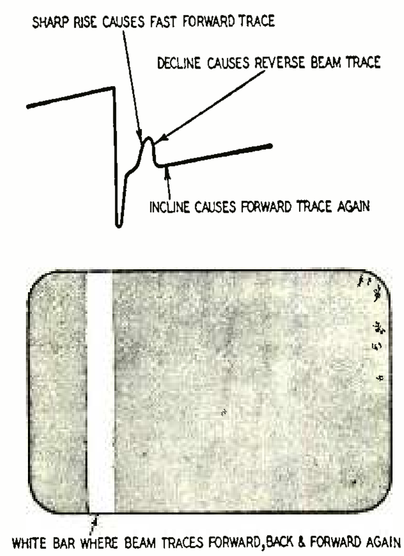


Fig. 2—How a white vertical bar is produced on the picture tube screen.

It provides the initial scanning voltage of the horizontal line trace. Since the horizontal output tube is alternately driven into conduction and to cutoff, a portion of the initial horizontal scan is missing during the time when the horizontal output tube is not conducting. The resistance of the damper tube circuit is regulated so that there is a gradual decay of the second alternation of the transient, and the damped wave is used to fill in the scanning gap which would exist otherwise.

The energy is also used to boost the low-voltage power supply by adding an additional 50 to 250 volts. The amount of additional voltage contributed by the damper circuit depends on the type of horizontal output system and the amount of conduction in the damper tube. Since the damper conducts intermittently, the voltage developed is pulsating and some filtering is necessary. The filter system of the voltage boost network usually employs two small-value capacitors and a choke coil similar to that used in conventional low-voltage power supplies.

Commercial types

Damper circuit design depends on the type of horizontal output system employed. There are two general methods in use in modern receivers, one consisting of the isolation type flyback shown in Fig. 3. This flyback system has been in use for a long time, though most modern receivers employ the autotransformer method. Since, however, the isolation type flyback is still found in receivers, the technician should be familiar with its characteristics.

As shown in Fig. 3, the flyback system uses a horizontal output transformer with two secondary windings. One winding furnishes the filament voltage for the high-voltage rectifier tube, and the other secondary winding is connected to the horizontal deflection coils as well as to the damper tube. The voltage boost section is in the cathode circuit of the damper tube and consists of two capacitors and a choke coil used for linearity adjusting. The repetition rate of the pulse frequency is 15,750 cycles per second, so filter requirements are not as severe as for a low-voltage power supply. Hence the filter capacitors are usually small. The one attached directly to the cathode may be approximately .05 μf.; the one

(*Continued on page 74*)

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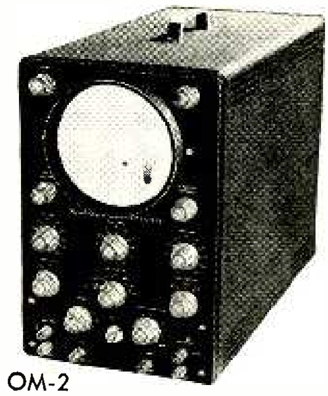

This new and improved oscilloscope retains all the outstanding features of the preceding model, but provides wider vertical frequency response, extended sweep-generator coverage, and increased stability. A new tube complement and improvements in the circuit make these new features possible. Vertical frequency response is essentially flat to over 1 mc, and down only 1½ DB at 500 kc. The sweep generator multivibrator functions reliably from 30 to 200,000 CPS, almost twice the coverage provided by the previous model. Deflection amplifiers are push-pull, and modern etched circuits are employed in critical parts of the design. A 5BP1 cathode-ray tube is used. The scope features external or internal sweep and sync, one volt peak-to-peak reference voltage, 3-position step-attenuated input, adjustable spot-shape control, and many other "extras" not expected at this price level. A calibrated grid screen is also provided for the face of the CRT, allowing more precise observation of wave shapes displayed. The new Model OM-2 is designed for general application wherever a reliable instrument with good response characteristics may be required. Complete step-by-step instructions and large pictorial diagrams assure easy assembly.

MODEL OM-2

$42.50

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HEATHKIT LOW CAPACITY PROBE KIT

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

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HEATHKIT ELECTRONIC SWITCH KIT

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

MODEL S-3

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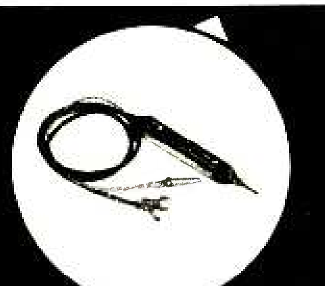


HEATHKIT SCOPE DEMODULATOR PROBE KIT

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

NO. 337-C

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HEATHKIT VOLTAGE CALIBRATOR KIT

This entirely new voltage calibrator produces near-perfect square wave signals of known amplitude. Precision 1% attenuator resistors assure accurate output amplitude, and multivibrator circuit guarantees good, sharp square waves, as distinguished from clipped sine waves. Output frequency is approximately 1000 CPS. Fixed outputs selected by panel switch are; .03, 0.1, 0.3, 1.0, 3.0, 10, 30, and 100 volts peak-to-peak.. Allows measurement of unknown signal amplitudes by comparing to known peak-to-peak output of VC-3 on an oscilloscope. Will also double as a square wave generator at 1000 cycles for determining gain, frequency response, or phase-shift characteristics of audio amplifiers. Equally valuable in the laboratory or in radio and TV service shops.

MODEL VC-3

$12.50

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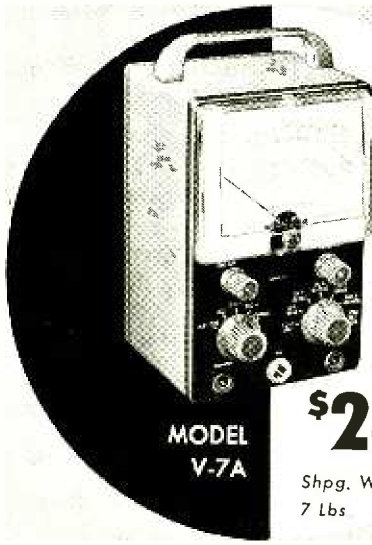
HEATHKIT ETCHED CIRCUIT VACUUM TUBE

Voltmeter Kit



MODEL V-7A

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- *Easy to build — a pleasure to use.*
- *1% precision resistors employed for high accuracy.*
- *Etched circuit board cuts assembly time in half.*

The fact that this instrument is the world's largest-selling VTVM says a great deal about its accuracy, reliability, and overall quality. The V-7A is equally popular in the laboratory or service shop, and represents an unbelievable test equipment bargain, without a corresponding sacrifice in quality. Its appearance reflects the performance of which it is capable. A large 4½" panel meter is used for indication, with clear, sharp calibrations for all ranges. Front panel controls consist of a rotary function switch and a rotary range selector switch, zero-adjust, and ohms-adjust controls. Precision 1% resistors are used in the voltage divider circuits and etched circuits are employed for most of the circuitry. This makes the kit much easier to build, eliminates the possibility of wiring errors, and assures duplication of laboratory instrument performance. This multi-function VTVM will measure AC voltage (rms), AC voltage (peak-to-peak), DC voltage, and resistance. There are 7 AC (rms) and DC voltage ranges of 0-1.5, 5, 15, 50, 150, 500, and 1500. In addition, there are 7 peak-to-peak AC ranges of 0-4, 14, 40, 140, 400, 1400, and 4000. 7 ohmmeter ranges provide multiplying factors of X1, X10, X100, X1000, X10K, X100K, and X1 megohm. Center-scale resistance readings are 10, 100, 1000, 10K, 100K ohms, 1 megohm, and 10 megohms. A DB scale is also provided. The precision and quality of the components used in this VTVM cannot be duplicated at this price through any other source. Model V-7A is the kind of instrument you will be proud to own and use.

HEATHKIT Etched Circuit RF PROBE KIT

This RF probe extends the frequency response of any 11-megohm VTVM so that it will measure RF up to 250 megacycles within ± 10%. Employs printed circuits for increased stability and ease of assembly. Ideal for extending service and laboratory applications of your Heathkit VTVM.

No. 309-C $3.50 Shpg. Wt. 1 Lb.

ETCHED CIRCUIT PEAK-TO-PEAK PROBE KIT

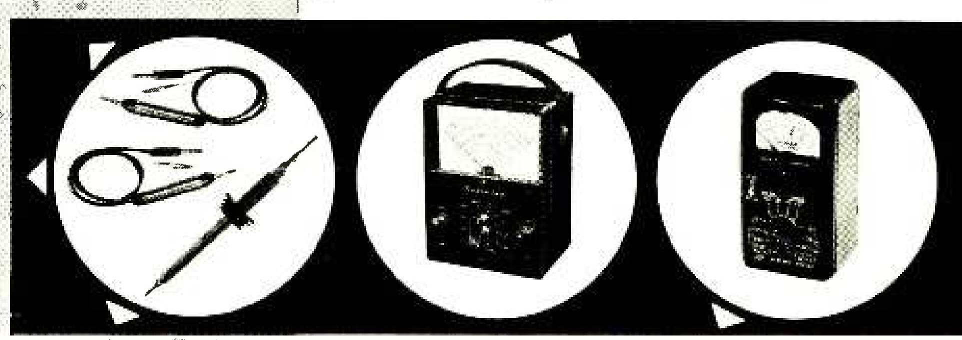
Use this peak-to-peak probe with your 11-megohm VTVM to measure peak-to-peak voltages directly on the DC scales of the instrument. Will measure p-to-p voltages in the frequency range of 5 kc to 5 mc. Employs etched circuit boards for increased circuit stability and simplified construction. Extend the usefulness of your VTVM. NOTE. Not required for the Heathkit V-7A VTVM.

NO. 338-C $5.50 Shpg. Wt. 2 Lbs.

HEATHKIT 20,000 OHMS/VOLT VOM KIT

Sensitivity of this instrument is 20,000 ohms-per-volt DC and 5,000 ohms-per-volt AC. Measuring ranges are 0-1.5, 5, 50, 150, 500, 1500, and 5000 volts for both AC and DC. Also measures current in the ranges of 0-150 microamperes, 15 ma, 150 ma, 500 ma, and 15 a. Resistance ranges provide multipliers of X1, X100, and X10,000, resulting in center scale readings of 15, 15,000, and 150,000 ohms. DB ranges cover from −10 db to +65 db. Housed in attractive black bakelite case with plastic carrying handle, this fine instrument provides a total of 25 meter ranges on its two-color scale. It employs a sensitive 50 microampere, 4½" meter and features all 1% precision multiplier resistors. Requires no external power, and is, therefore, valuable in portable applications where no AC power is available.

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



HEATHKIT 30,000 VOLT DC HIGH VOLTAGE PROBE KIT

This probe provides a multiplication factor of 100 on the DC ranges of the Heathkit 11-megohm VTVM. Precision multiplier resistor mounted inside the two-color plastic probe body. Plenty of insulation for completely safe operation, even at highest TV potentials. Designed especially for TV service work.

No. 336 $4.50 Shpg. Wt. 2 Lbs.

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The Model M-1 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 ohms (3,000 ohms center scale). Uses a 400 microampere meter for sensitivity of 1000 ohms-per-volt. A very popular test device for the home experimenter, electricians, and appliance repairmen, and for use as an "extra" instrument in the service shop. Its small size and rugged construction make it perfect for any portable application. Easily slips into your tool box, glove compartment, coat pocket, or desk drawer. Top quality, precision components employed throughout.

MODEL M-1 $14.50 Shpg. Wt. 3 Lbs.

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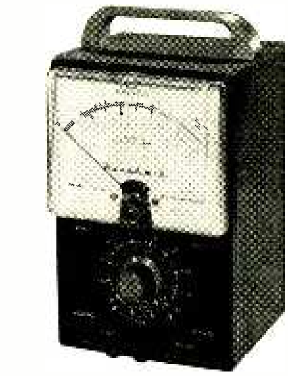
* *Brand new circuit for extended frequency response and added stability.*
* *Ten accurate ranges from 0-.01 to 0-300 volts.*
* *Modern, functional panel styling. "On-off" switch at both extreme ends of range switch.*



This brand new AC vacuum tube voltmeter emphasizes stability, broad frequency response, and sensitivity. It is designed especially for audio measurements, and low-level AC measurements in power supply filters, etc. Employs a cascode amplifier circuit with cathode-follower isolation between the input and the amplifier, and between the output stage and the preceeding stages. An extremely stable circuit with high input impedance (1 megohm at 1000 CPS). Response of the AV-3 is essentially flat from 10 CPS to 200 kc, and is usable for tests even beyond these frequency limits. Increased damping in the meter circuit stabilizes the meter for low frequency tests. Nylon insulating bushings at the input terminals reduce leakage, and permit the use of the 5-way Heath binding post.

The extremely wide voltage range covered by the AV-3 makes it especially valuable not only in high-fidelity and service work, but also in experimental laboratories. AC (RMS) voltage ranges are 0-.01, .03, .1, .3, 1, 3, 10, 30, 100, and 300 V. Decibel ranges cover −52 DB to +52 DB. An entirely new circuit as compared to the previous model. Employs 1% precision multiplier resistors for maximum accuracy. Handles AC measurements from a low value of one millivolt to a maximum of 300 volts.

MODEL AV-3

$29.95

Shpg. Wt. 5 Lbs.

HEATHKIT AUDIO WATTMETER KIT

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

MODEL AW-1

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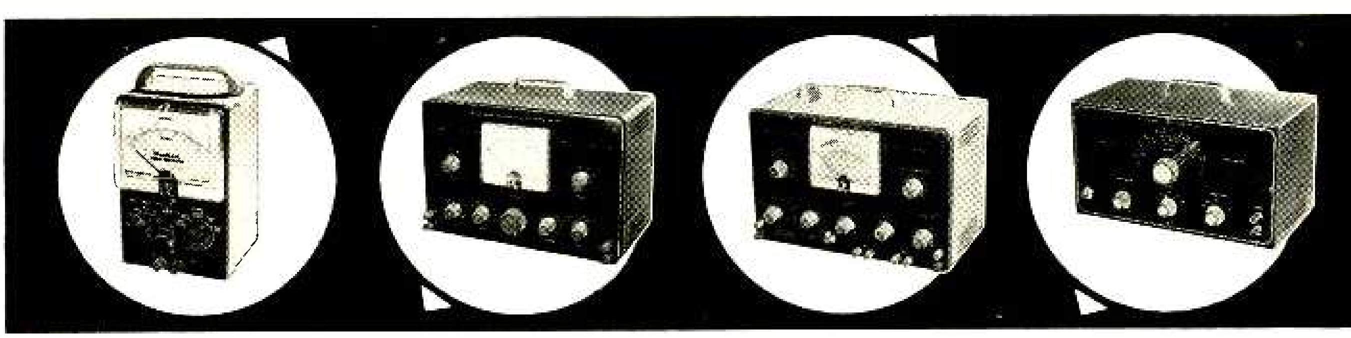
HEATHKIT AUDIO ANALYZER KIT

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

MODEL AA-1

$49.95

Shpg. Wt. 13 Lbs.



HEATHKIT HARMONIC DISTORTION METER KIT

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

MODEL HD-1

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HEATHKIT AUDIO OSCILLATOR KIT

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

MODEL AO-1

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This particular audio generator is "made to order" for high fidelity applications. It provides quick and accurate selection of low-distortion signals throughout the audio range. Three rotary selector switches on the front panel allow selection of two significant figures and a multiplier for determining audio frequency. In addition, it incorporates a step-type output attenuator and a continuously variable attenuator. Output is indicated on a large 4½" panel meter calibrated in volts and in db. Attenuator system operates in steps of 10 db, corresponding with the meter calibration. Output ranges are 0-.003, .01, .03, .1, .3, 1, 3, and 10 volts rms. A "load" switch provides for the use of a built-in 600 ohm load or an external load of higher impedance when required. Output and frequency indicators accurate to within ± 5%. Distortion is less than .1 of 1% between 20 cps and 20,000 cps. Total range is 10 cps to 100 kc. New engineering details combine to provide the user with an unusually high degree of operating efficiency. Oscillator frequency selected entirely by the switch method means that accurate resetability is provided. Comparable to units costing many dollars more, and ideal for use in critical high fidelity applications. Shop and compare, and you will appreciate the genuine value of this professional instrument.

HEATHKIT RESISTANCE SUBSTITUTION BOX KIT

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

MODEL RS-1
$5.50
Shpg. Wt. 2 Lbs.

HEATHKIT CONDENSER SUBSTITUTION BOX KIT

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

MODEL CS-1
$5.50
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HEATHKIT AUDIO GENERATOR KIT

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

MODEL AG-8
$29.50
Shpg. Wt. 11 Lbs.

HEATHKIT DECADE CONDENSER KIT

Precision, 1% silver-mica capacitors are employed in the Model DC-1 in such a way that a selection of precision capacitor values is provided ranging from 100 mmf (.0001 mfd) to 0.11 mfd (110,000 mmf) in 100 mmf steps. Extremely valuable in all types of design and development work. Switches are ceramic wafer types.

MODEL DC-1
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Shpg. Wt. 3 Lbs.

HEATHKIT DECADE RESISTANCE KIT

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

MODEL DR-1
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Shpg. Wt. 4 Lbs.

HEATHKIT VARIABLE VOLTAGE REGULATED POWER SUPPLY KIT

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

MODEL PS-3
$35.50
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HEATHKIT

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* *Modulated or unmodulated RF output.*
* *110 mc to 220 mc frequency coverage.*

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

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

MODEL SG-8

$19.50 Shpg. Wt. 8 Lbs.

HEATHKIT LABORATORY GENERATOR KIT

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

MODEL LG-1

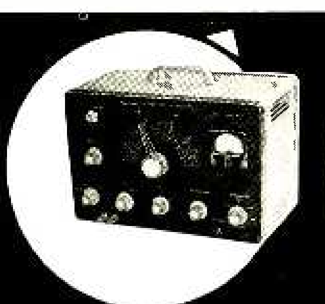
$48.95 Shpg. Wt. 16 Lbs.

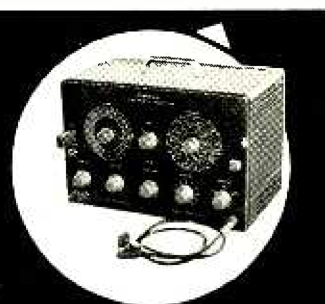
HEATHKIT TV ALIGNMENT GENERATOR KIT

This improved sweep generator model provides essential stability and flexibility for work on FM, monochrome TV, or color TV sets. Covers 3.6 mc to 220 mc in four bands. Provides usable output even on harmonics. Sweep deviation from 0-42 mc, depending on base frequency. All-electronic sweep circuit eliminates unwieldy mechanical arrangements. Includes built-in crystal marker generator providing output at 4.5 mc and multiples thereof, and variable marker covering 19 to 60 mc on fundamentals and from 57 to 180 mc on harmonics. Effective two-way blanking.

MODEL TS-4A

$49.50 Shpg. Wt. 16 Lbs.





HEATHKIT LINEARITY PATTERN GENERATOR KIT

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

MODEL LP-2

$22.50 Shpg. Wt. 7 Lbs.

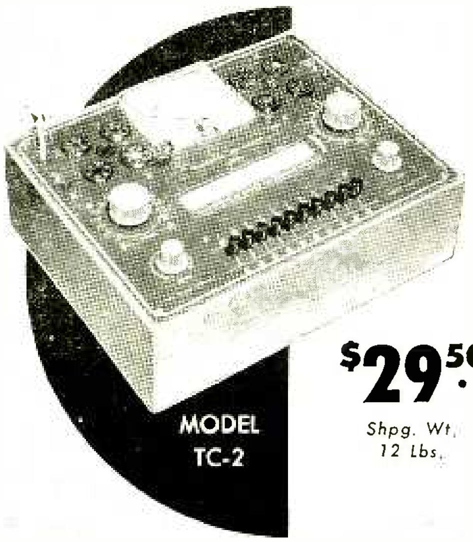
HEATHKIT CATHODE RAY TUBE CHECKER KIT

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

MODEL CC-1

$22.50 Shpg. Wt. 10 Lbs.

HEATHKIT Tube Checker Kit



$29.50

MODEL TC-2

Shpg. Wt. 12 Lbs.

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

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

* *Attractive counter-style cabinet.*
* *Wiring-harness simplifies assembly.*
* *Large 4½" meter with two-color "good-bad" scale.*
* *Separate tube element switches prevent obsolescence.*

HEATHKIT TV PICTURE TUBE TEST ADAPTER

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

MODEL 355

$4.50

Shpg. Wt. 1 Lb.

HEATHKIT PORTABLE TUBE CHECKER KIT

This portable tube checker is identical, electrically, with the Model TC-2. However, it is housed in an attractive and practical carrying case, finished in proxylin impregnated material. The cover is detachable, and the hardware is brass plated. This rugged unit is ideal for home service calls or any portable application.

MODEL TC-2P

$34.50 Shpg. Wt. 15 Lbs.

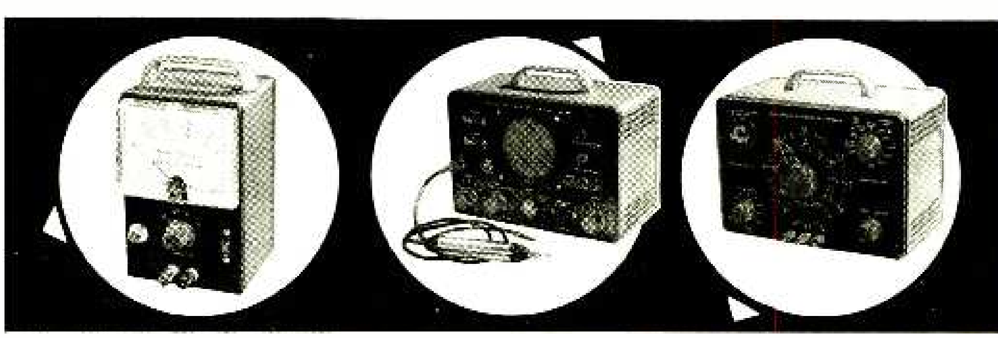
HEATHKIT VISUAL-AURAL SIGNAL TRACER KIT

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

MODEL T-3

$23.50

Shpg. Wt. 9 Lbs.



HEATHKIT DIRECT READING CAPACITY METER KIT

Operation of this instrument is simplicity itself. One has only to connect a capacitor to the terminals, select the proper range, and read the capacity value directly on the large 4½" meter calibrated in mmf and mfd. Ranges are 0 to 100 mmf, 1,000 mmf, 0.01 mfd, and 0.1 mfd full scale. Precision calibrating capacitors supplied. Not susceptible to hand capacity effects. Residual capacity less than 1 mmf. Especially valuable in production line checking, or in quality control.

MODEL CM-1

$29.50

Shpg. Wt. 7 Lbs.

HEATHKIT CONDENSER CHECKER KIT

The Model C-3 consists of an AC powered bridge for both capacitive and resistive measurements. Bridge balance is indicated on electron beam eye tube, and capacity or resistance value is indicated on front panel calibrations. Measures capacity in four ranges from .00001 mfd to .005 mfd, .001 mfd to .5 mfd, .1 mfd to 50 mfd, and 20 mfd to 1000 mfd. Measures resistance in two ranges, from 100 ohms to 50,000 ohms, and from 10,000 ohms to 5 megohms. Selection of five different polarizing voltages for checking capacitors, from 25 volts DC to 450 volts DC. Checks paper, mica, ceramic, and electrolytic capacitors. Indicates power factor of electrolytic condensers.

MODEL C-3

$19.50

Shpg. Wt. 7 Lbs.

HEATH COMPANY

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BENTON HARBOR 20, MICH.

PIONEER DESIGN . . .

New and unique approaches to instrument and equipment designs are a Heath Company tradition. We concentrate all our development efforts on kit projects, since this is our prime activity—and not just a sideline. This logically results in more efficient, more reliable circuit designs—and you benefit from this constant engineering progress. Buying from the undisputed leader in the electronic kit field assures you of completely modern equipment, with outstanding advanced design features.

HEATHKIT

Impedance Bridge Kit

- *½% precision resistors and silver-mica capacitors.*
- *Battery-type tubes, no warm-up required.*
- *Built-in phase shift generator and amplifier.*

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

MODEL IB-2

$59.50 *Shpg. Wt. 12 Lbs.*

HEATHKIT "Q" METER KIT

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

MODEL QM-1

$44.50

Shpg. Wt. 14 Lbs.

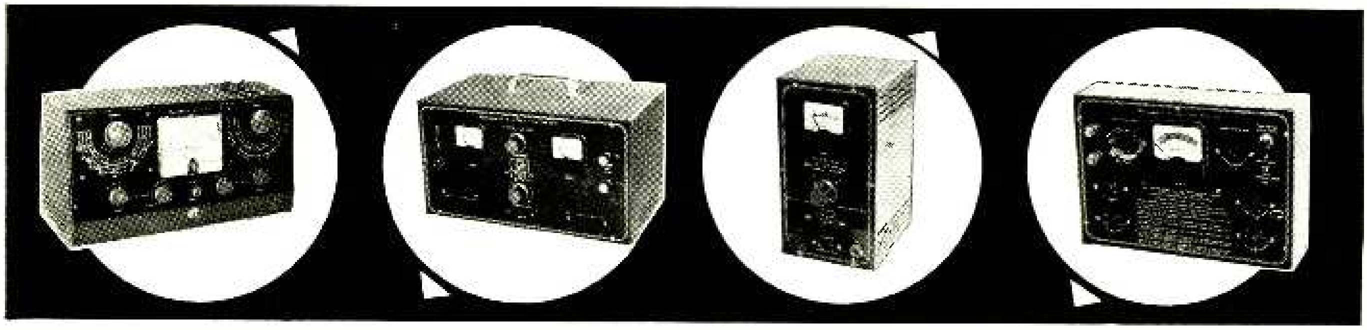
HEATHKIT ISOLATION TRANSFORMER KIT

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

MODEL IT-1

$16.50

Shpg. Wt. 9 Lbs.



HEATHKIT 6-12 VOLT BATTERY ELIMINATOR KIT

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

MODEL BE-4

$31.50

Shpg. Wt. 17 Lbs.

HEATHKIT 6-VOLT VIBRATOR TESTER KIT

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

MODEL VT-1

$14.50

Shpg. Wt. 6 Lbs.

HEATHKIT DX-100 PHONE AND CW Transmitter Kit

$189.50

Shipped motor freight unless otherwise specified. $50.00 deposit required on c.o.d. orders.

- * *Phone or CW on 160, 80, 40, 20, 15, 11 and 10 meters.*
- * *Built-in VFO, modulator, and power supplies.*
- * *High quality components used throughout for reliable performance.*
- * *Features 5-point TVI suppression.*

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

HEATHKIT COMMUNICATIONS TYPE ALL BAND RECEIVER KIT

This receiver covers 550 kc to 30 mc in four bands, and is ideal for the short-wave listener or beginning amateur. It provides good sensitivity and selectivity, combined with good image rejection. Amateur bands clearly marked on illuminated dial scale. Employs transformer type power supply—electrical bandspread—antenna trimmer—separate RF and AF gain controls—noise limiter—headphone jack—and automatic gain control. Has built-in BFO for CW reception.

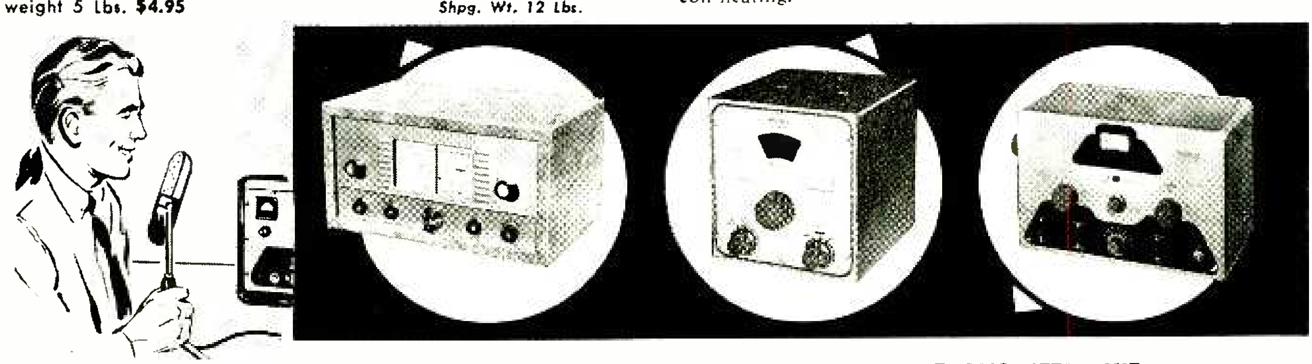
MODEL AR-3
$29.95
INCLUDING NEW EXCISE TAX
(Less Cabinet)
Shpg. Wt. 12 Lbs.

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

HEATHKIT VFO KIT

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

MODEL VF-1
$19.50
Shpg. Wt. 7 Lbs.



EASY ON THE BUDGET!

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

HEATH COMPANY
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BENTON HARBOR 20, MICH.

NEW HEATHKIT CW TRANSMITTER KIT

The brand new Heathkit Model DX-20 Transmitter is one of the most efficient little rigs available today. Featuring an entirely new circuit, it is ideal for the novice, and even for the advanced-class CW operator. A 6DQ6A final amplifier provides plate power input of 50 watts. A 6CL6 oscillator is employed, and a 5U4GB rectifier. The transmitter features one-knob bandswitching to cover 80, 40, 20, 15, 11 and 10 meters. It is designed for crystal excitation, but may be excited by an external VFO. A pi network output circuit matches antenna impedances between 50 and 1000 ohms. Front panel controls are functionally located for your convenience. If you appreciate a good signal on the CW bands, this is the transmitter for you!

MODEL DX-20
$35.95
Shpg. Wt. 18 lbs.

DOLLAR-SAVING ECONOMY . . .
There would be no particular achievement in selling inexpensive merchandise at a low price—although it is being done every day. However, there is something to crow about when, through tremendous purchasing power and factory-to-you distribution, Heath Company can offer top-quality equipment, using name-brand components, at such low prices. This is real economy, as opposed to the so-called "bargains". Needless to say, there is a big difference.

HEATHKIT PHONE AND CW

Transmitter Kit

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

MODEL DX-35

$56.95 *Shpg. Wt. 24 Lbs.*

The DX-35 features a 6146 final amplifier to provide 65 watts plate power input on CW, with controlled carrier modulation peaks up to 50 watts on phone. In addition, it is a most attractive transmitter. Modulator and power supplies are built-in, and the rig covers 80, 40, 20, 15, 11, and 10 meters with a single band-change switch. Pi network output coupling provided for matching various antenna impedances. A 12BY7 buffer stage provided ahead of the final amplifier for plenty of drive on all bands. 12BY7 oscillator and 12AU7 modulator. Provision for switch selection of three different crystals. Crystals reached through access door at rear. Front panel controls marked "off—CW—stand-by—phone", "final tuning", "antenna coupling", "drive level control", and "band change switch". Panel meter indicates final grid current or final plate current. A perfect low-power transmitter both for the novice, and for the more experienced operator. A remarkable power package for the price. Incidentally, the price includes tubes, and all other components necessary for assembly. As with all Heathkits, comprehensive instruction manual assures successful assembly.

HEATHKIT ANTENNA IMPEDANCE METER KIT

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

MODEL AM-1

$14.50

Shpg. Wt. 2 Lbs.

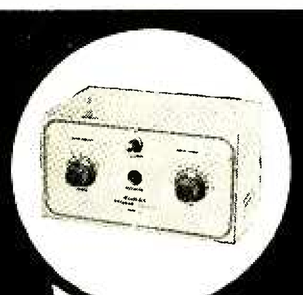
HEATHKIT "Q" MULTIPLIER KIT

The QF-1 functions with any receiver with an IF frequency between 450 and 460 kc that is not AC-DC type. Operates from the receiver power supply, requiring only 6.3 VAC at 300 ma. and 150 to 250 VDC at 2 ma. Simple to connect with cable and plugs supplied. Provides additional selectivity for separating two signals, or will reject one signal and eliminate heterodyne. A big help on crowded bands. Provides an effective Q of approximately 4,000 for sharp "peak" or "null". Tunes to any signal within the IF bandpass of the receiver, without changing main receiver tuning dial.

MODEL QF-1

$9.95

Shpg. Wt. 3 Lbs.



HEATHKIT ANTENNA COUPLER KIT

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

MODEL AC-1

$14.50

Shpg. Wt. 4 Lbs.

HEATHKIT GRID DIP METER KIT

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

MODEL GD-1B

$19.95

Shpg. Wt. 4 Lbs.

HEATHKIT BROADCAST BAND Receiver Kit

MODEL BR-2
(Less Cabinet)
Shpg. Wt. 10 Lbs.

$18.95
INCLUDING NEW EXCISE TAX‡

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

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

ATTENTION BEGINNERS . . .

This kit is an ideal "first project" if you have never built a Heathkit before. A good chance to "learn by doing."

- *Miniature tubes and high-gain IF transformer.*
- *Rod-type built-in antenna. Good sensitivity and selectivity.*
- *5½-inch PM speaker.*
- *Provision for phono jack.*
- *Transformer - operated power supply.*

CABINET: Proxylin impregnated fabric covered plywood cabinet available for the BR-2 receiver as shown. Complete with aluminum panel, reinforced speaker grill, and protective rubber feet. Shipping weight 5 lbs., part No. 91-9A...............$4.95‡

HEATHKIT PROFESSIONAL RADIATION COUNTER KIT

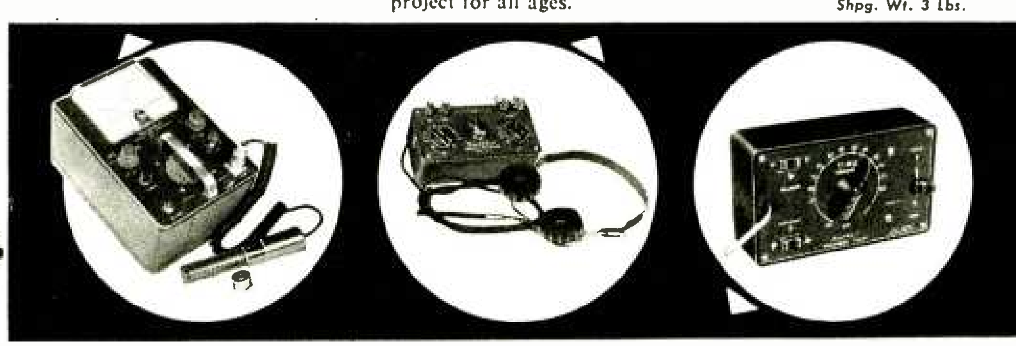
This sensitive and reliable instrument has already found extensive application in prospecting, and also in medical and industrial laboratories. It offers outstanding performance at a reasonable price. Front-panel meter indicates radiation level, and oral indication produced by panel-mounted speaker. Meter ranges are 0-100, 600, 6,000 and 60,000 counts per minute, and 0—.02, .1, 1 and 10 milliroentgens per hour. The probe, with expansion cord, employs type 6306 bismuth counter tube, sensitive to both beta and gamma radiation. It is simple to build, even for a beginner.

MODEL RC-1
$79.95
Shpg. Wt. 8 Lbs.

HEATHKIT CRYSTAL RECEIVER KIT

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

MODEL CR-1
$7.95
INCLUDING NEW EXCISE TAX‡
Shpg. Wt. 3 Lbs.



- *Amazing new circuit for high efficiency.*
- *Compact, portable and rugged.*
- *Stable circuit requires only one 67½ volt "B" battery and two 1½ volt "A" batteries.*

HEATHKIT ENLARGER TIMER KIT

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

MODEL ET-1
$11.50
Shpg. Wt. 3 Lbs.

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BENTON HARBOR 20, MICH.

COMPREHENSIVE INSTRUCTIONS . . .

The step-by-step assembly instructions provided with each Heathkit are the finest available anywhere. Each manual begins at the beginning, and assumes no previous training or experience on the part of the kit builder. This means that our kits can be built successfully by anyone who can follow instructions. As a matter of fact, new manuals are tested by having the kit built by someone in our office who has had no previous experience in electronics. This is your guarantee of complete and thorough instruction material.

HEATHKIT HIGH FIDELITY

Preamplifier Kit

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

Literally thousands of these preamplifiers are in use today, because the kit meets or exceeds specifications for the most rigorous high-fidelity applications, and will do justice to the finest available program sources. Provides a total of 5 inputs, each with individual level controls (three high-level and two low-level). Frequency response is within 1 DB from 25 CPS to 30,000 CPS, or within 1½ DB from 15 CPS to 35,000 CPS. Hum and noise are extremely low, with special balance control for absolute minimum hum level. Tone control provides 18 DB boost and 12 DB cut at 50 CPS, and 15 DB boost and 20 DB cut at 15,000 CPS. Cabinet measures only 12-9/16" W. x 3⅜" H. x 4⅞" D, and it is finished in beautiful satin-gold enamel. 4-position turnover and 4 position roll-off controls provide "LP," "RIAA," "AES," and "early 78" equalization, and 8, 12, 16, and 1 flat position for roll-off. Derives operating power from the main amplifier, requiring only 6.3 VAC at 1 ampere and 300 VDC at 10 MA. Easy to construct from step-by-step instructions and pictorial diagrams provided.

MODEL WA-P2 (With Cabinet) Shpg. Wt. 7 Lbs.

$19.75

HEATHKIT HIGH FIDELITY FM TUNER KIT

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

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

MODEL FM-3A **$25.95** INCLUDING NEW EXCISE TAX (With Cabinet) Shpg. Wt. 7 Lbs.

HEATHKIT BROADBAND AM TUNER KIT

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

MODEL BC-1 **$25.95** INCLUDING NEW EXCISE TAX (With Cabinet) Shpg. Wt. 8 Lbs.

HEATHKIT ELECTRONIC CROSS-OVER KIT

This unusual device functions to separate low frequencies and high frequencies so that they may be fed to separate amplifiers and to separate speakers. This eliminates the need for conventional cross-over circuits, since the Model XO-1 does the complete job electronically. Cross-over frequencies of 100, 200, 400, 700, 1,200, 2,000 and 3,500 CPS are selectable with front panel controls on the XO-1, and a separate level control is provided for each channel. Minimizes intermodulation distortion problems. Handles unlimited power, since frequency division is accomplished ahead of the power stage. Attenuation is 12 DB per octave, with sharp "knee" at cut-off frequency.

MODEL XO-1 **$18.95** Shpg. Wt. 6 Lbs.

HEATHKIT ADVANCED-DESIGN ***HIGH FIDELITY***

Amplifier Kit

MODEL W-5M
Shpg. Wt. 31 Lbs. Express Only

$59.75

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

MODEL W-5

Consists of Model W-5M *plus* Model WA-P2 preamplifier.

Shpg. Wt. 38 Lbs. Express only....$79.50

* *Full 25 watt output with KT-66 output tubes.*
* *All connectors brought out to front chassis apron.*
* *Protective cover over all above-chassis components.*

HEATHKIT DUAL-CHASSIS—WILLIAMSON TYPE HIGH FIDELITY AMPLIFIER KIT

This 20-watt high-fidelity amplifier employs the famous Acrosound Model TO-300 "ultra-linear" output transformer and uses 5881 output tubes. The power supply is built on a separate chassis, and the two chassis are inter-connected with a power cable. This provides additional flexibility in mounting. Frequency response is ± 1 DB from 6 CPS to 150 kc at 1 watt. Harmonic distortion is only 1% at 21 watts, and IM distortion is only 1.3% at 20 watts. (60 and 3,000 CPS). Output impedance is 4, 8, or 16 ohms. Hum and noise are 88 DB below 20 watts. A very popular high-fidelity unit employing top-quality components throughout.

MODEL W-3M: Shpg. Wt. 29 Lbs. Express only........$49.75

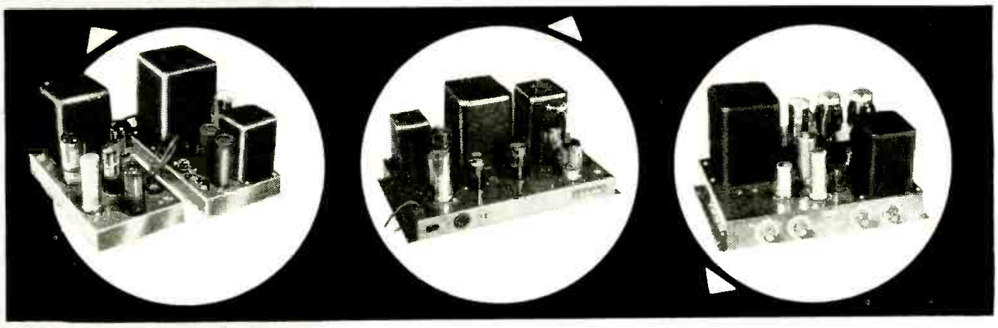
MODEL W-3: Consists of Model W-3M *plus* Model WA-P2 preamplifier. Shpg. Wt. 37 Lbs. Express only.............$69.50

HEATHKIT SINGLE CHASSIS—WILLIAMSON TYPE HIGH FIDELITY AMPLIFIER KIT

The 20-watt Model W-4AM Williamson type amplifier is a tremendous high-fidelity bargain. Combining the power supply and main amplifier on one chassis, and using a special-design output transformer by Chicago Standard brings you savings without a sacrifice in quality. Employing 5881 output tubes, the frequency response of the W-4AM is ± 1 DB from 10 CPS to 100 kc at 1 watt. Harmonic distortion is only 1.5% at 20 watts. Output impedance is 4, 8, or 16 ohms. Hum and noise are 95 DB below 20 watts.

MODEL W-4AM: Shpg. Wt. 28 Lbs. Express only.......$39.75

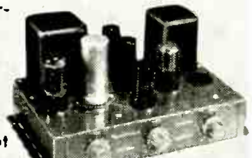
MODEL W-4A: Consists of Model W-4AM *plus* Model WA-P2 preamplifier. Shpg. Wt. 35 Lbs. Express only..............$59.50



HEATHKIT 7-WATT AMPLIFIER KIT

This amplifier is more limited in power than other Heathkit models, but it still qualifies as a high-fidelity unit, and its performance definitely exceeds that of many so-called "high-fidelity" phonograph amplifiers. Using a tapped-screen output transformer of new design, the Model A-7D provides a frequency response of ± 1½ DB from 20 to 20,000 CPS. Total distortion is held to a surprisingly low level. Output stage is push pull, and separate bass and treble tone controls are provided. *Shpg. Wt. 10 Lbs.*

MODEL A-7D **$17.95** INCLUDING NEW EXCISE TAX



MODEL A-7E: Similar to the A-7D, except that a 12SL7 tube has been added for preamplification. Two inputs, RIAA compensation, and extra gain. $19.95‡

HEATHKIT 20-WATT HIGH FIDELITY AMPLIFIER KIT

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

MODEL A-9B **$35.50** *Shpg. Wt. 23 Lbs.*

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

All prices marked with a ‡ include a new federal excise tax that now applies to receivers, tuners and some amplifiers, even though they may be in kit form. Since the tax is in effect as of July 5, 1956, we have no choice but to reflect it in our kit prices. This note is just to let you know we are not increasing our prices on some kits, but merely including this new tax in them.

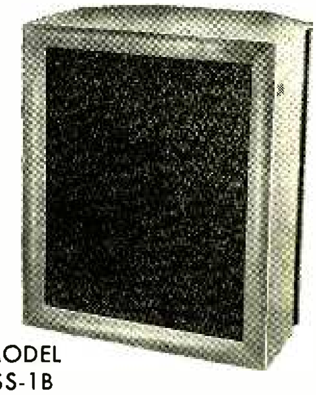
Thank you,
HEATH COMPANY

HEATHKIT HIGH FIDELITY

Range Extending

SPEAKER SYSTEM KIT

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



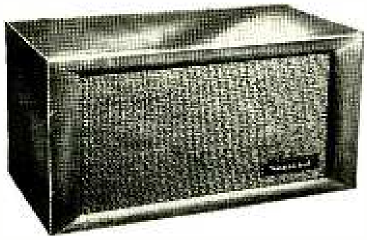
MODEL SS-1B

$99.95

Shpg. Wt. 80 Lbs.

This range extending unit is designed especially for use with the Model SS-1 speaker system. It consists of a 15" woofer, providing output between 35 and 600 CPS. and a compression-type super-tweeter that provides output between 4.000 and 16.000 CPS. Cross-over frequencies are 600, 1,600, and 4,000 CPS. The SS-1 provides the mid-range, and the SS-1B extends the coverage at both ends of the spectrum. Together, the two speaker systems provide output from 35 to 16,000 CPS within ± 5 DB. This easy-to-assemble speaker enclosure kit is made of top-quality furniture-grade plywood. All parts are pre-cut and pre-drilled, ready for assembly and the finish of your choice. Complete step-by-step instructions are provided for quick assembly by one not necessarily experienced in woodworking. Coils and capacitors for proper cross-over network are included, as is a balance control for super-tweeter output level. The SS-1 and SS-1B can provide you with unbelievably rich audio reproduction, and yet these units are priced reasonably. The SS-1B measures 29" H. x 23" W. x 17½" D. The speakers are both special-design Jensens, and the power rating is 35 watts. Impedance is 16 ohms.

HEATHKIT HIGH FIDELITY **SPEAKER SYSTEM KIT**



MODEL SS-1

$39.95

Shpg. Wt. 30 Lbs.

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

This speaker system is a fine reproducer in its own right, covering 50 to 12.000 CPS within ± 5 DB. However, the story does not end there. Should you desire to expand the system later, the SS-1 is designed to work with the SS-1B range extending unit — providing additional frequency coverage at both ends of the spectrum. It can fulfill your present needs, and still provide for the future. The SS-1 uses two Jensen speakers; an 8" midrange-woofer, and a compression-type tweeter. Cross-over frequency is 1,600 CPS, and the system is rated at 25 watts. Nominal impedance is 16 ohms. The cabinet is a ducted-port bass-reflex type. Attractively styled, the Model SS-1 features a broad "picture-frame" molding that will blend with any room decorating scheme. Pre-cut and pre-drilled wood parts are of furniture grade plywood. The kit is easy-to-build, and all component parts are included, along with complete step-by-step instructions for assembly. Can be built in just one evening, and will provide you with many years of listening enjoyment thereafter.

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

ORDER BLANK

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QUANTITY	ITEM	MODEL NO.	PRICE

(*Continued from page 59*)

on the other side of the choke is usually .035 μf.

Since the filter coil inductance has a bearing on the amount of ripple, it can be utilized to control linearity by providing an adjustable powdered-iron core. This affects the linearity of the horizontal line trace at the left side of the screen as it is drawn in or out of the coil. The voltage-boost ripple is filtered less, of course, when the slug is moved away from the center.

The flyback circuit in Fig. 3 uses the transformer for matching the impedance of the horizontal deflection coils to the horizontal output tube impedance by the turns ratio between the primary and secondary windings. The primary also has an autotransformer function and steps up the pulses at the anode of the horizontal output tube to an amplitude sufficient for high-voltage rectification.

A typical autotransformer type of horizontal sweep system is shown in Fig. 4 and is used in the RCA 21-S-501U as well as in the receivers of many other manufacturers. Here, the impedance of the horizontal deflection coils is matched to the plate impedance of the horizontal output tube by suitable taps on the primary winding. In most instances the impedance of the horizontal deflection coils has been increased in contrast to the low-impedance coils used in the older systems. It usually has only a single secondary winding, for the filaments of the high-voltage rectifier tube.

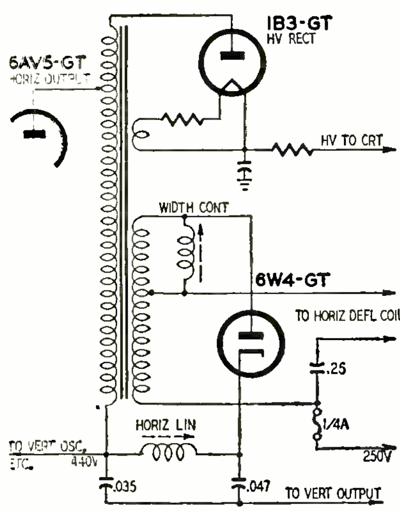

Fig. 3—Flyback circuit using isolation type horizontal output transformer.

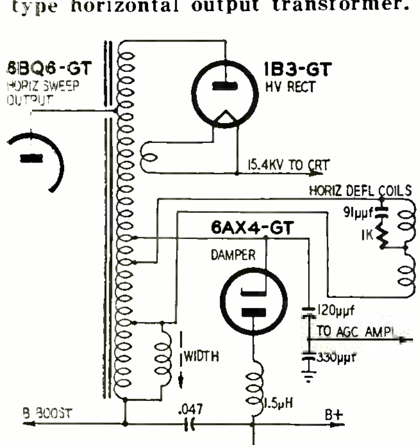

Fig. 4—The RCA 21-S-501U uses an autotransformer in its flyback system.

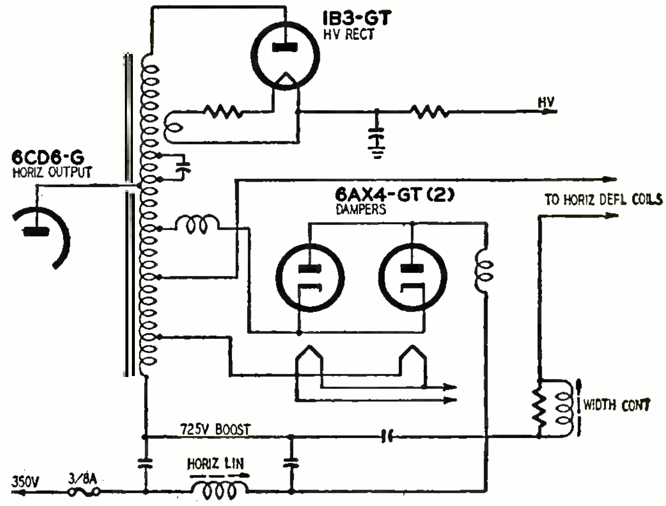

Fig. 5—For improved damping this circuit uses two 6AX4-GT's.

The autotransformer system is highly efficient and produces sufficient voltage for the larger-screen picture tubes without any need for voltage doubling. Since no secondary winding is employed for the deflection coils, the damper tube connections are reversed as compared to the isolated secondary winding type damper system. The waveform for the Fig. 4 system has opposite polarity. Thus the first alternation of the transient is in a positive direction. Since this places a positive potential on the cathode and a negative potential on the plate of the damper tube, it will not conduct. During the second alternation, however, the negative transient makes the plate positive with respect to the cathode and the tube conducts.

On occasion, two damper tubes may be employed for better transient suppression. A typical system of this type is shown in Fig. 5. Two 6AX4-GT dampers are used, connected in parallel and thus capable of passing twice the current of a single tube. If one such tube becomes defective, it should not be replaced without checking the remaining tube to ascertain the degree of emission left in the old tube. If the emission in the old tube has declined considerably, it will mean that the new tube assumes most of the burden of conduction and may be overloaded and hence short-lived. *When one tube needs to be replaced and the other has low emission, both should be replaced.*

A similar two-tube damping system using 6AX4-GT is used in Westinghouse's color receiver chassis V-2284-15.

Servicing factors

A light vertical bar at the left of the screen indicates nonlinear scan usually caused by improper damping. Before the damper tube is replaced, however, check the setting of the drive control since excessive drive increases the transient pulse amplitudes to the point where the damper circuit can no longer dissipate the energy properly. The symptoms of overdrive are also left-hand stretch and in some instances center compression.

If adjusting the drive control does not eliminate the white vertical bar, a new damper tube should be tried. If this does not remedy the condition, check the linearity control as well as the two filter capacitors in the voltage boost circuit.

Occasionally a severely misadjusted linearity control also contributes to the appearance of light vertical bars and for this reason the linearity control setting should be checked in conjunction with the width control setting. Failure to obtain proper horizontal linearity by adjusting these two controls (plus the drive control) calls for a check of the damper tube and associated components.

Several white vertical bars accompanied by raster ripple or distortion (Fig. 6) usually indicates an open voltage-boost filter capacitor or one of incorrect value. In such an instance, replace the units or use a capacitor checker which will test the capacitance of the voltage-boost capacitors as well as their leakage factor.

Leaky boost filter capacitors or overdrive can cause repeated failure of the damper tube because of excessive current through it. Too high a setting of

Fig. 6—Vertical bars and raster ripple produced by defective boost capacitor.

the drive control can also contribute to arcing in the damper section. If the drive control and boost capacitors are not at fault, arcing may be caused by an accumulation of dust on the socket and leads of the damper tube or to the proximity of the leads to each other or to the chassis. The point where arcing occurs can be discovered by operating the receiver in a darkened room, with the back removed and the high-voltage cage opened. If the arcing is intermittent, its location is usually indicated by the corona. And once the location has been found, the leads can be separated and cleaned of dust or grease. In crowded compartments it may be necessary sometimes to place a small piece of mica, cambric or insulating plastic between sections which arc.

Arcing is also produced when the insulation of damper or high-voltage rectifier tube circuit wiring is cracked or broken. In such cases high-voltage spaghetti tubing can be used or coat exposed parts with insulating cement.

It is difficult to ascertain whether the damper tube is passing an excessive amount of current since the cathode or plate circuit would have to be opened and a current-reading device inserted. Since manufacturers do not list the normal current, it is preferable to check for abnormal currents by measuring the voltages as indicated on the service notes for the receiver. Voltage measurements can be made at the screen of the horizontal output tube and at the output of the voltage-boost system and compared with the service notes for the receiver under check. Under most conditions test equipment should not be used for voltage checks at the plate of the horizontal output tube since the high pulse voltages can damage ordinary test equipment.

Since leakage in a damper tube loads down the horizontal output system, it decreases the amount of high voltage in proportion to the leakage. Hence, a decline or loss of high voltage may be caused by the damper tube.

In most receivers the boosted B-voltage obtained from the damper is applied to the bottom of the horizontal output transformer primary for application to the plate of the horizontal output tube. For this reason, failure of the damper tube or an open circuit such as could be caused by a defective linearity coil will remove horizontal output tube plate potential, and hence, high-voltage. Thus, the loss of high voltage should include a check of the damper system as well as testing the horizontal output tube and the high-voltage rectifier.

In some receivers the B-boost potential is applied to the vertical output stage and other circuits. Hence, loss or decline of the boost potential can affect the performance of these circuits. A reduction in damper efficiency may not only result in the generation of white-bar interference, but may also result in a decline in the vertical and horizontal sweep waveform amplitudes and consequent raster shrinkage. END

tv dx

By ROBERT B. COOPER

IN our December, 1956 column, we claimed a first in describing what appeared to be a new form of radio-wave propagation.

As often happens with something new, we found that it has been with us for some time, and we are just realizing what it is. Reports of high-band reception over distances of 1,000 miles and more first began to show up in 1952, but were always placed in the "who can believe this" file.

Mrs. Doris Johnson, a top dx'er of Longview, Wash., reports reception of channel 2, Honolulu, Hawaii, at 1251 PST, March 9. Doris had been looking for KONA since the F2 first began its rise last fall, but observed nothing, even on days when amateur 6-meter signals were skipping between the Islands and the West Coast (2,700 miles).

Reception lasted a brief 30 seconds, "very black in contrast, no sound and tended to fade slightly."

In the file, we find similar reports of positive-identification long-haul burst reception from Seybold, Dunkirk, N. Y.; Schafer, Kenmore, N. Y., and Hill, Gallipolis, Ohio. In each case, the paths have been basically north–south.

The time varies from 0600 EST to 2400 PST. Most reports center after 1800 local time. It looks as if we have a good deal more to learn about meteor-scatter work, or whatever it is that causes brief instances of skip reception on our screens.

From all indications, we have a new world record for television reception. With the sunspot cycle hitting its PEAK right now (the highest peak ever recorded by man), F2 skip between the BBC in London and Australia (10,800 miles) is now an accomplished fact. The proud holder of the record, Norman Burton of Revesby, New South Wales, Australia, began observations in October 1956, with a communications receiver and a special vertical antenna orientated on the Great Circle route.

Reception has been noted on 21 occasions on the 41.5-mc sound channel and on three instances both sound and 45-mc video have been intercepted. The channel-2 (British) 48.25-mc audio channel has been heard faintly on one occasion.

At home

Dx'er Barney Rauch of Peoria, Ill., notes meteor-burst reception at 1204, March 9, from WNCT, channel 9, a distance of 950 miles—another fine example of meteor-burst reception.

Tropospheric dx broke loose along the southern edge of the Great Lakes on Feb. 6–7, with several observers reporting high-band signals of excellent quality over distances as great as 600 miles. Billy Meers and George Bergen of La Grange, Ky., note reception of WIBW, 560 miles, channel 13, for 2 hours on the evening of Feb. 6. Dx-er Ed Prond of Dolton, Ill., noting 10 uhf stations from 3 states with WFMJ, 351 miles, his best for the evening.

The annual spring tropospheric opening along the Gulf Coast appeared in three segments on March 11, 17 and 22. Ray Escoffier, Clarence Rareshide of New Orleans, and Ed Bourgeois, Norco, La., report 600-mile reception on all vhf channels and from the extremes of Florida, Texas and all points between.

If the records of past years can be relied upon, the peak of the sporadic-E season should occur during the last week of June and first week of July. The season began earlier than last year with substantial openings occurring frequently after the 15th of April. Reception from South American stations should have been possible on May 1 throughout the southwestern United States, and we are interested in hearing any unusual reports for this date.

Sporadic-E can and does occur at all hours of the day or night and is unpredictable in most respects. Newcomers to the television dxing game will find E skip an excellent way to break into the hobby. Watch your lower vhf channels (especially those not taken by strong local stations) and, if your antenna is rotatable, check in all directions for signs of unusual reception. The early morning and early evening hours are especially productive.

August will find E skip dwindling in frequency of occurrence and by the 15th of August it may disappear almost entirely for another season. Openings occurring after Aug. 1 will most likely be weak and sporadic, in the afternoon.

One of the largest annual meteor showers is also scheduled for August and promises to bring a large increase in the burst count for MS dx enthusiasts. The Perseid shower is scheduled to peak 0200 on Aug. 12, but should provide very good MS conditions from Aug. 1 through 20. The period of 2200 to 0400 should be the most productive. This would be an excellent time to watch the high vhf channels.

Dx forms

RADIO-ELECTRONICS provides printed TV dx report forms to any dx'ers. Just drop a postcard with your name and address to TV Dx Column, RADIO-ELECTRONICS, 154 W. 14 St., New York 11, N. Y. END

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The more sound selling facts you can put before a customer, the more chance you have of closing a sale! And the Winegard Color'Ceptor gives you selling points no other antenna can offer . . . exclusive buying appeals that clinch 9 out of 10 sales!

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The gold-anodized finish of the Color'Ceptor gives it a rich, quality appearance not found in any other antenna. When you show the Color'Ceptor alongside competitive models, the Color'Ceptor is so distinctive, so *finished-looking* that it is invariably selected by your customers. Gold anodizing has a practical sales advantage, too. It provides immunity to corrosion—prevents deterioration in performance,

If the Winegard Color'Ceptor won't bring in a station you want to see . . . nothing will! Proof of performance was dramatically illustrated when Robert Seybold of Dunkirk, New York—using a Winegard Antenna—broke all long distance reception records in 1956 (see Radio-Electronics Magazine Jan. '57). Equipped with optional signal-boosting Power-Pack and patented "Electro-Lens"* focusing the Color'Ceptor is second to none for long distance reception and clear, watchable pictures in both black-and-white and color!

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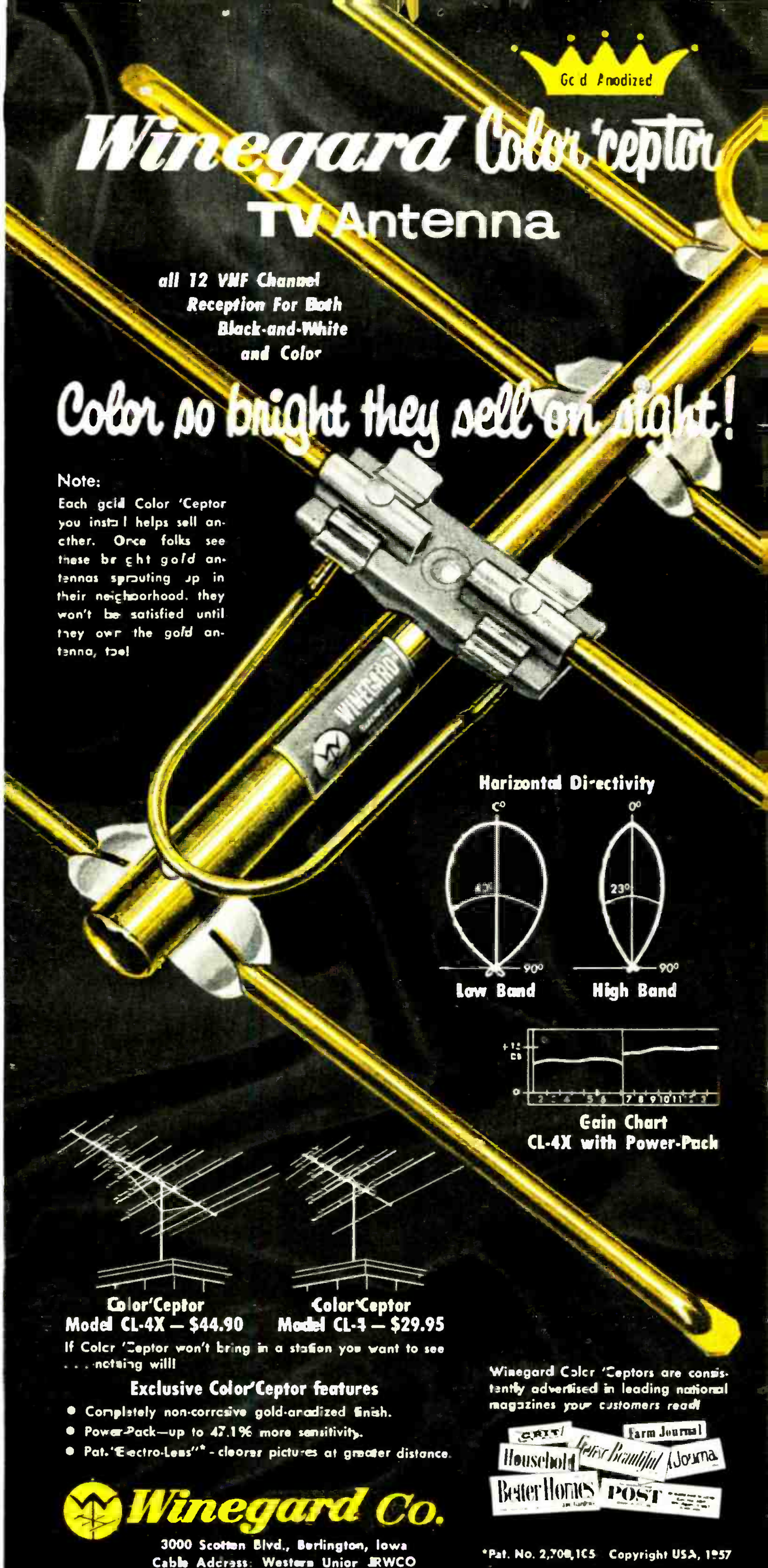
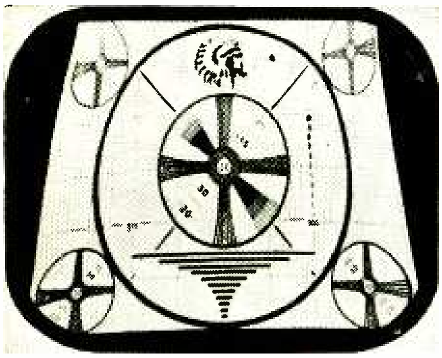


SAVED by the SCOPE

Current waveform solves keystone fault

By ROBERT G. MIDDLETON



An example of keystoning. In the defective set keystone was reversed, with narrowest scan at bottom of screen.

THE set came into the shop with a keystone raster (see photo). We started work by changing the yoke. When this failed to do the trick, the flyback transformer was suspected and replaced. When neither cleared up the keystone, we looked around for some stray magnetic field that might have distorted the electrostatic lens of the picture tube. Failing to locate such a field, we checked the sweep circuits.

This set did not show any dc voltage or resistance values far enough off to supply any clue of circuit misbehavior. That's when it got dubbed a dirty dog (they're the worst kind) and tossed into the doghouse.

It was an ideal situation to tackle with a scope.

A 2-ohm resistor was inserted in series with the return lead of the horizontal deflection coil and the scope connected across it (see Fig. 1). The pattern seen in Fig. 2 was obtained with a 20-cycle sweep.

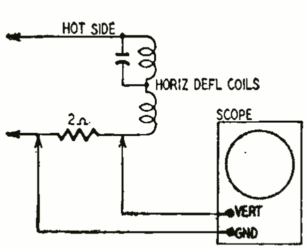


Fig. 1—Scope is connected across a 2-ohm resistor in series with return lead of horizontal deflection coils to observe current waveform.

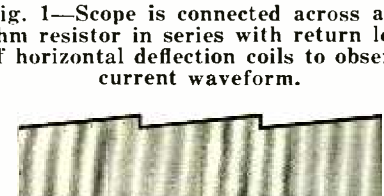


Fig. 2—Waveform of defective set.

Three periods of disturbance can be seen on the 15,750-cycle current waveform. The waveform itself appears as a shading in the display because of the low sweep rate and the dense distribution of the horizontal waveform cycles. The important aspect of this display is the outer contour, which shows three periods of disturbance (each occupying 1/60 second). This is a typical modulation waveform. The horizontal waveform was being molulated by the vertical waveform in the sweep and horizontal oscillator circuits of the receiver.

When this was observed, it revealed that the circuit action was faulty and that some of the voltage from the vertical output circuits must be backing up into the horizontal oscillator circuit. A search was started for open or defective bypass capacitors. The second trial found the culprit, a practically open 20-μf capacitor bypassing the horizontal oscillator supply line (see Fig. 3). When this capacitor was replaced, the receiver's operation returned to normal.

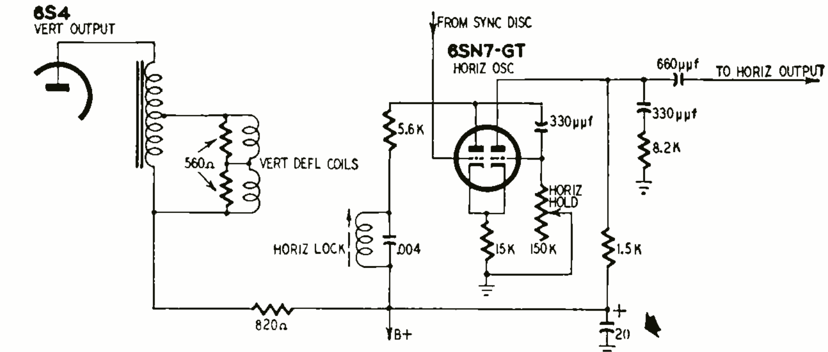


Fig. 3—Open 20-μf bypass capacitor allowed sawtooth current of vertical output circuit to modulate plate supply of horizontal oscillator.

Scopes are valuable

This job pointed out the great value of supplementing dc voltage and resistance measurements with ac waveform and peak-to-peak voltage measurements. In the case of Fig. 1, the peak-to-peak voltage should have been constant but it was not. The variation at a 60-cycle rate was the clue to a quick cure for the trouble.

The technician's chief problem is to determine whether a waveform is correct. For example, the waveform at the plate of a keyed agc tube is often obtained through a small capacitor. In such a case using a direct cable and probe often attenuates the pulse considerably and misleads the operator as to the nature of the trouble. Eventually we can expect to find probe data published with the waveform and peak-to-peak voltage data. Happy day!

It may come as a surprise to learn that some beginning technicians make the error of using a low-capacitance probe when checking if circuits, and a demodulator probe when checking video-frequency circuits. Many operators have come to grief by attempting to use a resistive isolation probe in sync or sweep circuits. These matters may seem elementary, but they are real stumbling blocks to the less-experienced.

Of course when a situation such as Fig. 2 arises, the technician will get no benefit unless he "uses his bean." First of all, there are practically no service data available on *current* waveforms and how to obtain them. Second, only limited information is available on waveform *distortions* of this type which involve complex waveform compositions.

There is no point in buying a scope unless the technician is somewhat of a rugged individualist, with enough gumption to make a definite effort toward self-improvement.

Many scopes have been purchased by service technicians in the belief that a pair of test leads can be connected to the instrument, the power turned on and screen patterns checked which will immediately point to the trouble in the receiver under test.

The variable of time is a very important factor in using a scope. With the proper apprenticeship a scope will pay for itself a hundred times over. END

TRANSOCEANIC TV DX

By CALVIN R. GRAF, W5LFM

WITH the 11-year sunspot cycle expected to hit its peak in late 1957, the possibility for transoceanic television reception becomes more likely as the sunspot number increases. European TV stations, especially the BBC, have been received as far south as southern Texas and west to California beginning in October and continuing the rest of the year. In San Antonio, Tex., reception of England, Northern Ireland, France, Switzerland and Germany have been almost daily occurrences. Best and most often reception is in the frequency range of 41 to 50 mc.

As the sunspot number increases, the F2 layer of the ionosphere, because of increased ionization, is better able to reflect high-frequency signals for longer paths and longer periods of time. During a sunspot minimum the maximum usable frequency for long-distance paths might be as low as 10–20 mc, but at the sunspot peak, it might rise as high as 50–70 mc for certain paths. And the sunspot cycle maximum expected in late 1957 might be the highest experienced in our lifetime! It has been reported that KPRC-TV, channel 2, Houston, Tex., has been received in South Africa, a distance of nearly 9,000 miles.

The accompanying chart lists locations, frequencies, lines per picture, video antenna power and antenna polarization of many TV stations which can easily be received. Remember that in most countries the number of scanning lines which form the picture are different from those of the United States. Except for the United States, Canada and a few South American countries which use 525 lines, most countries use 405, 625 or 819. This means the pictures cannot be locked in on a receiver designed for 525 lines without modifying the receiver circuit. Moreover, since our TV receivers have fixed channels which are different from other countries almost none of the frequencies will coincide. Most other countries use amplitude modulation for the sound carrier while we use frequency modulation. A shortwave receiver covering 40 to 50 mc or a converter is desirable.

Station	Frequencies (mc) Video	Audio	Video ERP* (kw)	Antenna Polarization	Audio	Lines
Great Britain						
London	45.0	41.5	34	V	AM	405
Belfast, N.I.	45.0	41.48	20	H	AM	405
Holme Moss	51.75	48.25	100	V	AM	405
N. Hessary Tor.	51.75	48.23	16	V	AM	405
Kirk o'Shotts Scotland	56.75	53.25	100	V	AM	405
Norwich	56.75	53.25	10	H	AM	405
France	52.4	41.25	50	H	AM	819
Switzerland	48.25	53.75	30	H	FM	625
Australia	64.25	69.75	100		FM	625
Russia	49.75	56.25	40	H	FM	625

*Effective radiated power.

German audio has been received on 45.625 and 48.8 mc (50 kc/swing FM). Russian programs are on from 1100–1500 EST, with the stations closed down Thursdays for maintenance.

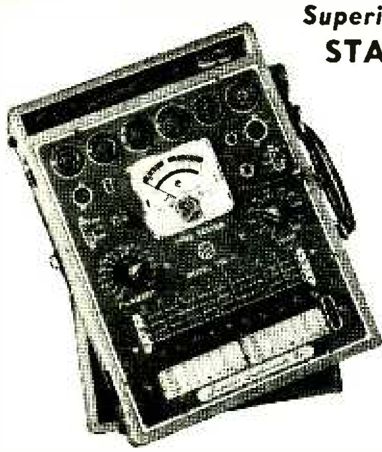
Reception of European stations is best between mid-morning and noon. Australia should be best from mid-afternoon to evening. Since propagation is by the F2 layer, the sun should be near noon at the mid-path point.

Most of the European stations received in south Texas have been heard from 0830 to 1230 CST, with the lower frequencies lasting the longest. During the months of November and December, 1956, BBC TV audio on 41.5 mc was received almost every day and BBC video on 45 mc was received about three-fourths of the time. Occasionally, frequencies as high as 53 mc are received.

When conditions are good, it doesn't require much of an antenna to receive transoceanic TV. A simple 300-ohm *vertical* folded dipole cut to 41.5 mc has picked up TV signals from five European countries. Signal strength is so great at times that the BBC has been heard using a pocket screwdriver for an antenna inside a concrete building! It doesn't take much—give it a try.

END

Superior's New Model TW-11
STANDARD PROFESSIONAL
TUBE TESTER



- Tests all tubes, including 4, 5, 6, 7, Octal, Lockin, Hearing Aid, Thyratron, Miniatures, Sub-miniatures, Novals, Sub-minars, Proximity fuse types, etc.
- Uses the new self-cleaning Lever Action Switches for individual element testing. Because **all elements are numbered according to pin-number in the RMA base numbering system**, the user can instantly identify which element is under test. Tubes having tapped filaments and tubes with filaments terminating in more than one pin are truly tested with the Model TW-11 as any of the pins may be placed in the neutral position when necessary.
- The Model TW-11 does not use any combination type sockets. Instead individual sockets are used for each type of tube. Thus **it is impossible to damage a tube by inserting it in the wrong socket.**
- Free-moving built-in roll chart provides complete data for all tubes. All tube listings printed in large easy-to-read type.

NOISE TEST: Phono-jack on front panel for plugging in either phones or external amplifier will detect microphonic tubes or noise due to faulty elements and loose internal connections.

EXTRAORDINARY FEATURE

SEPARATE SCALE FOR LOW-CURRENT TUBES—Previously, on emission-type tube testers, it has been standard practice to use one scale for all tubes. As a result, the calibration for low-current types has been restricted to a small portion of the scale. The extra scale used here greatly simplifies testing of low-current types.

The Model TW-11 operates on 105-130 Volt 60 Cycles A.C. Comes housed in a beautiful hand-rubbed oak cabinet complete with portable cover.

$47.50 NET

Superior's New Model TD-55
TUBE TESTER

FOR
- **The Experimenter or Part-time Serviceman,** who has delayed purchasing a higher priced Tube Tester.
- **The Professional Serviceman,** who needs an extra Tube Tester for outside calls.
- **The busy TV Service Organization,** which needs extra Tube Testers for its field men.

Speedy, yet efficient operation is accomplished by:
1. Simplification of all switching and controls.
2. Elimination of old style sockets used for testing obsolete tubes (26, 27, 57, 59, etc.) and providing sockets and circuits for efficiently testing the new Noval and Sub-Minar types.

You can't insert a tube in wrong socket
It is impossible to insert the tube in the wrong socket when using the new Model TD-55. Separate sockets are used, one for each type of tube base. If the tube fits in the socket it can be tested.

"Free-point" element switching system
The Model TD-55 incorporates a newly designed element selector switch system which reduces the possibility of obsolescence to an absolute minimum. Any pin may be used as a filament pin and the voltage applied between that pin and any other pin or even the "top-cap".

Checks for shorts and leakages between all elements
The Model TD-55 provides a super sensitive method of checking for shorts and leakages up to 5 Megohms between any and all of the terminals. Continuity between various sections is individually indicated. This is important, especially in the case of an element terminating at more than one pin. In such cases the element or internal connection often completes a circuit.

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

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

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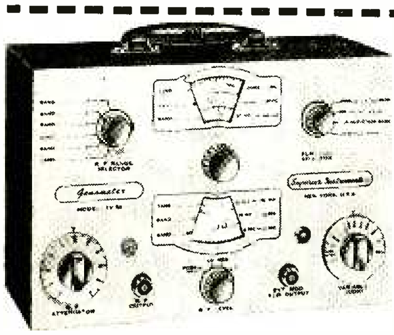
Superior's New Model TV-50
GENOMETER



A versatile all-inclusive GENERATOR which provides ALL the outputs for servicing:

A.M. Radio • F.M. Radio • Amplifiers • Black and White TV • Color TV

7 Signal Generators in One!

- ✓ R.F. Signal Generator for A.M.
- ✓ R.F. Signal Generator for F.M.
- ✓ Audio Frequency Generator
- ✓ Bar Generator
- ✓ Cross Hatch Generator
- ✓ Color Dot Pattern Generator
- ✓ Marker Generator

DOT PATTERN GENERATOR (FOR COLOR TV): Although you will be able to use most of your regular standard equipment for servicing Color TV, the one addition which is a "must" is a Dot Pattern Generator. The Dot Pattern projected on any color TV Receiver tube by the Model TV-50 will enable you to adjust for proper color convergence.

R. F. SIGNAL GENERATOR: The Model TV-50 Genometer provides complete coverage for A.M. and F.M. alignment. Generates Radio Frequencies from 100 Kilocycles to 60 Megacycles on fundamentals and from 60 Megacycles to 180 Megacycles on powerful harmonics.

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

MARKER GENERATOR: The Model TV-50 includes all the most frequently needed marker points. The following markers are provided: 189 Kc., 262.5 Kc., 456 Kc., 600 Kc., 1000 Kc., 1400 Kc., 1600 Kc., 2000 Kc., 2500 Kc., 3579 Kc., 4.5 Mc., 5 Mc., 10.7 Mc., (3579 Kc. is the color burst frequency.)

BAR GENERATOR: The Model TV 50 projects an actual Bar Pattern on any TV Receiver Screen. Pattern will consist of 4 to 16 horizontal bars or 7 to 20 vertical bars.

CROSS HATCH GENERATOR: The Model TV-50 Genometer will project a cross-hatch pattern on any TV picture tube. The pattern will consist of non-shifting horizontal and vertical lines interlaced to provide a stable cross-hatch effect.

THE MODEL TV-50 comes absolutely complete with shielded leads and operating instructions. Only ....

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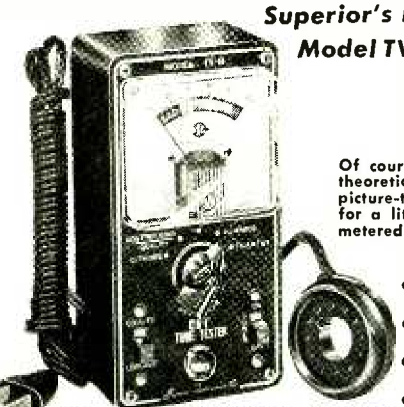
Superior's New Model TV-40
PICTURE TUBE TESTER



NOT A GADGET—NOT A MAKE-SHIFT ADAPTER, BUT A WIRED PICTURE TUBE TESTER WITH A METER FOR MEASURING DEGREE OF EMISSION—AT ONLY $15.85

Of course you can buy an adapter for about $5—which theoretically will convert your standard tube tester into a picture-tube tester; or a neon type instrument which sells for a little more and is supposed to be "as good as" a metered instrument. Superior does not make nor do they recommend use of C.R.T. adapters or neon gadgets because a Cathode Ray Tube is a very complex device, and to properly test it, you need an instrument designed exclusively to test C.R. Tubes and nothing else.

Tests ALL magnetically deflected tubes... in the set... out of the set... in the carton!!

- Tests all magnetically deflected picture tubes from 7 inch to 30 inch types.
- Tests for quality by the well established emission method. All readings on "Good-Bad" scale.
- Tests for inter-element shorts and leakages up to 5 megohms.
- Test for open elements.

EASY TO USE: Simply insert line cord into any 110 volt A.C. outlet, then attach tester socket to tube base (Ion trap need not be on tube). Throw switch up for quality test... read direct on Good-Bad scale. Throw switch down for all leakage tests.

Model TV-40 C.R.T. Tube Tester comes absolutely complete—nothing else to buy. Housed in round cornered, molded bakelite case. Only

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USE APPROVAL FORM ON NEXT PAGE

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Superior's New Model **76**

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CONDENSER BRIDGE
with a range of .00001 Microfarad to 1000 Microfarads (Measures power factor and leakage too.)

IT'S A
RESISTANCE BRIDGE
with a range of 100 ohms to 5 megohms

IT'S A
SIGNAL TRACER
which will enable you to trace the signal from antenna to speaker of all receivers and to finally pinpoint the exact cause of trouble whether it be a part or circuit defect.

IT'S A
TV ANTENNA TESTER
The TV Antenna Tester section is used first to determine if a "break" exists in the TV antenna and if a break does exist the specific point (in feet from set) where it is.

Specifications

✓CAPACITY BRIDGE SECTION
4 Ranges: .00001 Microfarad to .005 Microfarad; .001 Microfarad to .5 Microfarad; .1 Microfarad to 50 Microfarads; 20 Microfarads to 1000 Microfarads. This section will also locate shorts, and leakages up to 20 megohms. And finally, this section will measure the power factor of all condensers from .1 to 1000 Microfarads. (Power factor is the ability of a condenser to retain a charge and thereby filter efficiently.)

✓RESISTANCE BRIDGE SECTION
2 Ranges: 100 ohms to 50,000 ohms; 10,000 ohms to 5 megohms. Resistance can be measured without disconnecting capacitor connected across it. (Except, of course, when the R C combination is part of an R C bank.)

As Design Engineers, we the undersigned would like to say that the Model 76 is in our opinion the best combination unit of its kind we have been privileged to design. Although it is comparatively a low-priced tester, it will, after you become acquainted with its multiple services, be your most frequently used instrument.

S. LITT
L. MELENKEVITZ

✓SIGNAL TRACER SECTION
A built-in high gain pentode voltage amplifier, plus a diode rectifier, plus a direct coupled triode amplifier are combined to provide this highly sensitive signal tracing service. With the use of the R.F. and A.F. Probes included with the Model 76, you can make stage gain measurements, locate signal loss in R.F. and Audio stages, localize faulty stages, locate distortion and hum, etc. Provision has been made for use of phones and meter if desired.

✓TV ANTENNA TESTER SECTION
Loss of sync., snow and instability are only a few of the faults which may be due to a break in the antenna, so why not check the TV antenna first? The Model 76 will enable you to locate a break in any TV antenna and if a break does exist, the Model 76 will measure the location of the break in feet from the set terminals. 2 Ranges: 2' to 200' for 72 ohm coax and 2' to 250' for 300 ohm ribbon.

Model 76 comes complete with all accessories including R.F. and A.F. Probes; Test Leads and operating instructions. Nothing else to buy. Only

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☐ Model TV-40..........Total Price $15.85 $3.85 within 10 days. Balance $4.00 monthly for 3 months.

POWER FACTOR ....what it means

What effect does a capacitor's power factor have in filter and bypass circuits?

By H. P. MANLY

YOUR capacitor tester probably has an adjustment marked *power factor* with a dial graduated from 0 to 50 or 60. When checking electrolytics you set this adjustment and read the power factor. If that reading exceeds some certain value, what does it mean? Will the capacitor allow excessive ripple voltage when used in a power supply filter? Is its effective capacitance less than the measured value? Will it do a poor job of bypassing? Is it getting toward the end of its useful life? (The answer to all these questions is "yes.")

Some simple experiments will bring out the real meaning of capacitor power factor. First, use your capacitor tester to measure capacitance and power factor of an electrolytic which is in good condition. Then connect a 20- or 30-ohm resistor in series with the capacitor and make a second measurement. It will be necessary to move the power-factor pointer to a higher number.

Try a paper capacitor of the largest value on hand, at least 0.5 μf. Then connect a resistor of several hundred ohms in series and make another check. Again you will have to move the power-factor pointer to a higher number.

Adding series resistors increases the power factor. Obviously the extra resistance must increase the loss or waste of energy. The power factor of a capacitor is a measure of the energy that is lost or wasted as the capacitor charges and discharges when acted upon by alternating voltage.

Almost any kind of energy loss in any electrical device may be represented as an equivalent resistance. In the case of a capacitor we represent the loss by resistance in series with a pure capacitance (see Fig. 1). This is the series resistance you added during the preceding experiments.

Although series resistance changes the power factor we cannot measure the factor in ohms. This is because power factor depends on capacitance, frequency of the applied voltage and the internal series resistance. If you really want to know what power factor is, read the next four paragraphs. Otherwise skip to the effects of power factor in filtering and bypassing.

In a perfect capacitor, one without any losses, current would lead the applied alternating voltage by exactly 90°, as seen in Fig. 2-a. The power factor would be zero. In ceramic, mica and many paper capacitors, the power factor actually is close to that.

If a capacitor has internal series resistance just equal to its capacitive reactance, both in ohms, current will lead the voltage by 45°, as in Fig. 2-b, and the power factor will be 0.707. Less internal resistance allows greater lead and smaller power factors. More resistance reduces the lead, brings current more nearly into time (phase) with the applied voltage and increases the power factor.

Capacitor power factor is equal to the cosine of the angle by which current leads applied voltage. No cosine can be greater than 1.00, so maximum power factor is 1.00. Lesser values are stated as decimal fractions. It is customary to change these fractions to percentages: 0.707 becomes 70.7%, 1.00 becomes 100% and so on.

Fig. 3 shows relations between power factors as percentages and capacitive reactances as fractions or multiples of internal series resistance. Power factors up to 20% or 30%, when changed back to decimal fractions, nearly equal the ratio of internal resistance to capacitive reactance.

Ripple voltage

Because we will be talking about ripple voltage at some length, let's begin with some of its characteristics. Ripple is the alternating voltage or alternating component that accompanies dc output voltage delivered from the filter of power supply. It is usually specified as a percentage of dc output voltage. If ripple is 5 volts rms, with 100 dc volts, the ripple would be 5%.

Ripple can be reduced in four ways: 1. by more filter capacitance; 2. by more load resistance and smaller load current; 3. by higher frequency; 4. by smaller power factor in filter capacitors.

Were everything else to remain unchanged, doubling the capacitance would halve the ripple and halving the capacitance would double the ripple. This inverse proportion would also hold for load resistance and frequency, provided nothing else changed.

In practice the proportions do not work out so precisely because change in one element varies the effect of others. The stated proportions hold fairly well with changes of capacitance, vary widely with changes in load and are close for changes in frequency. The effect of power factor is due for special consideration.

At the filter output of any ordinary power supply there will be some ripple voltage. What we want to determine is the extent to which filter capacitors with high power factors in-

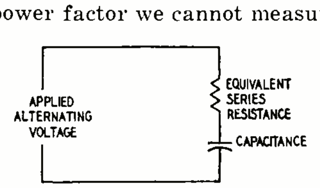


Fig. 1—Representative circuit for energy loss in a capacitor.

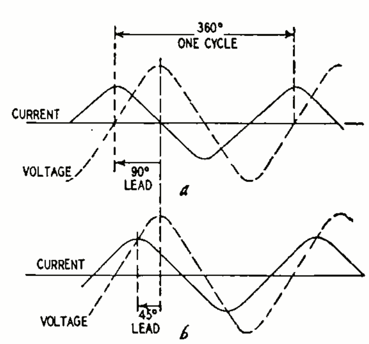


Fig. 2-a—In ideal capacitor, current leads voltage by 90°; b—When internal resistance equals capacitive reactance, current leads voltage by 45°.

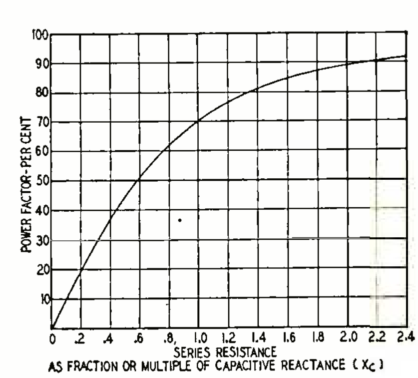
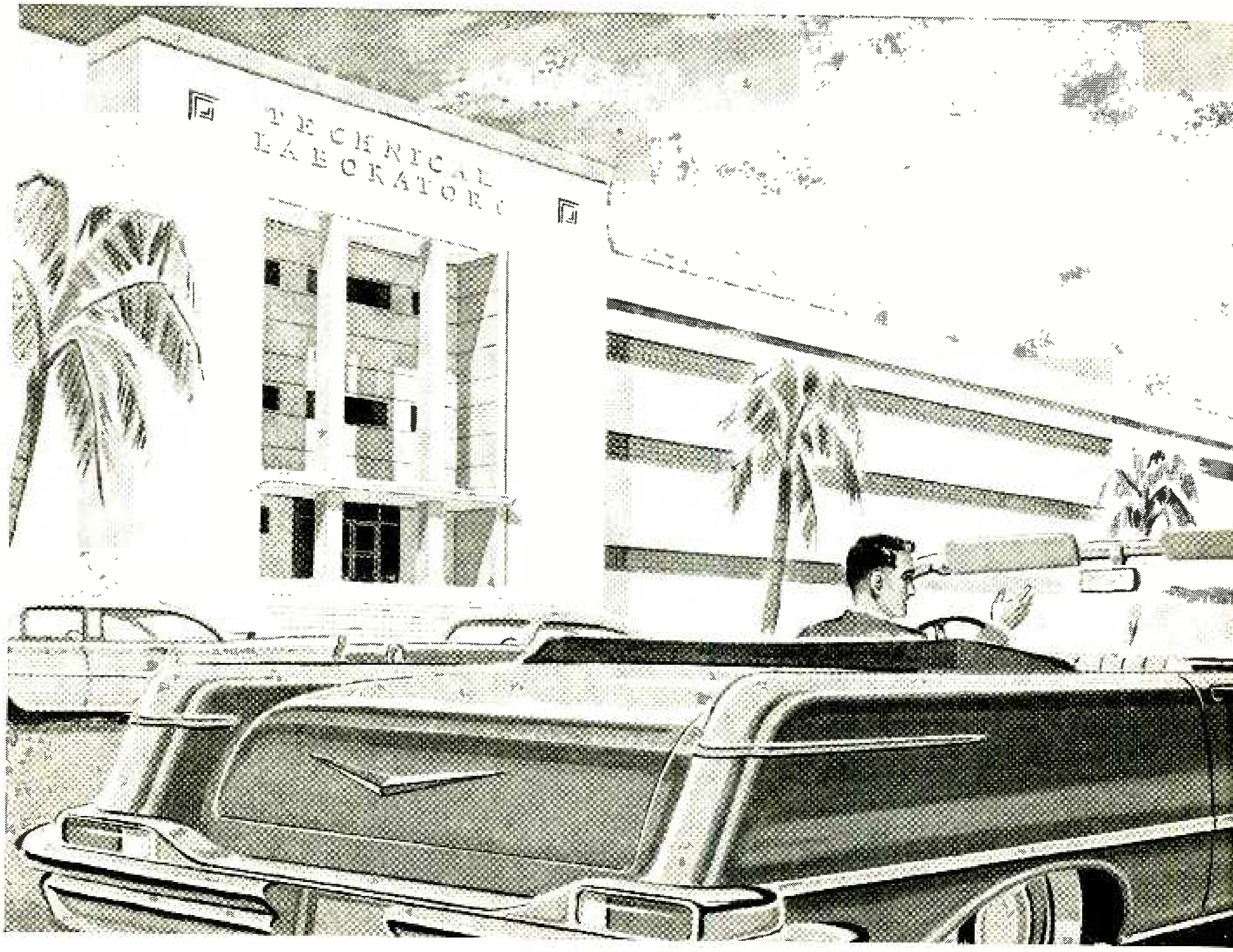


Fig. 3—Relation between power factors and capacitive reactance.



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crease the ripple above minimum. Minimum ripple would be that with any given capacitance, load and frequency when using a capacitor of smallest practicable power factor.

It is possible to have power factors as small as 2% or 3% in electrolytics, but the factor usually is something between 5% and 10%. In some of the earlier electrolytics, including wet types, power factors were as great as 25% or more.

Fig. 4 shows how an increase in power factor raises the ripple above minimum. Except for critical applications requiring low ripple, a power factor as great as 25% may cause no serious trouble. However, at a 50% power factor ripple may increase 15% or more and for still greater factors the ripple goes up rapidly.

While an increase of power factor as a percentage above minimum may not appear serious there is another effect which may mean trouble. There is the change of ripple waveform with greater power factors. With factors up to almost 40% the waveform is nicely rounded (see Fig. 5-a). Sharp peaks, as in Fig. 5-b, develop at about 70% power factor. With 90% power factor the waveform becomes a sawtooth and little filtering effect remains (see Fig. 5-c). Sharp peaks change a soft audio hum into a noisy buzz.

Power factor and frequency

Most testers measure power factor at a frequency of 60 cycles. Power factor increases as frequency rises. It happens this way. Internal resistance remains constant but capacitive reactance drops with rising frequency. Then the ratio of resistance to reactance goes up. Fig. 3 shows that power factor will increase as this ratio becomes greater. Accordingly, the power factor must increase with a rise of frequency.

Let's see what this increasing power factor means when a capacitor is used for bypassing a wide range of audio frequencies, say from 100 to 5,000 cycles.

To answer this question we must remember that the object of bypassing a resistor is to reduce the alternating voltage across it. If there were no bypass capacitor, the ac voltage across the resistor would depend only on resistance and current.

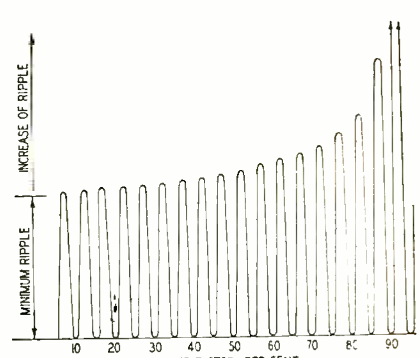

Fig. 4—Ripple increases as the power factor goes up.

The bypass capacitor has capacitive reactance. When the capacitor and its reactance are across the resistor, the combination offers *impedance* to alternating current. Then ac voltage across the combination will depend not on resistance and current but on impedance and current.

As we all know, the reactance of a capacitor decreases when frequency increases. The decreasing reactance drops the impedance of the paralleled resistor and capacitor, so ac voltage across the combination decreases as frequency goes up.

Experiments were carried out with one paper and three electrolytic capacitors, all having measured capacitances close to 8.5 μf and all used as bypasses across a 158-ohm resistor. Frequency was varied from 100 to 5,000 cycles. Alternating current from the audio generator was held constant at all frequencies. Alternating voltage across the capacitor–resistor combination was measured with an oscilloscope and separate calibrating standard. The test setup is shown in Fig. 6.

Alternating voltage across the resistor was maximum, of course, with no bypass capacitor. This voltage was considered as 100%. Connecting any of the capacitors dropped the alternating voltage. Had voltage dropped proportionately to decreasing impedance it would have followed the short-dashed curve of Fig. 7.

Measurements with the paper capacitor yielded the solid-line curve. Prac-

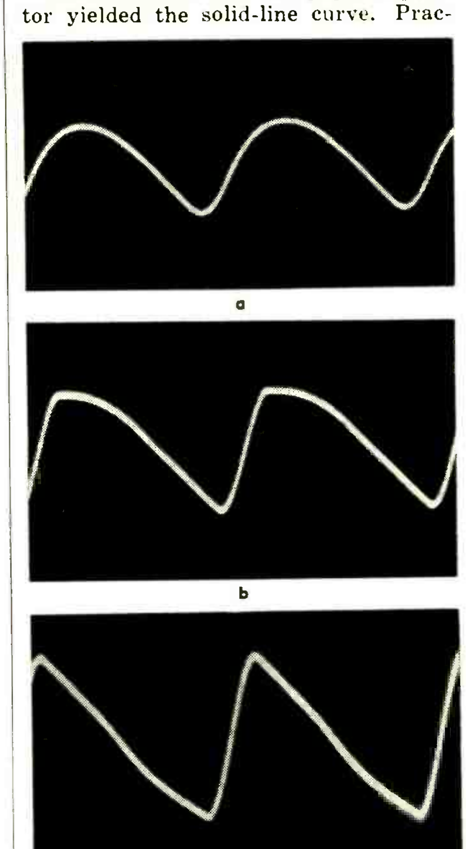

Fig. 5—Waveforms of filter output at different power factors: a—40%; b—70%; c—90%.

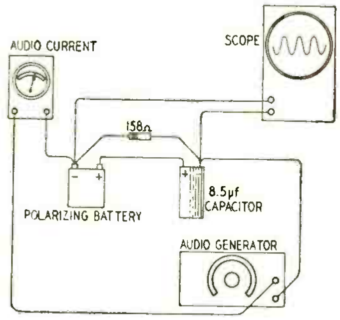

Fig. 6—Test setup for measuring ratio between ac voltage drop and frequency.

tice always seems to vary more or less from theory, but the paper capacitor performed much as would be predicted from falling impedance. An electrolytic of exceptionally small power factor gave a nearly identical curve.

A second electrolytic with a power factor of about 9% at 60 cycles produced the curve drawn with alternate dots and dashes. The third electrolytic, whose power factor was about 32% at 60 cycles, produced the curve drawn with long dashes.

It is apparent that an electrolytic with a power factor up to about 10% at 60 cycles is an effective bypass to nearly 1,000 cycles, and not too bad at higher frequencies. A capacitor with 30% power factor begins to fall down on the job around 300 cycles. If power factor is not too great at low frequencies, the drop of reactance with rising frequency more than compensates for any increase of power factor. But a power factor which is large at low frequencies gets so bad at higher frequencies that it overcomes falling reactance and ruins the bypassing.

Internal series resistance and power factor of an electrolytic increase to quite an extent during its life. If leakage does not become excessive, this rise of power factor may be the thing which finally causes unsatisfactory operation. In any event, power factor gives a clue to useful life remaining for an electrolytic. Factors from 15% on up usually mean that old age is creeping up and trouble is due before long.

Abnormally high operating temperatures will dry out the electrolyte in many electrolytics. This increases the internal resistance and power factor—temporarily after small temperature

(*Continued on page* 90)

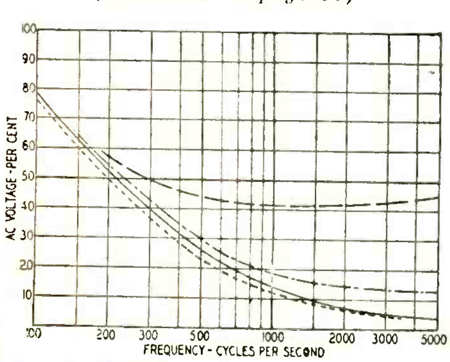

Fig. 7—Relation of voltage drop to frequency at different power factors.

Is a Degree Essential for an Electronic Engineering Career?

"Student" Fred Gunther in the IBM school

Fred Gunther has no degree. Yet, today, at IBM, Fred is a Technical Engineer working on America's biggest electronics project. His story is significant to every technician who feels that lack of formal training is blocking his road to the top.

Let's go back to 1950 and watch Fred Gunther, at 18, as he goes about the business of determining his life's work. Fred spent almost a year trying his hand at various jobs. None of these turned out to be the one that Fred wanted to devote his life to. So, still undecided about his career, Fred entered the Navy for a four-year hitch.

Fred learned something very valuable in the Service, as have many other men who eventually discover the electronics field. His aptitude tests revealed him as an excellent electronics prospect, and he received ten months' training in electronics fundamentals and radar. Upon his discharge in 1955, he was an Electronics Technician, First Class.

Something even more important to Fred's career occurred during his Service hitch. He began to hear such terms as "automation" . . . "data processing" . . . "electronic computer." "Then, one evening, while glancing through the paper," he recalls, "I spotted a story about *Project SAGE.*"

What is Project SAGE?

SAGE 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 entire perimeter. At the heart of this system are giant electronic computers, which digest data filtered in from Texas towers, picket ships, reconnaissance planes, ground observers. The computers analyze this information for action by the Strategic Air Command and other defense units. These computers are the largest in the world. Each contains perhaps a million parts—occupies an entire city block. They are built for the Project by IBM.

Answering instructor's questions

At the operating console of the computer

Home to the family, Pemberton, N. J.

Fred joins IBM

SAGE fascinated Fred, for it embodies the most advanced electronic concepts. And, when he learned that IBM would train him for six months, at full salary, plus a living allowance, to become a Computer *Units* Field Engineer, he seized the opportunity. Fred started his new electronics career in the IBM school, with twenty other technicians. He attended classes 8 hours a day. Courses consisted of some 20 subjects—computer circuitry and units, maintenance techniques—everything he would need to become a full-fledged Computer *Units* Field Engineer.

Assigned to McGuire AFB

His six months' training completed, Fred was assigned in May, 1956, to McGuire Field, where the first of the giant SAGE computers is located. Here he assisted in the cable installation for this vastly complicated electronic giant. He helped to set up the computer, interconnect its many sections, check it out and make it ready for operation. Fred spent five months at McGuire, but his education was not yet completed.

Becoming a Computer Systems Engineer

"I like to think it was due to my interest and grade of work," Fred says, "but at any rate, last October I was invited to return to Kingston for further training—to become, in fact, a Computer *Systems* Engineer. Naturally, I was proud and pleased, for this training would give me a much greater range of understanding . . . make me more valuable to the company and myself . . . and give me a chance to assume actual engineering responsibility." Fred completed the Computer Systems course. After several months of outstanding work in his new capacity, he received a *third* promotion—to Technical Engineer—in a field engineering liaison group.

What does the future hold?

What does the future hold for Fred Gunther, now that he has become a Technical Engineer? "It's hard to even set a goal in a field as rapidly moving as this," Fred says, "but with my IBM training back of me, the future sure looks good. I've advanced from Radar Technician to Computer *Units* Field Engineer to Computer *Systems* Engineer to Technical Engineer *in two years*—and received a valuable electronics education besides!"

How about YOU?

Since Fred Gunther joined IBM Military Products and the Project SAGE program, opportunities are more promising than ever. This long-range program is destined for increasing national importance, and IBM will invest thousands of dollars in the right men to insure its success.

If you have 2 years' technical schooling—or equivalent experience—IBM will train you for 6 months as a *Computer Units Field Engineer*.

If IBM considers your experience equivalent to an E.E., M.E., or Physics degree, you'll receive 8 months' training as a *Computer Systems Engineer*.

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ELECTRONICS

(Continued from page 87)

rises but permanently after extreme temperatures. In the internal resistance that causes high power factor there is energy dissipation as heat, which tends to raise the power factor further. Power factor will also increase at low temperatures, but will return to its former value at normal temperatures.

We might think that high power factors would decrease the dc output voltage from a filter seriously. Actually the decrease is no more than about 2% with a power factor as great as 50%. Such a loss is negligible.

Capacitor testers

Most of the testers which have power-factor dials measure capacitance with a bridge circuit similar to the simplified one shown in Fig. 8. An internal standard capacitor is balanced against the capacitor being measured. If the measured capacitor has much internal resistance, the bridge cannot be balanced until a resistance in series with the standard capacitor is adjusted to compensate for the measured capacitor's resistance. When this compensating resistance is suitably calibrated, it becomes a measurement of power factor in the tested capacitor.

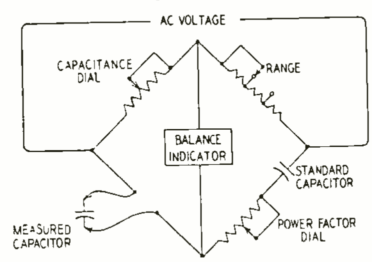
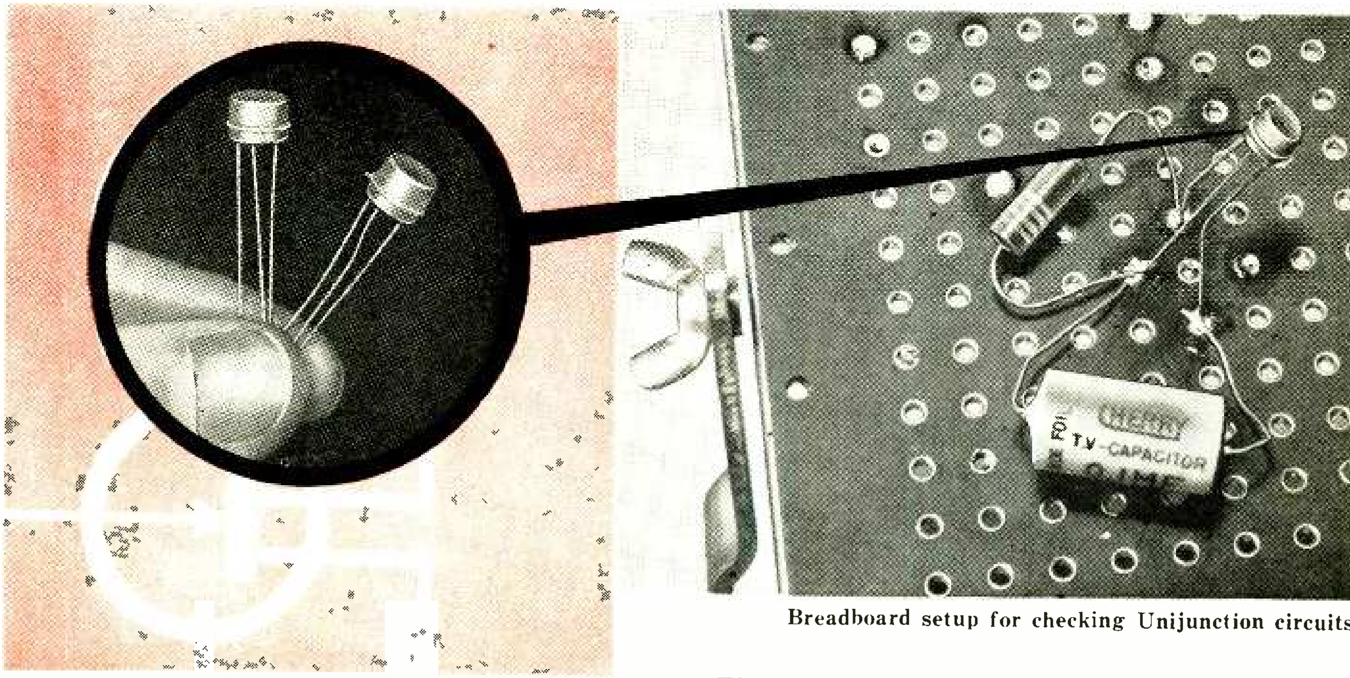


Fig. 8—Typical circuit for measuring a capacitor's power factor.

The power factor dial on a tester may or may not be accurately calibrated. Close calibration is not essential because, as you can see from the graphs and diagrams, moderate variations of power factor have little effect on receiver performance. In a general way we may say that any power factor in excess of 20% is likely to cause trouble in critical applications. A factor as large as 40% to 50% should mean rejection for any applications.

An approximate check for calibration of a power-factor dial can easily be made. In series with a high-quality paper capacitor whose value is 1 μf within 2% connect a 680-ohm 5% fixed composition resistor. This combination should require setting the power-factor pointer somewhere between 23.5 and 26.5 on its dial. Were the series capacitor and resistor of exact values, the dial setting would be 25 or 25%.

If the pointer is far off to begin with, it may be set to a corrected position without difficulty on most testers. This will allow close calibration at and near the center of the dial range. Errors may exist for lower and higher readings but the variations should be unimportant in practical servicing. END



Breadboard setup for checking Unijunction circuits.

This new double-base diode has a number of useful applications. Try some!

using the UNIJUNCTION

By LOUIS E. GARNER, JR.

PARALLELING the development of the transistor have been the invention and development of special semiconductor devices. Many of these have as great a potential as their better known and older cousin, the transistor.

Among the most promising of these devices is a unit with characteristics so unique that it can be used as an oscillator when combined with *only one* other component, plus a power source! Closely akin to the common diode and the triode transistor, it has properties different from either. Its potential applications include possible use in computers, ham gear, test instruments, radar, television and special types of control and measurement equipment.

Invented by General Electric and developed under a U. S. Air Force contract, this device was originally called a double-base diode due to its physical similarity to a junction diode in having not one, but *two*, base connections. Today the unit is termed a Unijunction transistor, a name indicating that it has control characteristics similar to those of a transistor but is equipped with a *single* junction instead of the two common to junction triode transistors.

The construction of a Unijunction transistor is diagrammed in Fig. 1-a and the schematic symbol to represent it is shown in Fig. 1-b. Lead connections for the G-E type 4JD5A1 Unijunction transistor (formerly the G-EZJ-14) are identified in Fig. 1-c.

Basically, this semiconductor device consists of a small bar or rod of N-type semiconductor material with a lead connection brought out from each end. The bar serves as the base electrode and its two connections are identified as base 1 (B-1) and base 2 (B2). A simple p-n junction is formed along the bar and serves as the emitter electrode (E). Various semiconductor materials may be used in the bar. Some of the early double-based diodes were made of germanium, but the present 4JD5A1 Unijunction transistor is a silicon device.

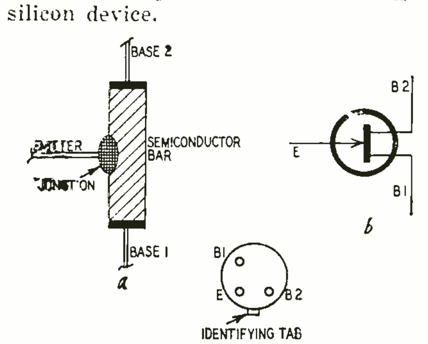


Fig. 1—The Unijunction transistor; a—construction; b—schematic symbol; c—lead connections.

If the two base leads are connected together externally and used as a single electrode, the Unijunction transistor behaves as a conventional junction diode with base (B1 and B2) and emitter electrodes. Connected in this fashion, it can be used as a rectifier or as a detector, like any junction diode.

However, when Unijunction transistor operation is desired, dc voltages are applied between base 1 and base 2 and between base 1 and the emitter. The emitter and base 2 are generally made positive with respect to base 1. Under these conditions, with relatively low voltages applied, the Unijunction transistor acts essentially like a high-value resistor. A small emitter current can flow with a value directly proportional to the applied emitter voltage.

As the emitter-to-base-1 voltage is raised, a point is reached at which the

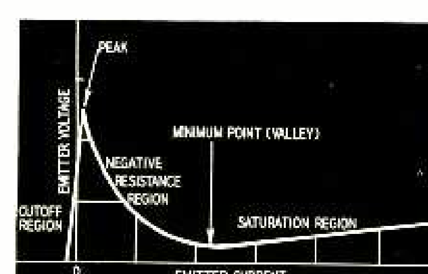
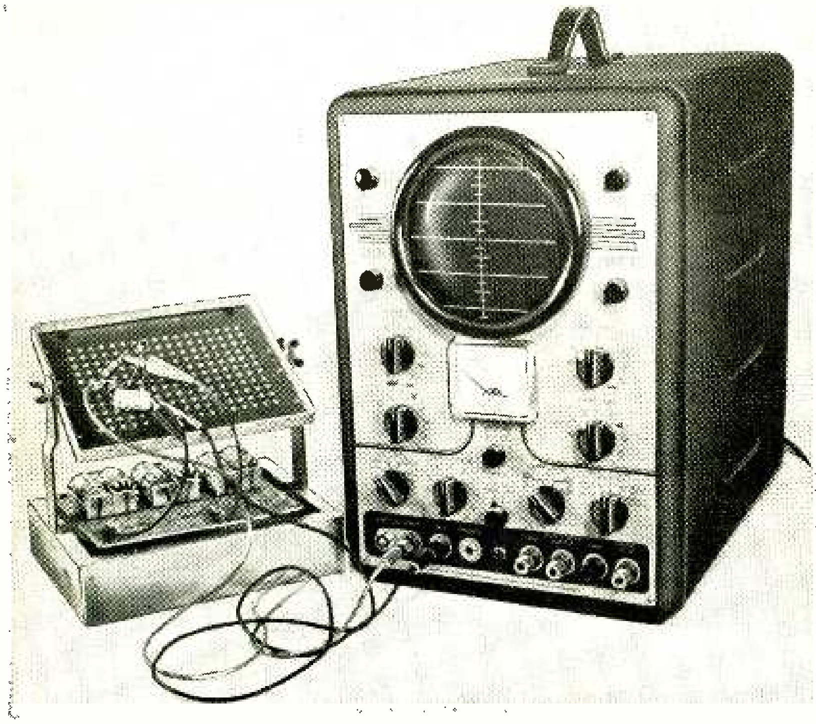


Fig. 2—Typical input characteristics.



Sawtooth oscillator of Fig. 3.

emitter current suddenly increases. In effect, the emitter-to-base-1 resistance drops from a very high to a very low value. The action is roughly analogous to that of a thyratron tube when it "fires." Thus, if the triode transistor can be considered as the semiconductor or solid-state counterpart of the vacuum tube, then the Unijunction transistor, in a similar fashion, can be considered as the semiconductor counterpart of a gas-filled triode or thyratron.

This change from a nonconducting to a conducting state is brought about by injecting minority carriers * into the junction region. The action is similar to injecting minority carriers into the base region of a triode transistor. The presence of these injected carriers causes an appreciable drop in the emitter-to-base-1 resistance.

Input characteristics

The basic operating characteristics of the Unijunction transistor are shown graphically in the curve of Fig. 2. As the emitter voltage is gradually raised there is a small, but steady, increase in emitter current. This is shown by the line to the left of the peak. Until the peak is reached, its behavior is like that of a conventional high-value resistance. The emitter current (bias) is very small, in the order of a few microamperes.

Once the peak is reached the emitter bias current suddenly increases. The emitter current may continue to increase even as the applied voltage is lowered. This gives the curve a negative or downward slope and is characteristic of devices having negative resistance which exhibit this same general characteristic.

Among vacuum tubes, a tetrode operated with the plate at a lower voltage than its screen grid may behave in a similar fashion. An increase in applied voltage can result in a decrease in current and vice versa. This characteristic in a vacuum tube is used in the dynatron oscillator.

Among other types of semiconductor devices, the point-contact transistor, with an alpha greater than one, can exhibit a negative resistance characteristic when used in a circuit which places its base above circuit ground; hence the reason for this type of transistor's instability except in common- or grounded-base circuits.

After the negative resistance region (Fig. 2), a minimum point or valley is reached beyond which the Unijunction behaves as if it were a conventional (positive) resistor—that is, increases in emitter voltage result in corresponding increases in emitter current. Its effective resistance under such conditions is much lower than before the peak was reached. For example, before the peak is reached, the effective input resistance of the device may be in the tens of thousands or even hundreds of thousands of ohms. After the valley is reached, the effective input resistance may be in the tens or hundreds of ohms.

The input characteristics curve of the Unijunction transistor exhibits three distinct regions: a high (positive) resistance region before the peak is reached, called the cutoff region; a region of negative resistance between the peak and minimum points of the curve (the valley), sometimes called the transition region; a region of low (positive) resistance past the valley, called the saturating region.

Practical circuits can be designed to operate along the slopes of any of these regions (cutoff, transition and saturating) or to utilize the slopes of two or more regions. Often, the cutoff and transition (negative resistance) regions are used.

Tentative specifications of the 4JD5A1 Unijunction transistor are given on page 99.

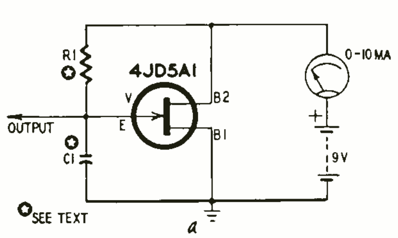
As with any electronic device, the possible circuit applications of the Unijunction transistor are limited only by the requirements and imagination of the circuit designer. We will try to outline a few typical circuits, but remember that space limitations prohibit an exhaustive treatment of circuitry. Anyone interested in using the Unijunction in his own work will find it worth while to set up some of the experimental circuits shown, do his own tests and try devising new circuits.

* In a conventional conductor, such as copper, electric current flow consists of a movement of free electrons through the material. In a semiconductor, such as germanium, an electric current may be made up both of free electrons carrying a negative charge and of "holes" carrying a positive charge. A "hole" is an electron *deficiency* in the molecular structure of the material and can be transferred from molecule to molecule through the material, behaving *as if it were* a positive-charged particle with the mass of an electron.

There are three basic types of semiconductors: *intrinsic*, having an equal number of free electrons and "holes"; *p-type*, having a surplus of positive "holes"; *n-type*, having a surplus of negative electrons. Transistors are made of p- and n-type semiconductors.

However, with either type of semiconductor, *not all* current flow will be made up by the predominant particle. Thus, although positive "holes" predominate in a p-type (for "positive") semiconductor, there are some electrons available. Similarly, although negative electrons predominate in an n-type (for "negative") semiconductor, there may be "holes" available. Since the opposite type of particle is present in smaller or *minority* quantities, they are called "minority carriers."

Thus, "holes" are minority carriers in n-type semiconductors while electrons are minority carriers in p-type semiconductors.



b

Fig. 3-a—Sawtooth oscillator circuit; b—sawtooth produced by the generator.

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Model SA-HF – Often called "the workhorse of the sound industry." Meets most p.a. and industrial requirements. Response to 10,000 cycles and more efficient than the Model MA-25. Will deliver that extra punch needed to cut through heavy noise. Use for speech or high quality music. Tropicalized and hermetically sealed for continuous top flight performance even under adverse weather conditions.
Response: 80 to 10,000 cps. Power Capacity: Full Range 30 watts, Adjusted Range 60 watts. Impedance: 16 ohms. List Price: $36.00.*

Model MA-25 – Use this rugged, weather-proof driver unit where response to 6500 cycles is adequate or to preserve "balance" when used with high cut-off frequency trumpets. Low in cost, high in quality, featuring high efficiency magnet, tropicalized 2" voice coil, "rim-centered" breakdown-proof bakelite diaphragm.
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ELECTRONICS

Since the Unijunction is a relatively new device, not all distributors will have it in stock. For price contact the General Electric Co., Semiconductor Products, Electronics Park, Syracuse, N. Y. The transistors are available, but prices will be high, at least for a time.

Sawtooth oscillator

Knowing that the Unijunction transistor has some characteristics roughly analogous to those of a thyratron tube, you may conclude that the unit will, like a thyratron, operate as a simple relaxation oscillator. It can and will! A typical relaxation oscillator circuit is seen in Fig. 3-a. This type of circuit can provide a linear sawtooth for use as a sweep signal in oscilloscopes, TV receivers, radar, TV cameras or other types of equipment.

Referring to Fig. 3-a, R1 may have values ranging from 1,000 to 47,000 ohms and C1 values of from .002 to 0.5 μf, depending on the exact waveshape needed and the desired repetition rate. Although a 9-volt dc power source was used a higher (or lower) supply voltage may be used, as long as the maximum ratings of the transistor are not exceeded.

In operation, C1 is gradually charged through R1. The E-to-B1 voltage rises as C1 charges. As long as this voltage is below the peak value (see Fig. 2), the transistor's input (E-to-B1) resistance is high. When the peak is reached, the transistor suddenly switches to a conducting state and C1 discharges rapidly through the low E-to-B1 resistance. With C1 discharged, the transistor returns to its nonconducting state, the E-to-B1 resistance becomes quite high and the action can repeat.

The output signal waveform depends upon what portion of R1–C1's charging curve is used in developing the signal, but generally approximates a linear sawtooth. The frequency depends on the values of R1 and C1 and, to a lesser extent, the supply voltage and the characteristics of the individual transistor. Frequency limits are from a few cycles to well over 100,000.

A typical sawtooth signal obtained with this circuit is shown in Fig. 3-b. Note the rapid retrace. The circuit values used to obtain this waveform were: R1, 1,800 ohms; C1, .05 μf; dc supply, 9 volts. The frequency was about 4,000 or 5,000 cycles.

In some instances, depending on the supply voltage and other circuit parameters, the emitter-to-base-2 resistance may take the place of fixed resistor R1. With such an arrangement, R1 may be omitted and the circuit will oscillate with just the transistor and *one other* component (C1), plus the power supply!

Pulse generator

The basic sawtooth oscillator circuit can supply fairly sharp pulses if resistive loads are placed in series with the two base electrodes. This modification of the basic circuit is shown in Fig. 4-a. Series resistors R2 and R3 may have values ranging from less than 100 to as high as several thousand ohms. The values for R1 and C1 may be the same as for the basic sawtooth oscillator.

In operation, the pulse is formed by the current surge through the series resistor(s) as the transistor "fires" and discharges C1. A negative-going pulse is formed between B2 and circuit ground (across R2) while a positive-going pulse is developed between B1 and ground (across R3). A typical negative-going pulse is shown in Fig. 4-b.

If only a single pulse is needed, having either positive or negative polarity, then one of the resistors (R2 or R3) may be omitted and replaced with a direct connection. The pulse shown in Fig. 4-b was obtained with the following circuit values: R1, 1,800 ohms; C1, .05 μf; R2, 470 ohms; dc supply, 9 volts. R3 was omitted.

Driven sweep

Another variation of the basic circuit is shown in Fig. 5-a. This circuit will deliver a sawtooth signal only when driven by an external signal. The waveshape of the driving signal is relatively unimportant — it may be a sine or square wave, pulse or triangular wave — as long as it has a definite positive-going component. Potential applications of the driven sweep include its use as the slave sweep in a cathode-ray oscilloscope, synchroscope or in a radar indicator as well as in special computer circuits.

Referring to the schematic diagram, assume first that no signal is applied between the base electrodes. Note that no dc voltage is applied to these two electrodes. C1 is charged through series resistor R1 to the full dc supply voltage, but the transistor does not "fire" since there is no voltage between B1 and B2.

When a signal, such as a sine wave, is applied between B2 and B1, B2 is

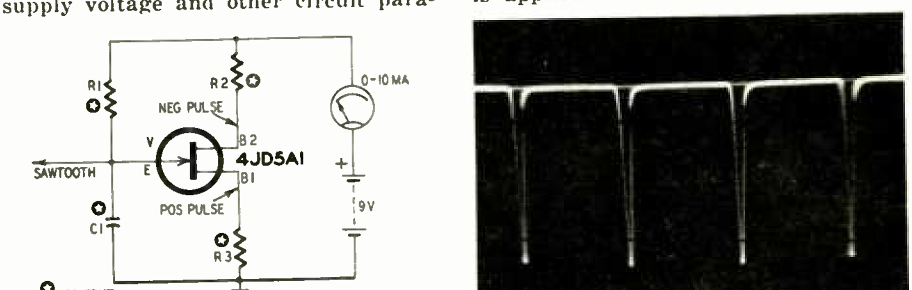

Fig. 4-a—Pulse generator circuit; b— pulse waveform.

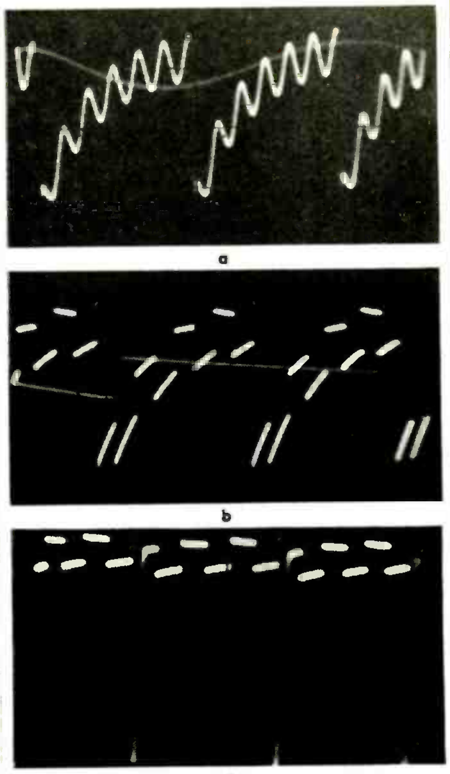

Fig. 6—Waveforms in frequency-divider circuit. a—driven with sine wave; b—driven with square wave; c—output 2 when driven with square wave.

Next, an external signal is applied across R3; the positive half-cycle of this signal, superimposed upon the fixed charge of C1, is sufficient to "fire" the transistor. C1 is discharged through the emitter–base-1 circuit and through R3, then recharges again. The applied input signal will be superimposed upon the sawtooth waveform produced as C1 charges and will again "fire" the transistor as the "peak" is approached.

This action keeps repeating as long as a signal is applied to the input. Each time the transistor "fires," a pulse is developed across R4, as in the basic pulse generator (Fig. 4-a).

C1's charging time is a function of circuit parameters and this time, in turn, determines the numbers of cycles of the applied signal which are accepted before the circuit "fires" and delivers an output pulse. The waveshape of the applied signal is relatively unimportant.

The types of signal obtained at the emitter (output 1) with sine- and square-wave input signals are shown in Figs. 6-a and 6-b, respectively. A typical output pulse obtained from B2 (output 2) with a square-wave output is shown in fig. 6-c. Note how the pulse divides the square wave into a fixed number of cycles.

Input signal frequencies were 6,000 cycles for Fig. 6-a, 4,000 cycles for Fig. 6-b, and 3,000 cycles for Fig. 6-c. END

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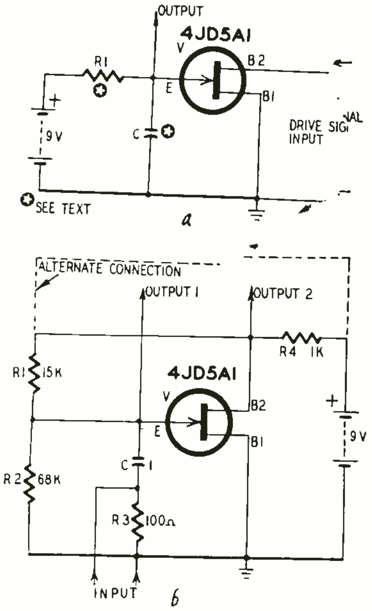

R1—15,000 ohms
R2—68,000 ohms
R3—100 ohms
R4—1,000 ohms

All resistors ½ watt
C—1 µf
V—4JD5A1
Battery—9 volts

Fig. 5—Special Unijunction circuits; a—driven sweep; b—frequency divider.

driven positive on alternate half-cycles. When B2 is driven positive, the transistor "fires," discharging C1. Capacitor C1 then recharges through R1 and the entire cycle is repeated the next time B2 is driven positive.

Since C1 is discharged and recharged, forming the sawtooth output signal, only when the applied drive signal makes B2 positive with respect to B1, the waveshape of the drive signal is not too important. For example, if instead of a sine-wave, a single positive-going pulse were applied to the circuit the output signal would be one cycle.

Frequency divider

The computer designer or the engineer working with complex electronic systems often requires a "frequency-dividing" circuit — one that will provide an output signal for a specific number of cycles of an applied signal given frequency. The Unijunction is well suited to this type of circuitry.

A typical circuit is shown in Fig. 5-b. This circuit combines some of the features of the "free-running" relaxation oscillator with the basic characteristics of a driven sweep.

Refer to the schematic diagram. Let us assume, that there is no signal applied to the input terminals (across R3). C1 is charged through R1, R4 and R3. R3 is kept fairly small compared to R1 and R4 and, therefore, can be ignored as far as the charging cycle is concerned. The maximum voltage to which C1 can charge is determined by the ratio of R1 plus R4 and R2, or by the ratio of R1 and R2 alone if the alternate circuit arrangement is chosen (R1 returned to positive side of power supply instead of B2—shown by the dotted line). If the ratio of this voltage divider is properly chosen, C1 can be charged to just below "firing" voltage.

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Hi-Fi Jinks With Strauss
Paulik and Vienna State Opera Orchestra
Vanguard SRV-104

A special demonstration record, this is a tremendous bargain at $1.95. It contains three of the most popular waltzes, two polkas, two marches and a czardas from the series of Vanguard recordings of the music of the Strausses. Though the drum is not as big as in *A Hi-Fi Carnival With Strauss* (VRS-948), it shares the other virtues of the series. Especially notable is the definition of the snare drums and tambourine.

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Under Analysis
Sauter-Finnegan Orchestra
RCA-Victor LPM-1341

If you prefer pop music, this is one of the few recordings anywhere near the class of the above several classics. Here Sauter-Finnegan take apart 11 popular classics such as *Avalon, Stardust, I Get a Kick Out of You*, and put them together again with a really big drum, deep marimba, bass sax, plenty of percussion, a big bass and all the fixings to produce a very impressive sound.

BRITTEN: Young Person's Guide to the Orchestra
DOHNANYI: Variations on a Nursery Tune
Slatkin conducting Concert Arts Orchestra
Capitol P-8373

Put this on the required listening list. The Britten piece is engagingly instructive in showing off the nature and capabilities of various instruments and is recorded with the fine definition needed to make it really useful as a test or demonstration piece. The percussion section is especially fine and the fugue offers a real measure of system definition. The Dohnanyi *Variations* is a delightful musical spoof as well as a demonstration of what a good man can do even with so trite a theme as "*Twinkle, Twinkle Little Star.*"

Marimbas Mexicanas
Marimba Chiappas Orchestra
Capitol of the World T-10043

This should delight just about every hi-fi fan and his family and friends as well. The Marimba Chiappas—a consort of marimbas plus plenty of Latin American percussion—plays bright tunes with brilliant rolls, a sharp rhythm, good bass beat and plenty of high highs. It will give both woofers and tweeters a good workout.

Chopin by Starlight
Carmen Dragon conducting Hollywood Bowl Orchestra
Capitol P-8371

Ten of Chopin's most popular piano pieces in big, lush orchestral transcriptions with the excellent sound the Bowl orchestra so consistently dishes out.

Music of Great Keyboard Masters
Sascha Gorodnitzki, pianist
Capitol P-8374

If you like your piano pieces played on the piano, here is a baker's dozen of outstanding concert encores, including a couple by Chopin, as well as Liszt, Debussy, Schumann, Rachmaninoff, Prokofiev and Paderewski, adequately played on a resonant piano and very well recorded.

MOZART: Concerto for Clarinet
Quintet for Clarinet
Benny Goodman, Clarinet
Munch conducting Boston Symphony and Quartet
RCA Victor LM-2073

Two of the greatest clarinet show pieces played by the greatest jazz clarinetist. Experts may quibble about Benny's expressiveness but the ordinary listener will enjoy the very satisfying sound.

STRAVINSKY: Soldier's Story
As performed at Edinburgh Festival in 1954
RCA Victor LM-2079

A unique work, this might be called a fairy story with music. The small ensemble of seven instruments and three voices is faithfully recorded with an intimacy which goes over nicely in a living room. Some may object to having the tale told in cockney and Oxford accents but otherwise this is an authoritative recording.

BACH: Sonatas and Partitas for Unaccompanied Violin
Nathan Millstein
Capitol PCR-8370 (three 12-inch LP's)

I don't suppose anybody but Bach buffs and fiddlers will want to listen to more than 2 hours of Millstein fiddling Bach but those who do will be rewarded with just about the definitive recording of these works, one which reveals every facet of both the music and the virtuosity of technique necessary to play it well. In the first movement of the third partita there is a remarkable series of fingering transients. A superb recording of the violin.

DELIBES: *Sylvia* (Complete)
Robert Irving conducting
Philharmonia Orchestra of London
RCA Victor LM-2036

This British recording is another example of very fine balance and excellent definition. The drums are nice but never excessive; the triangle is beautifully round. The liveness is just right for an illusion of presence; the solo instruments are very natural. Portions of *Sylvia* are old hi-fi war horses and those sections in this version provide very fine demonstration. However, in addition this presents the complete score (including previously cut sections transcribed from the original piano score). Very pleasant in every respect.

BRUCHNER: *Symphony No. 4* (Romantic)
Steinberg conducting Pittsburgh Symphony
Capitol P-8352

I must confess to a prejudice about most of Bruchner's music. It, and particularly this symphony, seems to me to be so full of the most obvious musical clichés, that I might, in my musical innocence, well have composed it myself. I mention it because this prejudice probably disqualifies me from making any valid judgments of his music and my readers ought to know it. But if you do not have such a prejudice, I think you'll find this a satisfying version both as to sound and music. The sound is romantically opulent and live and the definition must be more than adequate for the clichés seemed more obvious to me than ever.

SAINT-SAENS: *Piano Concerto No. 2*
Piano Concerto No. 4
Jeanne Marie Darre, pianist
National French Radio Orchestra
Capitol P-18036

Part two of the *Fourth Concerto* is based on a particularly lovely theme, very cleverly developed, and remains a favorite for me despite hundreds of rehearings. If you like the piano concerto you'll like this recording. The piano is nicely live and very well played; the sound is excellent and the rendition is also.

BEETHOVEN: *Violin Concerto*
Heifetz with Boston Symphony
RCA Victor LM-1992

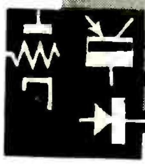
This should be a best seller, pleasing both the music lover and the hi-fi enthusiast equally well. Heifetz's playing of this concerto during the past 20 years or more has become a standard of comparison. From a sound point of view this is one of RCA Victor's very best.

The kettledrums are just loud enough to be impressive without stealing the spotlight from the soloist. The fiddle is miked very close up and has terrific presence. The fiddle tone is typically Heifetz. The listener who is a fiddler himself will be able to hear every detail of technique. The balance of fiddle to orchestra is definitely artificial in terms of what one hears in a concert hall for the fiddle is as Heifetz hears it and the orchestra is as heard in the balcony of the concert hall. But I don't think the music suffers from this; on the contrary, the intimacy of the fiddle seems to increase the emotional impact.

The Weavers at Carnegie Hall
Vanguard VRS-9010

A concert of folk songs recorded at an actual performance complete with applause and whistles. Not up to Vanguard's highest standards but the Weavers sing without the affectations of the folk-song "artists" and far closer to the way the songs are actually sung by "folks." The miking does not flatter the voices but does produce excellent verisimiltude. END

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

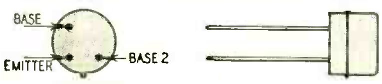


New Tubes & Semi-conductors

A Unijunction transistor, germanium and silicon rectifiers, a beam power tube, a reflex transistor, medium-power audio transistors and a medium-mu triode–sharp-cutoff pentode were among the important introductions this month.

Unijunction transistor

The 4JD5A1, a silicon Unijunction transistor made by G-E, is a 3-terminal device having N type negative-resistance switching characteristics between the emitter and base terminals.



4JD5A1

Tentative specifications list the transistor's maximum ratings as:

Interbase voltage (V_{BB})	45
Interbase power dissipation (mw)	250
I_E (ma)	50
Operating temperature (°C)	−65 to +150

IN1013

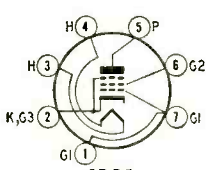
Two germanium junction rectifiers connected as a voltage doubler make up this G-E rectifier. It is intended to replace other types of rectifiers used in television receivers.

Recommended operating values are:

Input (rms volts)	117
Peak inverse voltage	340
Full-load drop (each section) (volts)	0.12
Series surge resistor (ohms)	4
Operating temperature (°C)	40
Operating fin temperature (°C)	50

6DS5

This RCA seven-pin miniature beam power tube intended for use in audio output stages of radio and TV receiv-



6DS5

ers, has high power sensitivity and high efficiency.

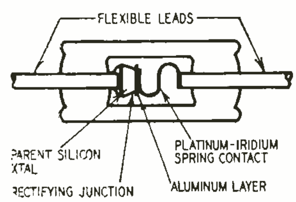
Typical operating characteristics, cathode-bias operation, are:

E_b	200
E_{c2}	200
Cathode-bias resistor (ohms)	180
E_{g1} peak af	7.5
I_b zero signal (ma)	34.5
I_b maximum signal (ma)	32.5
I_{c2} zero signal (ma)	3.5
I_{c2} maximum signal (ma)	9
R_p	28,000
g_m	6,000
R_L	6,000
Total harmonic distortion (%)	10
Maximum signal power output (watts)	2.8

Silicon rectifiers

A series of low-power silicon rectifiers has been announced by Hughes Products. Ten different ratings are available.

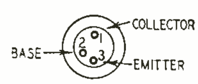
At the low end of the group is the HR10211 with maximum ac input, 140 volts; maximum reverse dc, 175 volts; maximum average rectified current, 150 ma; power dissipation, 175 mw. At the high end is the HR10255, with a maxi-



mum ac rating of input, 275 volts; maximum reverse dc, 375 volts; maximum average rectified current, 200 ma; power dissipation, 200 mw.

MN13A, B, C

These three transistors are p-n-p, germanium junction units, designed for medium-power applications in the audio-frequency range. All are produced by Motorola.



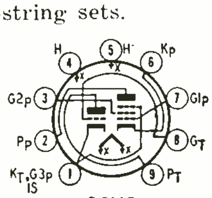
MN13A,B,C

Their characteristics are:

	MN13A	MN13B	MN13C
Maximum E_c	−40	−40	−40
Maximum E_e	−20	−20	−20
I_c (ma)	−150	−150	−150
Power dissipation (65°C) (mw)	350	350	350
Current gain (max)	20	40	80
Current gain (min)	10	20	40
Input impedance (max) (ohms)	100	120	175
Input impedance (min) (ohms)	30	40	75
Frequency cutoff (kc)	50	45	40

6CU8

A general-purpose medium-mu triode–sharp cutoff pentode intended for applications in monochrome and color TV sets, has been introduced by RCA. The nine-pin miniature tube has a 6-volt 450-ma heater with controlled warmup for series-string sets.



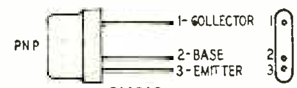
6CU8

Typical characteristics when used as a class A_1 amplifier are:

	Triode section	Pentode section
E_b	200	200
E_{c1}	−6	(cathode resistor 180 ohms)
E_{c2}		150
μ	19	
R_p	5,750	300,000
g_m	3,300	6,200
I_b (ma)	13	9.5
I_{c2} (ma)		2.8

2N310

Texas Instruments Inc., has announced a new p-n-p grown-diffused germanium transistor designed to serve as a reflex if–af amplifier in 455-kc if radio receivers.



2N310

Typical common-emitter operating characteristics are:

E_c	−9
I_c (ma)	−2
If power gain (db)	37
Audio voltage gain	28
Max E_c	−30
Max I_c (ma)	−5
Max collector dissipation (mw)	30
Max operating temperature (°C)	55

Other types

Other tubes announced this month were a uhf diode, (5647) by Sylvania; a line of 170°C. stud-mount silicon rectifiers by G-E; a medium-mu twin triode (6350) by RCA, and the 4CX250K and 4CX250M beam power ceramic and metal tetrodes made by Eitel-McCullough. 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 July, 1923 (Special Radio Number), Science and Invention (formerly Electrical Experimenter)

Fortunes in Radio, by H. Gernsback.
First German Train With Duplex Radio-phone, by Dr. Albert Neuburger.
New South American Broadcast Station.
High-Speed Radio Transmitter and Receiver on Board Ship.
Sharply Tuned Detector and Amplifier, by Bert T. Bonaventure.
The Reinartz Tuner, by Leroy Western.
Forecasting Weather by Radio.
A Tuned-Impedance Radio-Frequency Receiver, by Howard Allen Duncan.
One-Tube Super-Regenerator, by Marius Logan.
3 Tube "Cigar Box" Receiving Set, by Clyde J. Fitch.
Reflex Circuit Saves Tubes, by A. P. Peck.
A Short and Intermediate Wave Regenerative Receiver, by Joseph Schuck.
A Novice Receiver, by John F. Bront.
WJZ's New Home, by A. P. Peck.

Technicians' News

STATE LEADERS CONFER

Meeting for the first time since the joint industry conference in March, service leaders from the northeastern states gathered at the Hotel Roosevelt in New York on May 5 to review recent events and lay plans for future activities. The meeting was directed by Frank E. Silverman, president of the Television Service Association Inc. of Connecticut and chairman of the United Electronic Service Council.

A 20-point industry program designed to reduce most of the frictions in the electronics industry was discussed. The program had been temporarily set aside by the National Electronic Distributors Association (NEDA) until legal aspects of some points had been cleared up. Mr. Silverman announced that the program had been properly revised by an attorney and with the council's approval would be resubmitted to NEDA.

A six-point program submitted by Morris Green, Almo Radio Co., Philadelphia, was also considered. After a careful study of the proposal the council voted to commend Mr. Green and his committee for the report and to urge its adoption at the earliest possible date.

Among those attending the meeting were: Gordon Vrooman, president of the Empire State Federation of Electronic Technicians; Donald Roberts, president of the Syracuse Television Technicians Association; Bert Bregenzer, chairman of the Federation of Radio & Television Service Associations of Pennsylvania; Norman Selinger, Television Service Associations of Metropolitan Washington; Dave Krantz, Philadelphia Television Service Co., and Jack Wheaton, secretary of ESFETA.

TESA BACKS LICENSING

TESA–Chicagoland presents the arguments for licensing in a recently issued 3-page pamphlet. A discussion of what problems face the technician, what has been proposed, what the plan will do for the technician and what the opposition has said is included. In closing, the pamphlet states: "Now it's your turn—Won't you do yourself a favor and assure your future by writing to your State Senators and Representatives asking that they support the bill to license the TV service industry?"

COLUMBUS REJECTS

The City Commission in Columbus, Ga., rejected a proposal asking it to set up a licensing ordinance "that would protect citizens from radio and television repairmen who overcharge for their services." Commissioner Ed Berry said that licensing had been proposed several months ago and was turned down because adequate laws already existed to protect people from "cheating and swindling."

ESFETA MEETS

Gordon Vrooman of the Syracuse TV Technicians Association was re-elected president of the Empire State Federation of Electronic Technicians Association. Robert Larsen of the Radio Television Guild of Long Island was elected vice president and George Carlson, Electronic Technicians Association of Jamestown, secretary. P. P. (Pat) Pratt of the Television Electronic Service Association of Western New York received a unanimous vote for re-election as treasurer. Thomas Salisbury of the Mohawk Valley TV Technicians Guild won the sergeant-at-arms position.

Four new associations were accepted as members: Tri County Electronic Technicians Association, Rockland Association of Electronic TV Services, Mohawk Valley TV Technicians Guild and Tompkins County TV Dealers Association. With the addition of these groups ESFETA now represents 80% of the organized service associations in New York State.

Discussions centered on the efforts of the National Electronic Distributors Association to encourage liason between manufacturing, distribution and service segments of the electronics industry. In developing representation on the respective Educational Committees, it was felt that the service segment should receive more recognition than indicated by correspondence received in connection with NEDA's efforts. A letter explaining ESFETA's position was sent to the responsible parties.

MINNESOTA STANDARDS

Statewide registered standards for qualifying radio and television service technicians have been drawn up by the Minnesota Television Service Engineers Inc. (MINTSE) in cooperation with the Radio Television Service Association of Minneapolis.

Among the requirements are a minimum term of apprenticeship 4,000 hours' on-the-job training for servicemen with an additional 4,000 hours for technicians.

Wages are set at a percentage of the trained technician's salary, with a serviceman's salary 75% that of a technician's. Upon completion of a technician's test, full technician's wage is paid.

PRESIDENTS COUNCIL MEETS

A recent meeting of the Presidents Council of the Los Angeles TV service associations initiated work toward a formal joining of all 10 associations in the area under a single charter. Reports were also made at the meeting on the California State Electronics Association's sponsored bill for TV service licensing.

NATESA DIRECTORS CONFER

More than 100 directors attended the National Alliance of Television & Electronic Service Association's board of directors' meeting in New Orleans.

During the one-day session, a special committee was set up to prepare a brochure on licensing. It will be a "do and don't" publication. Captive service was also discussed and NATESA went on record as feeling that captive service is not in the best interests of anyone, including those entering into this type of operation.

The meeting also listened to addresses by Bud Tolmer, CBS chief field engineer and J. T. McMurphy, general sales manager of the Accessory Division of Philco Corp. McMurphy revealed that the American public spent more on service, parts, tubes and accessories in 1956 than on new television sets.

More than $1.5 billion was spent at the service dealer's during 1956. In 1957, Mr. McMurphy predicted, sales of parts, accessories and service will exceed $2 billion.

TESAM ELECTION

The Television Electronic Service Association of Missouri has elected Wayne Lemons president. Other officers are: Edward Engle, secretary; Warren Callison, treasurer, and regional vice presidents Dennison Houghton, northeast; Howard Freiner, southeast; M. C. Crane, northwest; Arent Patterson, southwest.

Three new directors—Howard Seiggen, Mac Metoyer and Jack Mulford—were also elected.

ANTENNA SAFETY LAWS

Danville, Va., has begun inspection of radio and TV antennas in accordance with a new city ordinance. The law requires that installations of antennas be reported to the city's Electric Department within 48 hours. For a fee of $1.50 the antenna will then be inspected for correct and safe installation. Safety factors stressed are proper grounding, lightning arresters and location away from power lines.

In Miami, Fla., the city's Building Department has decided to enforce its hitherto ignored TV antenna law. No antennas should be installed without a permit costing $1. Home owners have been advised to check with dealers and make sure that a permit has been obtained. Failure to obey the law could cost $200, 60 days in jail, or both.

SWEEP CIRCUIT CLINIC

The Radio Television Association—Pasadena, at a recent meeting, heard and saw a demonstration and lecture on horizontal sweep systems, presented by Irving Tjomsland, of the Triad Transformer Co. Mr. Tjomsland used a special live demonstration board of his own construction. He also described a step-by-step method for determining all horizontal sweep system (horizontal output and high voltage) troubles. The demonstration was followed by a question-and-answer period, after which coffee and doughnuts were served. Eighty-three technicians attended the meeting.

Miss Judy Tjomsland, daughter of the dynamic demonstrator's designer and constructor, signals for power to the unit.

NEW DETROIT GROUP

A nonprofit organization, the American Institute of Television, has been formed to represent all members of the industry, including service technicians, retailers, suppliers and producers.

The 30 charter members have named a temporary board of directors and officers. The group's objectives are to represent the television industry; establish sound business principles and ethical concepts; instill consumer trust and confidence; protect the interests of all members legally, financially and community-wise and to establish a basis for "the greatest public relations campaign in the history of the industry."

ARTS AGAINST LICENSING

The Associated Radio & Television Servicemen (ARTS) of Chicago, Ill., has come out against the licensing bill being presented to the Illinois State Legislature. One of the main points the group opposes is the annual $100 fee.

ARTS feels that the considerations on which a licensing law should be based are: Is it needed? Is it just? Is it sound? Is it fair? Is it wise? rather than on a high licensing fee to make it attractive to the state. END

Attention . .

Service Technicians' Associations

Club Members • Student Groups

Special subscription rates to RADIO-ELECTRONICS are available to associations, clubs, schools, employe groups, etc. For information write—

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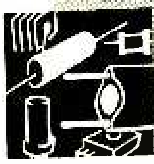
RADIO-ELECTRONICS
154 West 14th St., New York 11, N. Y.

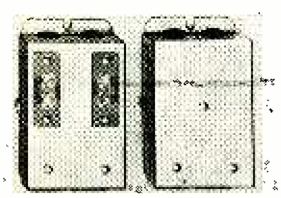
new Devices



CONELRAD ALARM KIT. *CA-1.* For use with any radio receiver that has avc. When monitored station goes off the air,

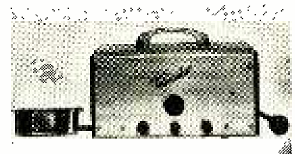
transmitter controlled by CA-1 is cut off and indicator lights. Manual reset button. 8-amp relay. Sensitivity control.—**Heath Co.**, 305 Territorial Road, Benton Harbor, Mich.

MASTER TV TAP OFFS. Single and double master antenna system wall outlet boxes. *TO1-75;* 75 ohms, 1 receiver, *TO 2-75* (right): 75 ohms, 2 receivers. *TO1-300:* 300 ohms, 1 receiver. *TO2-300* (left): 300 ohms, 2 receivers — **Blonder-Tongue Labs, Inc.**, 9-25 Alling St., Newark 2, N. J.



CONVERTER. *Model HC-10* SSB/CW and AM/MCW. For any receiver with if between 450–500 kc. 1-, 2- or 3-kc selectivity on either sideband and 0.5, 2, 4 or 6 kc on both sidebands. Slot filter for attenuation of co-channel interference. Combination noise limiter and

squelch control.—**Hammarlund Manufacturing Co., Inc.**, 460 W. 34th St., New York, N. Y.

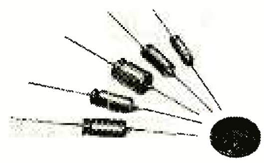


POWER CONVERTER. *TV Special Chief* converts 12-volt dc to 110-volts 60-cycle ac. 100-125 watts. *Supreme* delivers 175–200 watts.—**Terado Co.**, 1068 Raymond Ave., St. Paul 14, Minn.

MINIATURE CAPACITORS. *Type ML.* For transistor radios, hearing aids, portable TV sets and applications where size is

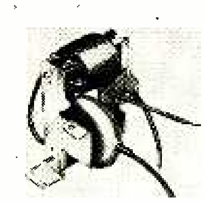
important. Hermetically sealed aluminum cans or ceramic case. —**Pyramid Electric Co.**, 1445 Hudson Blvd., N. Bergen, N. J.

MINIATURE ELECTROLYTICS. *TT Series.* Aluminum-



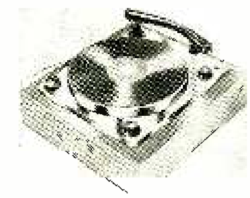
cased. 30 capacitance and voltage ranges. From 1–110 μf and from 1–50 volts.—**P. R. Mallory & Co., Inc.**, 3029 E. Washington St., Indianapolis 6, Ind.

REPLACEMENT FLYBACKS, *HO-269* (illustrated) replaces Zenith S-22720; *HO-270*, Zenith S-18125; *HO-271*, Zenith S-23438; *HO-264*, Philco 32-8709-1; *HO-265*, Admiral 79C70-1; *HO-266*, Magnavox 360659; *HO-267*, Zenith S-20099; *HO-268*, Zenith



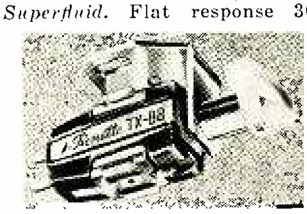
S-23049. — **Chicago Standard Transformer Corp.**, 3501 W. Addison St., Chicago 18, Ill.

3-SPEED RECORD PLAYER. *PK-160.* 4-pole shaded induction motor. 10-inch, 3-pound turntable. Pressed steel chassis. Rubber turntable mat. Interchange-



able plug-in heads. 45-rpm adapter mounts on chassis.—**Lafayette Radio**, 165-08 Liberty Ave., Jamaica 33, N. Y.

PHONO CARTRIDGE, *TX 88 Superfluid.* Flat response 30–



24,000 cycles. Little IM distortion. 0.4-volt output. Stylus replaceable without tools.—**Ronette Acoustical Corp.**, 190 Earle Ave., Lynbrook, N. Y.

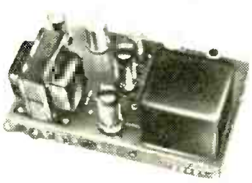
RECORD SPRAY. Fidelitone *Lubri-Stat* eliminates static elec-

trical buildup. Reduces record and needle wear. Nontoxic.—**Permo, Inc.**, 6415 N. Ravenswood Ave., Chicago 26, Ill.

AMPLIFIER SYSTEM. *Model 19.* 60 watts. Preamp and power amplifier. 20–20,000 cycles. IM distortion below 1% at full output. 6550 output tubes. 14½ x

10¾ x 5¼ inches. 28 pounds.—**Tech-Master Corp.**, 75 Front St., Brooklyn 1, N. Y.

HI-FI AMPLIFIER. *Eico HF-50.* 50-watt Ultra-Linear power amplifier. 20–20,000 cycles with less than 0.5% harmonic distortion. IM distortion less than 1%



at rated output. 21-db inverse feedback. EL34 output tubes. 0.5-volt input for 50-watt output. — **Electronic Instrument Corp.**, 84 Withers St., Brooklyn 11, N. Y.

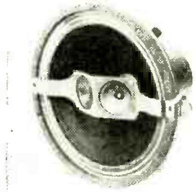
EQUALIZER CONTROL UNIT. *Model CC-1.* Kit or wired. Bass, treble, volume controls. Rumble filter. 4-position input selector. RIAA or LP curve. 6 pounds.

13 x 3 x 5 inches. — **Madison Electronics, Inc.**, Madison, N. J.

INTERCOM SYSTEM. Transistors and printed-circuit boards. 2100 series: 3 tubes replaced by 1 diode and 2 transistors. 2 diodes and 3 transistors replace 4 tubes in 3100 series. New sets can be added to existing systems

without modifications. — **Webster Electric Co.**, 1900 Clark St., Racine, Wis.

COAXIAL SPEAKER. *WIGO CX 212 B.* 25–17,000 cycles. 12



inches, 30 watts. Cast aluminum frame. Flat response. Flux density 13,500 gauss.—**United Audio Products**, 202-4 E. 19 St., New York 3, N. Y.

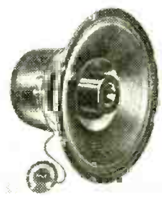
ELLIPTICAL TWEETER. *T-64.* For 2, 3 or 4-way hi-fi systems.

Special paper cone.—**Sonotone Corp.**, Elmsford, N. Y.

REAR-SEAT SPEAKER KITS. 5 models. Speaker, grille, 3-position switch, wire, hardware

and instrutions.—**Utah Radio Products Corp.**, 1124 E. Franklin St., Huntington, Ind.

THREE-WAY SPEAKER. *SI DX 839.* 35–15,000 cycles. 12 inches, 25 watts. 3 concentric radiators for reproduction of bass, middle and high frequencies. Bass and mid-range cones

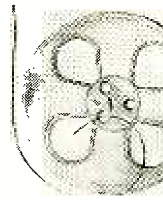


use 1¾-pound magnet. Horn-loaded compression tweeter. Built-in mechanical and electrical crossovers. Impedance, 16 ohms.—**Allied Radio Corp.**, 100 N. Western Ave., Chicago 80, Ill.

WOOFER. *A1-403.* 40–1,500 cycles. 12 inches. Electromechanical crossover system for 1,500-

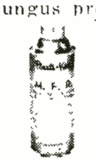
cycle rolloff. 8-ohm impedance. 14.5-ounce magnet. 25 watts program. 50 watts peak.—**General Electric Co.**, Specialty Electronic Components Dept., W. Genesee St., Auburn, N. Y.

TAPE REEL. *C-Slot reel.* For magnetic recording tape. Curved groove in hub for easy thread-



ing. Tape slipped into groove in direction opposite of reel rotation.—**Audio Devices, Inc.**, 444 Madison Ave., New York 22, N. Y.

PROTECTIVE VARNISH. Moisture and fungus protection of-

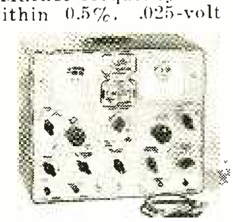


fered by *MFR*. 16-ounce self-spray can.—**Argos Products Co.**, Genoa, Ill.

WOOD SCRATCH REPAIR. *Skratch Stik*. Repairs scratches on TV sets, wood furniture, cab-

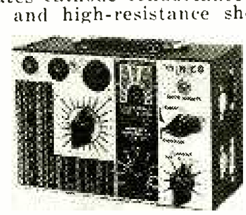
inets, floors and woodwork. Mahogany, walnut and light wood. —**General Cement Manufacturing Co.**, 400 S. Wyman St., Rockford, Ill.

SWEEP AND MARKER GENERATOR. *Model 615*. All-electronic sweep has no moving parts. AM less than 0.1 db per mc. Marker-frequency accuracy is within 0.5%. .025-volt rms



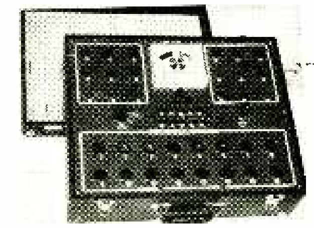
marker. Frequency 2.5–5.5, 19–50, 54–108 and 108–216 mc. Variable sweep width 0–15 mc.—**Hickok Electrical Instrument Co.**, 10531 Dupont Ave., Cleveland 8, Ohio.

TUBE TESTER. *Minico 400*. Electron-ray indicator tube indicates cathode conductance and gas and high-resistance shorts.



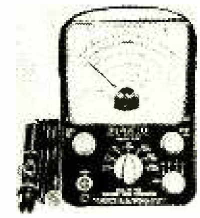
3 sockets test 98% of all TV tubes.—**Minnesota Instrument Co.**, 137 W. 7th St., St. Paul 2, Minn.

TUBE TESTER. *Model A-1000 Rapid-Chek*. Tests octal, loctal, 7- and 9-pin miniature tubes for gas, leakage, grid emission, shorts and tube worth. Gas and leakage read on meter.—**American Scientific Development Co.**,



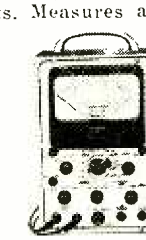
334-336 South Main, Fort Atkinson, Wis.

TEST INSTRUMENT KITS. *Model V-70* (illustrated): vtvm with 21 ranges. *Model C-20*: resistance-capacitance-ratio bridge. *Model B-10*: battery eliminator. *Model S-50*: 5-inch oscilloscope. *Model T-60*: tube



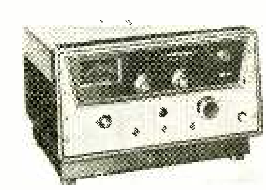
tester.—**Paco Electronics Co., Inc.**, 70-31 84th St., Glendale, N. Y.

TRANSISTORIZED VTVM-VOM KIT. Transistors make vtvm completely portable. 50-μa movement. Precision components. Measures ac, dc volt-



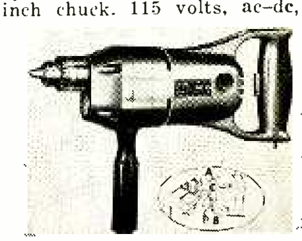
age; af output voltage-frequency response, volume level, dc resistance and direct current as vom. As vtvm, measures dc voltage, resistance and circuit current.—**Transvision, Inc.**, New Rochelle, N. Y.

KILOWATT RF AMPLIFIER. *Model HT-33*. Single-knob band switching selects proper grid coil and plate tank inductance. Fixed 52-ohm output impedance. Ceramic power tubes, two 866-A rectifiers, OB2 and OA2 regu-



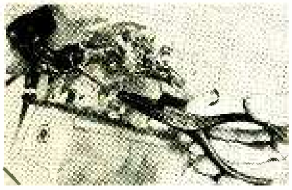
lators. Circuit metering. Covers 80-, 40-, 20-, 15-, 11- and 10-meter amateur bands.—**Hallicrafters Co.**, 4401 W. Fifth Ave., Chicago 24, Ill.

POWER DRILL. *Model 808*. 2 speeds, 3,000 and 1,000 rpm. ⅜-inch chuck. 115 volts, ac-dc, 2



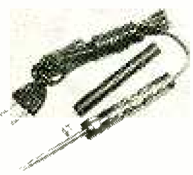
amps.—**Wen Products, Inc.,** 5804 Northwest Highway, Chicago 31, Ill.

HEAVY-DUTY PLIERS. Linemen's, diagonals, electricians', wiring, needlenose, ignition,



water-pump and general. Triple-coated with high-dielectric material. *PL805* needlenose (illustrated).—**Hunter Tool Co.,** Box 564, Whittier, Calif.

MIDGET SOLDERING IRON. *Model SL-10.* 10 watts. ½ ounce, 6 inches long. 110 volts ac or dc.



Heats in less than minute. 6-foot line cord.—**Meadow Sales Corp.,** 2712 W. Montrose Ave., Chicago 18, Ill.

MINIATURE ROTARY SWITCH. *Series BHM POTPOT.* Encapsulated. Color-coded leads. Rated at 50 ma at 300 volts and

500 ma at 30 volts. Diameter 29/32 inch. 1⅛ inches long.—**Clarostat Manufacturing Co., Inc.,** Dover, N. H.

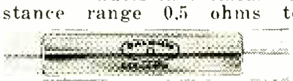
PICTURE-TUBE BRIGHTENER. *Comet SP43.* For restoring normal contrast and brightness to dim picture tubes. Can be used with series or parallel

filament circuits, electromagnetic or electrostatic deflection tubes. Fits all makes of TV sets.—**Anchor Products Co.,** 2712 W. Montrose Ave., Chicago 18, Ill.

CONTROL CLEANER. *Kleen-trol.* To clean and lubricate

controls. No carbon tetrachloride. Packaged in metal Can.—**R-Columbia Products Co.,** Highwood, Ill.

POWER RESISTOR. *Dalohm RSE* type. 5 wattage ratings from 2–10 watts in 7 sizes. Resistance range 0.5 ohms to

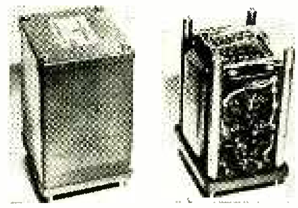


175,000 ohms, depending on size and tolerance. Tolerances, 0.5%, 0.1%, 0.25%, 0.5%, 1% and 3%. Wirewound, inserted in a nickel-plated brass tube. Shock-resistant.—**Dale Products Inc.,** Box 136, Columbus, Neb.

DIGITAL OHMMETER. *Model DOX-500 illustrated.* 5 digits. Direct reading. Automatic rang-

ing. .01 ohm to 10 megohms. Modular construction. 3½ x 19 x 12 inches. *Model DOX-400,* 4 digits—**Electro Instruments, Inc.,** 3794 Rosecrans, San Diego, Calif.

DC TO AC CONVERTERS.

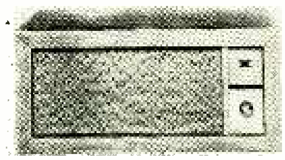


Compact and lightweight. Transistorized units replace dynamotor and vibrator supplies. Standard units produce up to 250 volts ac from 28 volts dc.—**UAC Electronics,** 143 E. 49th St., New York 17, N. Y.

CONELRAD MONITOR. Completely wired. Ready to use. When station goes off the air, electronic audio alarm set off.

For use with any radio that has avc.—**American Electronics Co.,** 1203-05 Bryant Ave., New York 59, N. Y.

ACOUSTIC DELAY UNIT. *Xophonic.* For hi-fi audio instal-



lations. Produces concert-hall effects by picking up signal from main amplifier, delaying it .05 second and reproducing it from speaker in room rear or other point remote from main speaker. Uses small driver (speaker) unit feeding at low level into 50-foot length of aluminum pipe used as acoustic delay line, microphone, 3-stage amplifier and speaker, all in small cabinet.—**Radio Craftsmen, Inc.,** subsidiary of Precision Radiation Instruments, Inc., 4223 W. Jefferson Blvd., Los Angeles 16, Calif. END

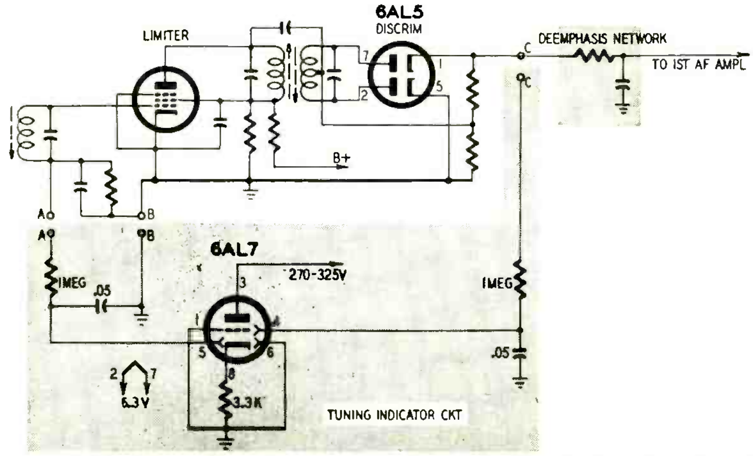
All specifications given on these pages are from manufacturers' data.

Question Box

FM TUNING INDICATOR

I would like to use a 6AL7 indicator with my FM tuner which has a linear Foster-Seeley type discriminator. I have drawn B plus from my power amplifier as it cannot be obtained from the tuner. So far I have not been able to get enough deflection action from the 6AL7 for satisfactory tuning. Please describe the proper circuit and modifications.—A. T. Philadelphia, Pa.

It is unnecessary to alter any existing wiring. All you should have to do is add the 6AL7 circuit as indicated in the diagram. This requires a total of three connections to the tuner (points A, B and C). As B plus is not available in the tuner a separate connection to a power source is needed for the plate (target). The B plus should be between 270 and 325 volts. If deflection is insufficient, lower the 6AL7's plate voltage.



A slightly different approach is presented by Frank J. DiElsi in RADIO-ELECTRONICS, March, 1957, page 105.

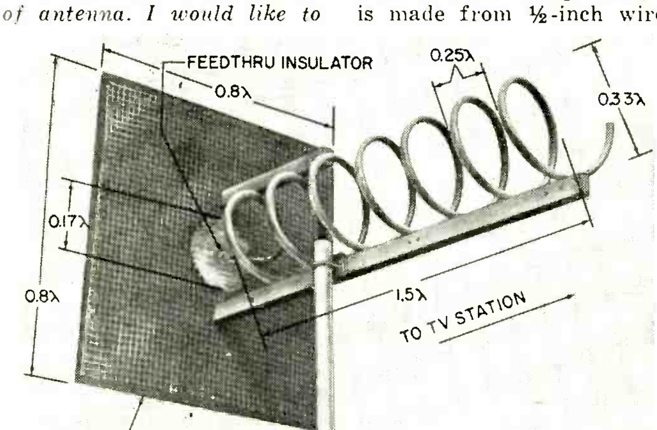
HELICAL ANTENNA FOR UHF TELEVISION

In your April, 1957, issue you describe a helical antenna for guided-missle work. I find that it would be nicely suited for uhf television reception. Some time ago I saw some data on this type of antenna. I would like to build one, but I need some data to work from. Can you help me?—E. A., Millstone, Conn.

This data appeared in RADIO-ELECTRONICS, October, 1954.

A helical antenna is a high-gain broad-band unit. Its unpopularity is due to the awkwardness of construction. It is hard to mount and its wind resistance is high.

The photo shows the general shape and dimensions of the antenna and a method of mounting. The ground screen is made from ½-inch wire mesh fastened to a metal or wooden frame. A metal ground plate about 1/6 wavelength in diameter should be soldered to the center of the ground screen. It can be made from sheet copper.



The transmission line (RG-63/U, RG-79/U, or RG-89/U) is connected to the antenna through a hole in the center of the ground plate. The center conductor goes to the helix, the outer one to the ground plate.

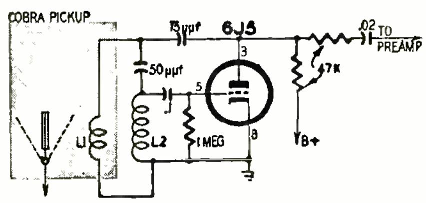
The main difficulty is winding the helix. A soft grade of aluminum tubing, clothesline or ground wire should be used. It will have to be wound on a heavy wooden or metal cylinder. Exact calculations are pointless as the helix will "relax" when removed from the winding form. Diameter should be approximately ⅓ wavelength. Use insulating pieces to support the turns and hold them in place.

The antenna has an impedance of approximately 125 ohms. Good results are obtained by using a length of 6 wavelengths. Since the antenna has a fairly broad bandwidth the dimensions listed are not critical. A helical antenna is practical only for uhf.

ZENITH COBRA PICKUP

I have a Zenith Cobra-matic record changer Model S14028. I've tried connecting it to a G-E preamplifier but it doesn't work. I've been told that the cartridge works through an rf oscillator but I don't know what type of circuit to use. Can you help me?—A. R. D., New Orleans, La.

The diagram shows the basic circuit of the oscillator used with the Cobra-type pickup that you have. The oscillator operates at around 2.5 mc. Coil L1 in the pickup cartridge is the feedback winding and L2 is the grid coil of the oscillator transformer. The stylus is fastened rigidly to a steel vane pivoted so needle movement causes it



to swing closer to or farther away from L1. This changes the Q of L1 and varies the amount of plate-to-grid feedback so the plate current varies at an audio rate. An audio voltage appears across the plate load resistor and is tapped off and fed into a preamplifier stage.

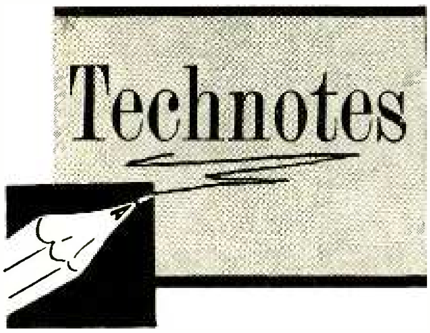
The oscillator would probably be hard to duplicate unless you obtain an exact replacement for L2 and can copy the circuit and layout of the oscillator in one of the sets designed for this particular cartridge.

Later Zenith Cobra pickups use ceramic cartridges. We suggest that you replace the tone arm and cartridge on your changer with later models. Your Zenith parts distributor will be able to supply the proper parts. END

PEST

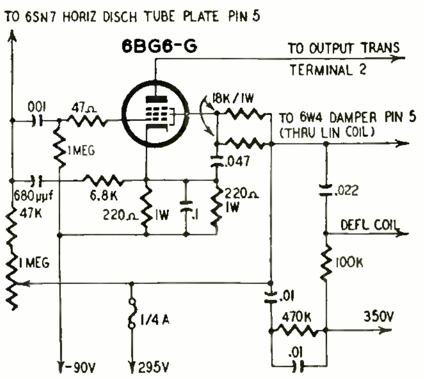
The man who brings his set to me
And wants it fixed where he can see,
And stands above me all day long,
And tells me what *he* thinks is wrong.

—*Jeanne DeGood*



CAPEHART CX-33

Complaint was rapidly fluctuating width, wavy edges and a pattern of monkey-chatter on both picture and raster. Horizontal and vertical sync were good, but picture quality was poor. The set would have a period of normal operation in both regular and narrow width.



Voltages were within normal tolerances, with the screen voltage dropping as the picture settled in the narrow-width condition. This was a first-class intermittent which just the touch of the test probe would bring back to normal.

Suspecting C-278, cathode to ground from the damper, we jumped the ¼-amp high-voltage fuse before going further. Immediately the picture returned to normal and remained that way. This pigtail fuse had developed an imperfect contact that caused the supply voltage to fluctuate, affecting the horizontal output.—*H. L. Matsinger*

RCA CTC5 CHASSIS

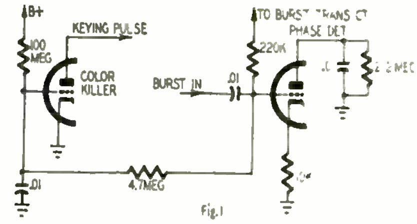
The set showed a slow change in kinescope color during warm-up. This difficulty was found to be due to changes in the values of R-419 and R-420. Both these resistors are 910 ohms, 1 watt. After replacement with 2-watt resistors color remained steady.

In this same chassis we find that an intermittent change in screen color can be caused by C-722. This is a 10-μf dual electrolytic bypass capacitor in the demodulator cathode circuits. A simple change to a dual .01-μf ceramic solves this problem.—*L. Warren*

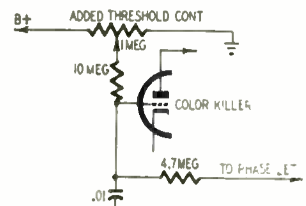
COLOR-KILLER CONTROL

The complaint on an old 15-inch Sylvania color TV receiver was that the color appeared intermittently, dropping out at times with only black-and-white reproduction remaining. There was no pattern to the color dropout; it seemed to occur at random.

Tube replacement gave little or no



improvement. With the output from a color bar generator applied to the receiver color reproduction was good and steady. But with attenuation of the color bar signal, the color dropped out at a higher level than would normally be expected. It appeared that the color-killer threshold was set too high for the available signal from the antenna.



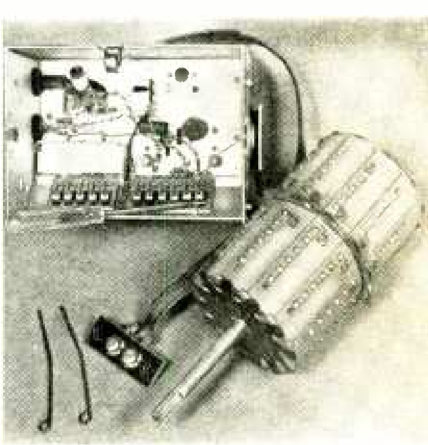
A check of the color-killer arrangement (Fig. 1) showed that the threshold was fixed. As an experiment, the 100-megohm resistor from the grid of the color killer to B plus was cut open. Now, the signal from the antenna provided good steady color reception. This confirmed the conclusion that the threshold of the color killer was on the "ragged edge" for the prevailing signal level.

A 1-megohm potentiometer was then installed (Fig. 2) so that the value of positive voltage applied to the grid of the color killer could be adjusted. The pot was adjusted to the point where steady color reception was assured, but high enough to minimize color noise. This simple addition of a threshold control cured the difficulty.—*Robert G. Middleton*

TURRET TUNERS

Standard Coil tuners with dirty contact springs and studs are a familiar story. A short treatment with carbon-tetrachloride and 420 abrasive paper normally relieves the complaint of intermittent loss of picture, sound, and having to rock the channel selector around to get the set working.

In cases where this treatment does

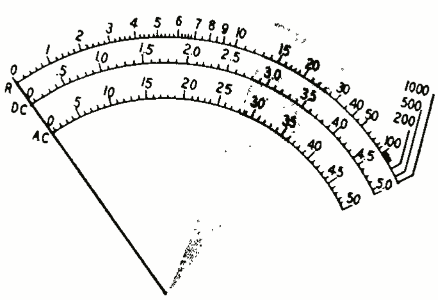


not work the trouble is probably due to some of the eleven contact springs having lost their original tension. Dropping the turret from its case puts them within easy reach. The repair is simple: pry them out from the mounting board about 1/16 or 1/32 inch. Use a small screwdriver and avoid prying them too far out.

A few tuners have remained intermitten even after resetting the springs, due to warping of the coil boards. These are quickly straightened out by dressing the shoulders of the affected channel with a few light strokes of a mill file and shimming each end of the coil board with plastic tape, or replace the coil.—*H. A. Highstone*

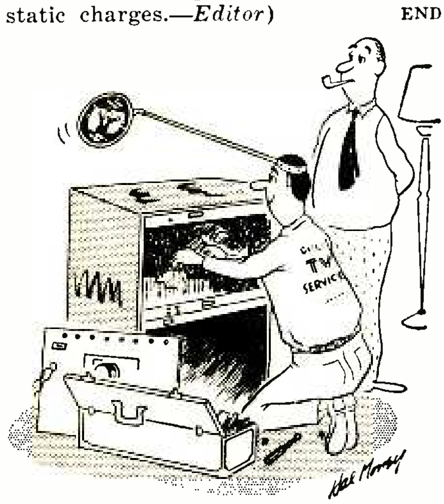
ERRATIC VTVM

I could not get a reading on my vtvm in the shaded portion of the scale (see diagram) regardless of the range or function. All components and voltages checked OK. Rotating the zero-adjust knob, the needle moved linearly to about 13 on the ohms scale . . . then a pause and a jump to about 29. The needle could not be stopped anywhere in the shaded portion of the scale.



Prying off the large plastic face cover, to my amazement, the instrument worked perfectly. Replacing the cover the same defect persisted. Suspecting perhaps the plastic cover had an electrostatic charge, I rinsed it under cold water and wiped it dry. The vtvm has worked like new ever since.—*Joseph L. Sokolick*

(Some manufacturers recommend wiping the meter face occasionally with a mixture of 10 parts of water to 1 part of Joy or similar liquid detergent. This cleans the plastic and eliminates static charges.—*Editor*) END



PHOTOGRAPHS

RADIO-ELECTRONICS can use good photographs of service benches, service shops, high-fidelity audio layouts, and any other interesting and original radio-electronic devices.

We will pay $6.00 each for good professional photos or equivalent, suitable for reproduction.

Full information on subject photographed will increase their acceptability.

The Editor, RADIO-ELECTRONICS

154 West 14th Street, New York 11, N. Y.

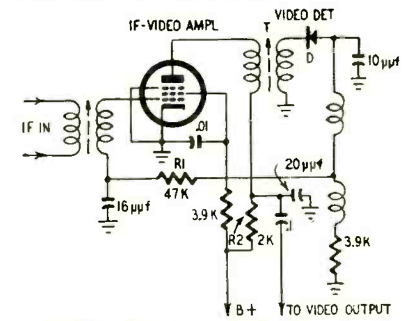
Patents

REFLEX VIDEO STAGE

Patent No. 2,777,056

Richard W. Bull, South Pasadena, Calif. (Assigned to Standard Coil Products Co., Inc., Los Angeles, Calif.)

The trend toward more compact and efficient TV receivers continues. Here is a single-tube stage that amplifies both if and video signals. The detector is a crystal diode.



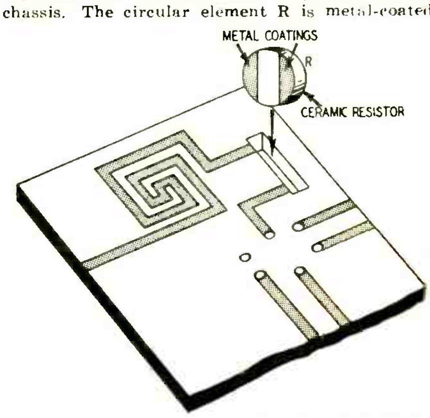
V amplifies the if as usual, then the signal is rectified by D, which provides the video modulation. This output is fed back through R1 to the grid of V for further amplification. The video signal passes through the primary of T with very little attenuation because this winding is tuned to a much higher frequency. Thus the video appears at nearly full strength across R2, the video load. From here it is transmitted to the video output stage (not shown).

PRINTED-CIRCUIT RESISTOR

Patent No. 2,777,039

Edwin P. Thias, Los Angeles, Calif. (Assigned to Standard Coil Products Co., Inc., Los Angeles, Calif.)

This resistor element is designed for easy insertion and connection on a printed circuit chassis. The circular element R is metal-coated



on each side to register with printed leads on the chassis. The resistive portion may be ceramic or other composition.

When the resistor is ready for connection into the circuit, it is placed in position. A simple dip-soldering operation completes the process.

HI-FI CLASS-B AMPLIFIER

Patent No. 2,772,329

John M. Miller, Jr., Baltimore, Md. (Assigned to Bendix Aviation Corp., Towson, Md.)

Class-B amplifiers are more efficient than class-A units but prone to greater distortion. This is largely due to the curvature of a tube character-

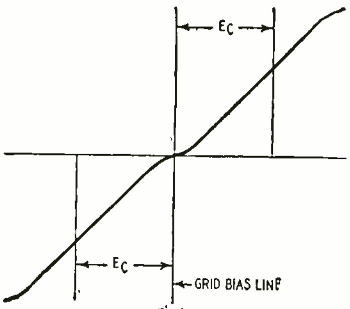


Fig. 1

istic near the origin. See Fig. 1. This invention uses ultrasonic bias to improve the fidelity.

Ultrasonic bias makes quality tape recording possible and a similar principle is used here. The bias is fed to both tubes in phase as in Fig. 2. Therefore, the composite characteristic of the tubes is swept back and forth (at a ultrasonic

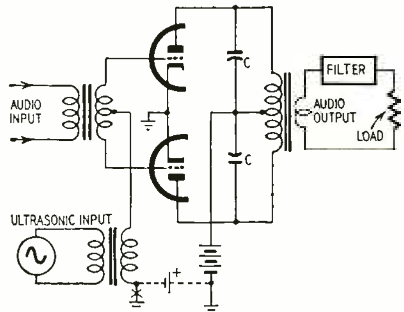


Fig. 2

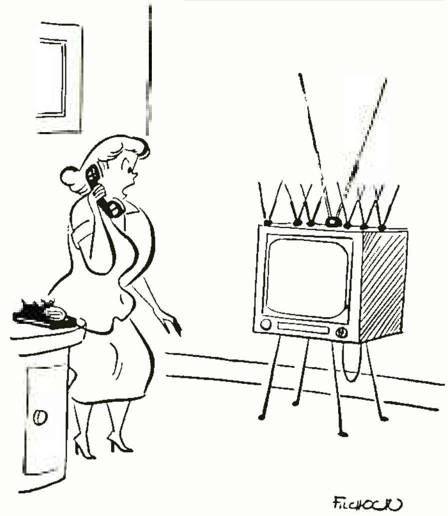
rate) along the grid bias axis. Instead of the *curve* shown in Fig. 1. we now have a characteristic "strip" of finite width. As a result, the irregularity near the origin is smoothed out. The inventor finds that distortion may be lowered as much as 79% at low output.

The ultrasonic frequency is bypassed by capacitors C and is further attenuated by a filter, to keep it out of the output signal.

ULTRA-PURE SILICON
Patent No. 2,773,655

Keith Huestis Butler, Marblehead, Mass., and Carl Marcus Olson, Newark, Del. (Assigned to E. L. du Pont de Nemours & Co., Wilmington, Del.)

This patent describes new and relatively simple chemical processes for producing ultra-pure (better than 99.98%) silicon. This makes possible the manufacture of better silicon transistors and power rectifiers. Although silicon has superior temperature characteristics when compared to germanium, it has not heretofore been available in sufficiently pure composition. END



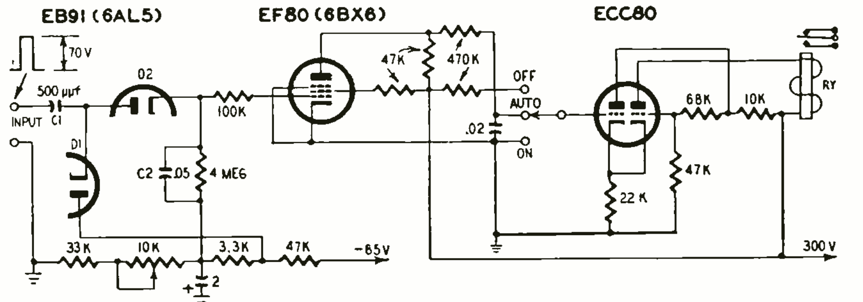
"Hello, TV Service? That rabbit ears antenna — well, last night it gave birth . . ."

radio-electronic Circuits

FREQUENCY-SENSITIVE RELAY

Circuits requiring frequency-sensitive relays generally use vibrating reeds or complex R-C tuned amplifiers with bridged-T, Wein-bridge or similar selective circuits in a feedback network. This circuit is designed around a diode pump integrator—a device developed for obtaining an average dc voltage level from a series of pulses. The circuit, developed during the design of an automatic range-selecting audio-frequency meter, was described in *Electronic Engineering* (London, England).

C1 and C2. When constant-amplitude pulses are applied to the input, the voltage across C2 is determined by the pulse frequency or repetition rate. The maximum voltage developed across C2 is E/4f volts per cycle where E is the pulse amplitude in volts and f the frequency in cycles. The voltage across C2 varies with frequency. This voltage change is amplified by the pentode and fed to a Schmitt trigger—a type of multivibrator that flips in one direction when the dc control potential rises to a certain critical level and then flops



With the circuit constants shown, the relay closes at 500 cycles and opens when the frequency drops below 497—a change of less than 1%. The diode integrator circuit consists of D1, D2, when the control voltage drops to a lower critical level. The relay is in the plate circuit of one section of the multivibrator. The 10,000-ohm pot adjusts the circuit for proper trigger action.

TRANSISTOR PHONO AMPLIFIER

If you've been looking for an amplifier to go with your battery-powered turntable, here it is! With a push-pull output, four transistors, volume and tone controls this amplifier is highly suited for a portable phonograph.

The amplifier circuit appears in Fig. 1. It has a frequency response of 50 to 10,000 cycles and operates from a crystal or ceramic pickup. It was originally described in *RCA Application Note AN 169*.

Only one type of transistor is used, an RCA 2N109 junction type.

An alternate input circuit for pickups with flat frequency response is seen in Fig. 2. Greater volume can be obtained by increasing the primary impedance of T1. If this circuit is used, R1 must be selected so that the time constant R1-C. is 75 microseconds. C. is the capacitance of the pickup. The functions of the volume and tone controls are reversed to lower changes in

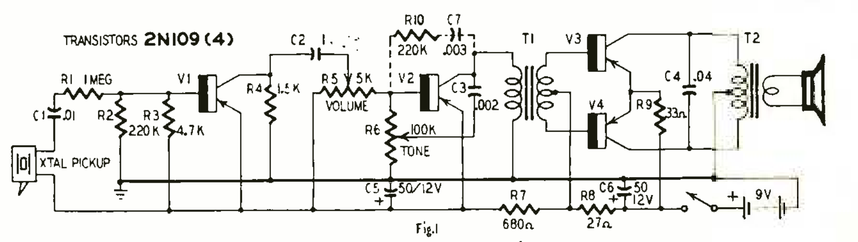


Fig. 1

R1—1 megohm
R2, 10—220,000 ohms
R3—4,700 ohms
R4—1,500 ohms
R5—pot, 5,000 ohms, logarithmic audio taper
R6—pot, 100,000 ohms, linear taper
R7—680 ohms
R8—27 ohms
R9—33 ohms
All resistors ½ watt

C1—.01 µf
C2—1.0 µf
C3—.002 µf
C4—.04 µf
C5, 6—50 µf, 12 volts, electrolytic
C7—.003 µf
T1—driver transformer, primary impedance 3,000 ohms; secondary (base-to-base) 5,000 ohms
T2—Output transformer, primary impedance 550 ohms (collector-to-collector); secondary to match speaker

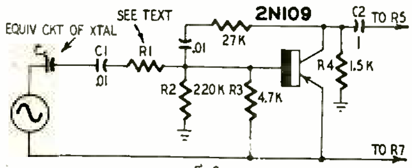


Fig. 2

frequency response with changes in the volume. Here the 100,000-ohm potentiometer (now the volume control) should have a logarithmic taper.

Output transformer T2 provides a load of 550 ohms. It should be a high-efficiency type with a low dc primary resistance, as the undistorted power output is reduced in proportion to the square of the dc voltage drop in the transformer primary.

To improve low-frequency response add resistor R10 and capacitor C7 (dotted lines in Fig. 1).

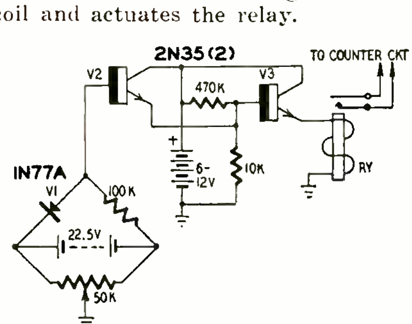
At normal volume the amplifier draws 22 ma. A typical 6-volt motor for 45-rpm turntables draws 30 ma. By combining the two units you could build a completely portable phonograph.

PHOTODIODE COUNTER

There are many methods of using phototubes to control a relay or other counter actuating devices. An interesting one was described recently in *Electronics* magazine.

The diagram shows a semiconductor circuit that does this job. It uses a 1N77A photodiode and two 2N35 junction transistors. The light-sensitive part of the circuit is a bridge with the photodiode as one leg. The 100,000-ohm resistor balances the diode's reverse resistance. A 50,000-ohm potentiometer is the opposite side of the bridge. It varies the no-signal current in the relay and sets the circuit's overall gain.

When light strikes the sensitive junction of the photodiode, its reverse resistance decreases. This increases the voltage at the base of V2, letting emitter current flow to the base of V3. The increased base current of V3 raises the emitter current through the relay coil and actuates the relay.



The potentiometer must be properly adjusted or the voltage at the base of V2 will be too negative to permit a change in bridge voltage to cause the transistor to conduct. A setting too far in the opposite direction will let both transistors conduct.

The relay was set to close at 4 ma and open at 2 ma. It can control a mechanical counter to give 200 counts per minute; with a counter tube, 60 counts per second can be obtained. END

Important Notice to

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154 West 14th Street, New York 11, N. Y.

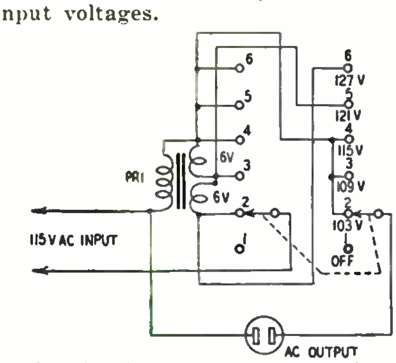
try This one

FORMING WIRE EYES

I've found that a small hole drilled in the blade of my screwdriver is very handy for forming wire eyes to fit screw terminals. To form an eye, simply insert the end of the wire into the hole and twist the screwdriver while holding the wire in the other hand. This kink is especially handy for it permits you to loosen the terminal screws and form a loop in the wire with just one tool — a screwdriver. — *John A. Comstock*

LINE-VOLTAGE REGULATOR

I have regulated line voltage by connecting a filament transformer as an autotransformer for several years. With proper switching, voltages can be lowered or raised sufficiently to show up weak selenium rectifiers or service TV sets that require critical ac input voltages.



The circuit uses a standard filament transformer. The desired voltage is selected with a two-pole six-position rotary switch. The ac output will be equal to the line voltage plus or minus the secondary voltages. This circuit provides 103 to 127 volts in 6-volt steps. A secondary rating of 2.5 or 3 amps will fill most service requirements.—*James Licitri*

LIGHTNING PROTECTION

Most rural radio service shops receive many sets whose antenna coils have been burned out by lightening discharges through them. The usual gap-type lightning arrester is insufficient protection because its spark-over voltage, although low enough to prevent fire, is high enough for static discharges to damage antenna windings.

A simple solution to this problem is to connect a small neon bulb (NE-2 or NE-51) between the set's antenna and ground terminals. These bulbs break down at about 80 volts, as compared with the UL requirement of 500 volts for spark-gap arresters, and thus offer much more protection. Like a good

OPPORTUNITY ADLETS

Rates—50c per word (including name, address and initials). Minimum ad 10 words. Cash must accompany all ads except those placed by accredited agencies. Discount, 10% for 12 consecutive issues. Misleading or objectionable ads not accepted. Copy for September issue must reach us before July 15, 1957.
RADIO-ELECTRONICS,
154 West 14 St., New York 11, N. Y.

HIGH-FIDELITY SPEAKERS REPAIRED. AMPRITE Speaker Service, 70 Vesey St., New York 7, N.Y. BA 7-2580.

CASH PAID! Sell your surplus electronic tubes. Want unused, clean transmitting, special purpose, receiving, TV types, magnetrons, klystrons, broadcast, etc. Also want military & commercial lab test and communications gear. We swap too, for tubes or choice equipment. Send specific details in first letter. For a fair deal write, wire or telephone: BARRY, 512 Broadway, New York 12, N.Y. WAlker 5-7000.

SURPLUS ELECTRONIC PARTS, Equipment, etc., Approximately 100 lb. Dayton, Parts Assortments $3 and $5 postpaid, #5JP2 Cathode Ray Tube $7.50 postpaid. No C.O.D. remittance with order. ALPINE PRODUCTS, Dept. 7A, 2236 Hepburn Ave., Dayton 6, Ohio.

LEARN MORSE CODE quickly, easily! Beginner's new, sensational manual, only 50c. AMERICAN ELECTRONICS, 1203F Bryant Ave., New York 59, N.Y.

TRANSISTORIZED Wireless Broadcaster Kit, $9.95. Wired, $11.95. Literature, AMERLABS, 471 Clifton Ave., Newark 4, N. J.

BUSY TELEVISION BUSINESS in pleasant California town. Priced at value of inventory and equipment. Box 357 Madera, Calif.

20-50% DISCOUNTS on Hi-Fi, tape recorders, tape, accessories, photographic equipment, individual quotations only. No catalogs. COMMAR CAMERA & HI-FI, 121-07 237th Street, Rosedale 22-R, N. Y.

WANTED: Electronics men to qualify for Engineering Degree equivalence by comprehensive examination. No courses. Excellent employment opportunities waiting. CRAMWELL INSTITUTE, RE-7, Adams, Mass.

TELEPHONE Extension in your car. Answer your home telephone by radio from your car. Complete diagrams and instructions. $1.25. A. CARRIER CO., 734—15th St., N.W., Washington 5, D.C.

DIAGRAMS FOR REPAIRING RADIOS $1. Television $2. Give make, Model. DIAGRAM SERVICE, Box 672-RE, Hartford 1, Conn.

WANTED: SIGNAL GENERATORS TS-403, TS-497, TS-621, SG-3/U, TS-437, TS-510, TS-588, TS-608, etc.; TS-186 Frequency Meters, AN/APR-4 Tuning Units, other "APR-" Receivers, ARC-3, other Surplus; also Hewlett-Packard and other laboratory quality equipment, Weston, etc. instruments; technical manuals; for quick cash or swap for Zenith Transistor Portables, etc. LITTELL, Fairhills Box 26, Dayton 9, Ohio.

LOOKING FOR CLEAN RESPONSE to 20 Cycles? Listen to the radically new "Racon Hi-C" foam suspension speaker. Write for free literature. RACON ELECTRIC CO., INC., 1261 Broadway, N.Y. 1, N.Y.

ALL MAKES OF ELECTRICAL INSTRUMENTS AND TESTING equipment repaired. HAZELTON INSTRUMENT Co., 128 Liberty Street, New York, N.Y.

MINIATURE Six Transistor Speaker-Radio complete $42.95 postpaid. ELECTRONIC OUTLET, Wolcott Ave., Lawrence, Mass.

COMPLETE Television Sets $11.95. JONES TV, 1115 Rambler, Pottstown, Pa.

"COIL WINDING METHODS" Handbook 30c. LABORATORIES, 328-B Fuller, Redwood City, Calif.

RECORDERS, Hi-Fi, Tapes. Free Wholesale Catalogue. CARSTON, 215-T East 88th St., New York 28, N.Y.

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Patents, Copyrights. SANDERS, Registered Patent Attorney, 6430 Evans, Chicago 37, Ill.

DIAGRAMS! Repair Information! Radios—Amplifiers—recorders $1, Televisions $1.50. Give make, model, chassis. TV MILTIE, Box 101EA, Hicksville, N.Y.

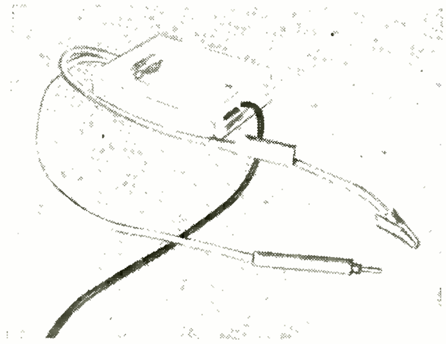
EAVESDROP with a pack of cigarettes. Miniature transistorized radio transmitter. Complete diagrams & instructions. $1.25. A. CARRIER CO., 734—15th St., N.W., Washington 5, D.C.

SOLAR-POWERED Transistor Radio kit $12 postpaid. PURDY, 325 Maple, S.F. California.

gap-type arrester, the neon bulb has absolutely no effect on the set's performance. For transformerless sets with no ground terminal, connect the lamp between the antenna terminal and the B-minus bus. Besides providing lightning protection, the lamp also protects the set against excessively strong signals from near-by transmitters. For visual indication of static discharges through the circuit, mount the lamp on the front panel.—*Charles Erwin Cohn*

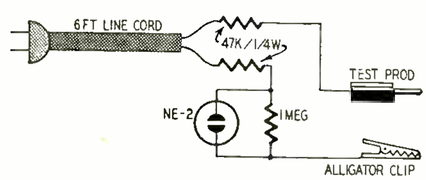
POCKET CONTINUITY TESTER

This little tester is easily shoved in a toolbox or pocket and provides a fast means of making simple troubleshoot-



ing tests. The few components are mounted on a piece of asbestos shingle pressed snugly into a clear plastic case.

The heart of this handy device is a NE-2 neon lamp. It is wired across a 1-megohm resistor, while a ¼-watt



47,000-ohm resistor is in series with each side of the line to obviate shock hazard. One test prod and one alligator clip provide easy testing.—*Harry J. Miller*

SLIP-ON ERASERS

Although it probably has never occurred to you, slip-on pencil erasers are handy to have around the shop. I use them as pilot bulb removers, protectors for lamps carried in my toolbox and as chassis mounts and shock mounts for tube sockets. In the latter applications they are cut to shape and cemented in place with rubber cement. The erasers are inexpensive and their uses limited only by the imagination of the technician.—*John A. Comstock*

STRAIGHTEN COMPONENT LEADS

Here is a way to straighten that bent and twisted lead on resistors, capacitors and other components. After getting the lead as straight as possible with a pair of pliers or your fingers, place it between two blocks of wood. Roll the top block back and forth a few times and the lead will be straight as new. Works on insulated wire too.—*Frank W. Dresser* END

Business and People

P. R. Mallory & Co., Indianapolis, Ind., introduced a new package design for its Distributor Division. Various products

such as vibrators, controls, capacitors, etc. are merchandised in different colored packages for easy identification.

Weller Electric Corp., Easton, Pa., is offering distributors an envelope stuffer

die cut in the shape of its model 8100K soldering kit. The stuffer lists the full Weller line and provides space for the distributor's imprint.

Allen B. Du Mont Labs' Television Tube Division, Clifton, N. J., now manufactures a complete line of receiving tubes for TV, radio, communications and industrial electronics. The company has been marketing TV picture tubes through distributors since 1938. Photo

shows Robert G. Scott (left), sales manager of the division; Alfred Y. Bentley, division manager, and John Wolke, assistant manager—renewal sales, examining some of the tubes in the new line.

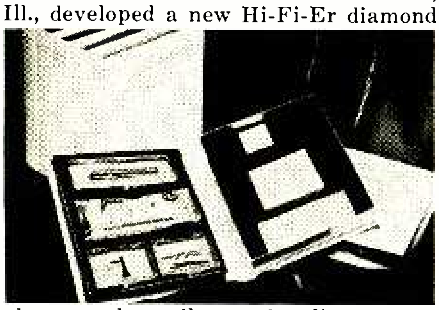
M. N. Beitman, president of Supreme publications, Highland Park, Ill., recently celebrated 20 years of associa-

tion with Teplitz Advertising Agency of Chicago. Photo shows Beitman (left), discussing advertising plans for the coming season with Henry H. Teplitz, head of the agency.

United Motors System, a Division of General Motors, Detroit, Mich., is offering distributors a new counter stand for

its Delco auto aerials with a mount for displaying an aerial and a pocket for literature on the complete line of auto aerials.

Jensen Industries, Inc., Forest Park, Ill., developed a new Hi-Fi-Er diamond



phonograph needle merchandiser for its dealers. It comes in a book-shaped package and contains the needle and accessories.

Gramer Halldorson Transformer Corp., Chicago, introduced its new line of miniaturized transformers for transistorized circuits with a Sweepstakes promotion. Distributors purchasing

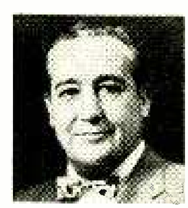
$250 worth of products were given a chance in the Sweepstakes held during the week of the Electronic Parts Distributors Show in Chicago. The prize was a custom-built gold-plated Williamson amplifier.

Hugo Sundberg was elected president and a member of the board of directors of Oxford Electric Corp., Chicago. He succeeds **Joseph D. Ceader** who is now chairman of the board. Sundberg had been vice president and general manager. Other newly elected officers are: **Herman Fine, Howard Corey, Angelo Sorice** and **Karl Wessel**, vice presidents; and **David E. Davis**, secretary-treasurer.

Donald C. Power (left), president of General Telephone Corp., and **Robert E. Lewis**, a vice president of Sylvania Electric Products, were elected directors of Sylvania at the annual stockholders meeting. The election increases board membership from 10 to 12.

Robert G. Calogero was appointed staff assistant in the Distributor Sales Department of the Raytheon's receiving and cathode-ray tube operations, Newton, Mass. He joined the company in 1950 and later became foreman of the Quincy, Mass., picture-tube plant.

Hiram Prince (photo) and **Charles Weigand** were appointed sales manager and chief engineer, respectively, of Permo, Inc., Chicago manufacturer of Fidelitone phonograph needles and accessories.



L. M. Heineman, for the past 25 years a prominent figure in the manufacture of loudspeakers and allied products, is now president of Permoflux Products Co., manufacturing high-fidelity loudspeakers, transformers, microphones and other electronic products. Permoflux Products Co. is a division of Linlar, Inc., also located in Glendale, Calif., and headed by Mr. Heineman. This company is manufacturing advanced products in the electronic field.

Obituaries

Paul F. Jackson, president and founder of the Jackson Electrical Instrument Co., Dayton, Ohio, at his home at the age of 51, after an illness of only two weeks. The company will continue to operate under the management of the same personnel associated with Mr. Jackson for many years and there will be no change in company policy.

John Jay Hopkins, chairman of the board of General Dynamics Corp., parent company of Stromberg-Carlson, and builder of the atomic submarine, the Nautilus, at Georgetown University Hospital in Washington, D.C.

Personnel Notes

. . . **R. C. Lanphier Jr.**, rejoined Sangamo Electric Co., Springfield, Ill., as vice president and director of sales. He returns to the company after three years with the Department of Defense in Washington, D. C. END

technical Literature

SEMICONDUCTORS

This 8 x 11-inch 23-page booklet explains basic transistor theory. It lists the characteristics of RCA semiconductors and has an interchangeability directory. A final section contains a number of interesting transistor circuits with a complete list of materials.

RCA Semiconductor Division, Somerville, N. J., 25c.

ABC'S OF MICROPHONES

A 22-page booklet explains microphones and how they work. Illustrations and text aid in selecting a microphone for a particular use. An 8-page catalog section pictures typical microphones. *Bulletin No. 246.*

Electro-Voice, Inc., Buchanan, Mich.

GERMANIUM TV RECTIFIERS

A replacement guide lists TV sets with rectifiers that can be replaced with G-E's new line of germanium rectifiers, giving the old rectifier number and that of the new G-E part.

General Electric Co., Semiconductor Products, Electronics Park, Syracuse, N. Y.

SEMICONDUCTOR PRODUCTS

The specifications of 11 germanium transistors are presented in this *Semiconductor Products, Technical Data* folder. 2N63, 2N64, 2N65, TS176, TS612, TS613, TS614, TS-616, TS-617, TS-618 and TS-619 types are included.

Tung-Sol Electric Inc., Semiconductor Div., 95 Eighth Ave., Newark 4, N. J.

TEST EQUIPMENT

Two bulletins list special design features and characteristics of two new pieces of test equipment. *Form 660* covers the model 660 white dot–bar–color display generator. *Form 415* features a new portable electronic volt-ohmmeter.

Hickok Electrical Instrument Co., 10531 Dupont Ave., Cleveland 8, Ohio.

POWER RESISTORS

Comprehensive data on construction, characteristics, coating, winding, insulation identification, mechanical strength and terminals and brackets are listed in *Bulletin C-1b.*

International Resistance Co., 401 N. Broad Street, Philadelphia 8, Pa.

CONTROL GUIDE

This cross reference *Guide No. 5* makes much replacement control information available. It covers radio, TV, auto sets as well as audio equipment.

Centralab, Div. of Globe Union Inc., 800 E. Keefe Ave., Milwaukee 1, Wis., 20c.

HI-FI COMPONENTS

A number of amplifiers, tuners and turntables are described in an attractive 18-page booklet, *Catalog 10-56.*

H. H. Scott, Inc., 385 Putnam Ave., Cambridge, Mass.

BOOK CATALOG

Approximately 80 current books are offered in this publisher's new catalog.

John F. Rider Publishers, Inc., 116 W. 14 St., New York 11, N. Y.

GENERAL CATALOG

A complete line from airline electronics systems to amateur communications equipment to mechanical filters and tube shields is fully described. This 96-page catalog is most artistically illustrated throughout. All products are conveniently grouped, with airborne, broadcast and trans-horizon communication equipment listed.

Collins Radio Co., 315 Second Ave. S. E., Cedar Rapids, Iowa.

ELECTROMAGNETIC CONTROLS

Seven new catalogs on these products are now available: *57-S1* on automatic transfer switches; *57-S2*, remote-control switches; *57-S3*, magnetically held contactors; *57-S4*, relays; *57-S5*, ac and dc solenoids; *57-S6*, electric plant controls; and *57-S7*, electromagnet controls. Request on company letterhead.

Automatic Switch Co., Director of Sales Promotion, 50-56 Hanover Road, Florham Park, N. J.

Any or all of these catalogs, bulletins, or periodicals are available to you on request direct to the manufacturers, whose addresses are listed at the end of each item. Use your letterhead—do not use postcards. To facilitate identification, mention the issue and page of RADIO-ELECTRONICS on which the item appears. UNLESS OTHERWISE STATED, ALL ITEMS ARE GRATIS. ALL LITERATURE OFFERS ARE VOID AFTER SIX MONTHS.

CORRECTION

Our printer omitted a line from the first sentence of the letter "Dimension Dilemma" in the Correspondence column on page 18 of the June issue. The first sentence should read "In recent times some manufacturers of batteries for standard penlights are straying from the 1 31/32 inch or so length."

We referred to a speaker enclosure, on page 39 of the May issue, as an "acoustical labyrinth." This term is trademarked by Stromberg-Carlson and denotes a speaker housing having a folded path for sound travel. Its use as an attempted descriptive term was therefore improper.

Our thanks to Mr. J. W. Whitesel, of Stromberg-Carlson's Patent Department, for calling this to our attention.

Books

PIN POINT TV TROUBLES IN 10 MINUTES. Coyne Electrical School, Chicago 12, Ill., distributed by Howard W. Sams & Co., Inc., Indianapolis 5, Ind. 5¾ x 8¼ inches, 299 pages. $3.95.

About 700 TV defects and their direct causes are listed as well as correct procedure for various adjustments. Seventeen chapters cover the typical receiver, section by section: sweep, sync, yoke, high voltage, etc.

A special feature is the quick and unique trouble-location system. A listing of picture symptoms refers the reader to one or more page numbers and the proper *trouble tables*. Here one finds the cause of the trouble and the paragraph where this topic is described. Waveforms to be found at various circuit points are illustrated.

ELEMENTS OF RADIO, 3rd edition, by Charles Hellman. D. Van Nostrand Co., Princeton, N. J. 6 x 9 inches, 354 pages. $4.95.

Intended for beginners, the language of this book is simple and attractive. While the promise of a "novel treatment" of the difficult phases of elementary ac theory may not be fully carried out, the treatment is highly understandable. Old acquaintances are informed that the third edition contains a new chapter on transistors and that special attention has been given to revision of the chapters on TV and modern electronic applications, as well as the appendix.—*FS*

PHOTOTUBES AND PHOTOCELLS, by David Mark. John F. Rider Publisher, Inc., 116 W. 14 St., New York 11, N. Y. Booklet No. 184. 5½ x 8½ inches, 128 pages. $2.90.

Phototubes and photocells are important devices in modern industry and technology. They help to count, control, measure and inspect. This book illustrates the characteristics of several types together with practical circuits using them. (Some of the latest cadmium sulfide cells and sun batteries are not included.)

Basic theory of junctions and semiconductors leads the reader to an understanding of photoconductivity and photovoltaic effects. Multiplier phototubes, thyratron relays, dc and ac amplifiers and colorimetry are among the important topics covered. The author describes practical applications such as sound-on-film, facsimile and TV, sniperscope, color sorting, egg inspection and many others.—*IQ*

TV—IT'S A CINCH!, by E. Aisberg, Gernsback Library, Inc., 154 W. 14th St., New York, N. Y. 5½ x 8½ inches, 224 pages. $2.90 soft cover, $4.60 hard cover.

A new approach to TV instruction—presenting technical information through colloquial dialogue — makes reading this book an excellent and interesting way to learn how TV works. The unconventional format may at first scare would-be learners away from a thorough and exhaustive text, but the presentation is based on sound principles which the author has found useful in three books written over a period of more than 30 years.

Originally written in French, the English edition is the eighth language in which this text has appeared, making it by all odds the most widely read of all the world's books on TV. It has already run as a serial in RADIO-ELECTRONICS.

All phases of television are completely discussed by Ken and Will. The reader's questions are anticipated by Will, who asks for and receives from Ken detailed explanations of many problems which are not always cleared up by authors of more conventional texts.

The whole theory of transmission is covered, with most of the space devoted to receiver circuitry, which is taken up a section at a time, from one end of the receiver to the other. Since the reader's technical level is supposed to be that of a person who already understands radio, such sections as the audio end and the low-voltage power supply are given proportionately brief consideration. A chapter is devoted to color TV, one to antennas—including directional types—and one to special circuits.

TV ENGINEERING HANDBOOK, prepared by a staff of 33 specialists. Edited by Donald G. Fink. McGraw-Hill Book Co., Inc., New York, N.Y. 6 x 9 inches, 1496 pages, 1159 illustrations. $18.

The first handbook on TV engineering, covering all phases of color and monochrome. Generation, transmission, propagation and reception of TV signals are described. Foreign and domestic systems and standards are compared.

One of the outstanding chapters is that on TV receivers. It totals more than 250 pages with data on circuit design, component specification, color and monochrome tubes, and complete schematics of typical sets. Other sections explain the theory of color, amplifier design, microwave systems and camera chains. There is a 30-page listing of definitions, and the index includes 4,500 items, assuring the technician and engineer of ready reference.

HI-FI HANDBOOK, by William F. Boyce, Howard W. Sams & Co., Inc., Indianapolis, Ind. 5½ x 8½ inches, 224 pages. $3.

A guide to the hi-fi enthusiast and an aid in deciding what you need for your system. The six illustrated chapters cover all phases of high fidelity. Starting with fidelity, sound and distortion you continue through: loudspeakers, loudspeaker baffles and enclosures, amplifiers, preamplifiers and controls, program source equipment and systems design, selection and installation.—*LS*

PUBLIC ADDRESS, by N. H. Crowhurst. Norman Price, Ltd., 283 City Road, London E.C. 1, England. 5½ x 8½ inches, 62 pages. 4s 6d.

Many individuals and small companies are engaged in this field. Technicians doing this work can benefit from interesting pointers given here by an expert. Correcting acoustic problems, connecting equipment and checking speaker phase are among the topics.

PA experts must deal not only with equipment but with people as well. A short important chapter shows how to deal with client and public. END

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2C51	2.25	404A	12.50	5651	1.40
2C53	9.75	416A	25.00	5654	1.40
2E24	2.34	416B	39.00	5675	8.00
2K25	13.50	417A	3.50	5676	.85
2K45	35.00	417A/5842	12.00	5687	1.85
2K55	15.00	*450TH	44.00	5691	4.75
3B24	1.50	KU-610	3.50	5692	5.00
3B24W	4.75	WL/655/658	90.00	5693	4.75
3B29	4.75	GL673	12.50	5703WA	4.50
3BP1	1.95	703A	1.10	5718	2.00
3C23	3.95	717A	.35	5719	2.00
3C31	1.00	CK722	.90	5725	2.00
3C45	7.00	*750TL	32.50	5726	.75
3J30	25.00	800	.90	5744	1.25
3K20000LK	Write	803	2.00	5749	1.25
*4-65A	15.00	805	4.00	5763	1.25
*4-125A	30.25	807	1.10	5812	1.00
*4-250A	35.00	807W/5933	1.75	5814	1.00
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4824 EL3C	4.50	814	2.50	5840	4.50
4PR60A	30.00	836	1.25	5876	8.00
4x500A	75.00	837	1.25	5881	2.95
5C22	25.00	838	.70	5910	.45
6AK5W	1.20	866A	1.20	5915	.50
6C21 450TL	11.50	872A	1.00	6111	4.95
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15E	1.20	918	1.10	6130/3c45	6.00
FG32	4.35	927	1.00	6161	52.50
35TG	2.00	930	1.50	6201	3.00
VC50/32V	8.00	954	.40	6350	10.00
RK-60 1641	1.25	955	.40	6539	9.00
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HY69	2.25	957	.35	8020	1.00
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VXR-130	1.50	CK1005	.35	9003	1.35
		CK1007	.45	9004	.30
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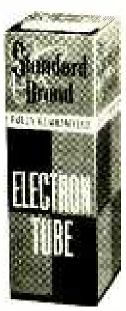

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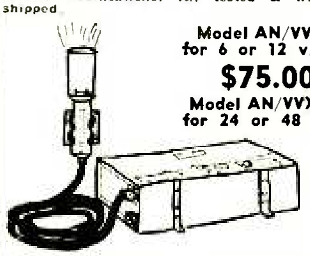

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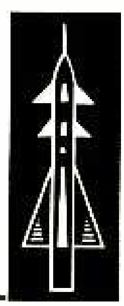

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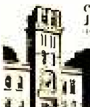

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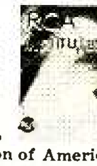

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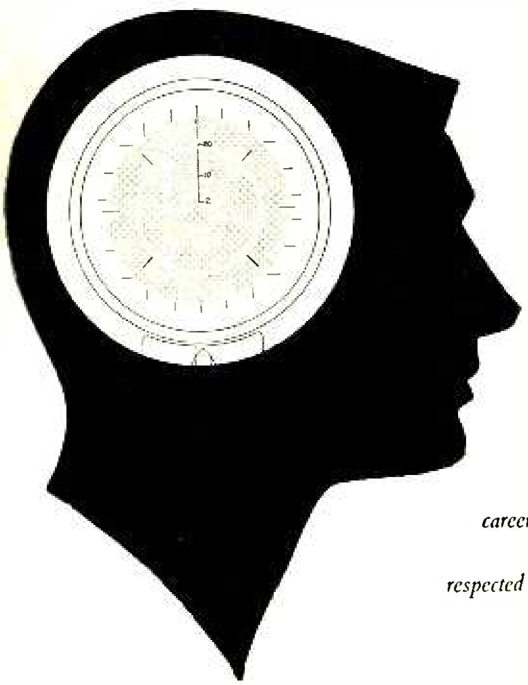

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