COMPLETE TV STATION LIST

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JUNE 1955

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HUGO GERNSBACK, Editor

In this issue:

Simple Antenna for TV or FM

•

Bar Generator-Sweep Adapter for U.H.F.

•

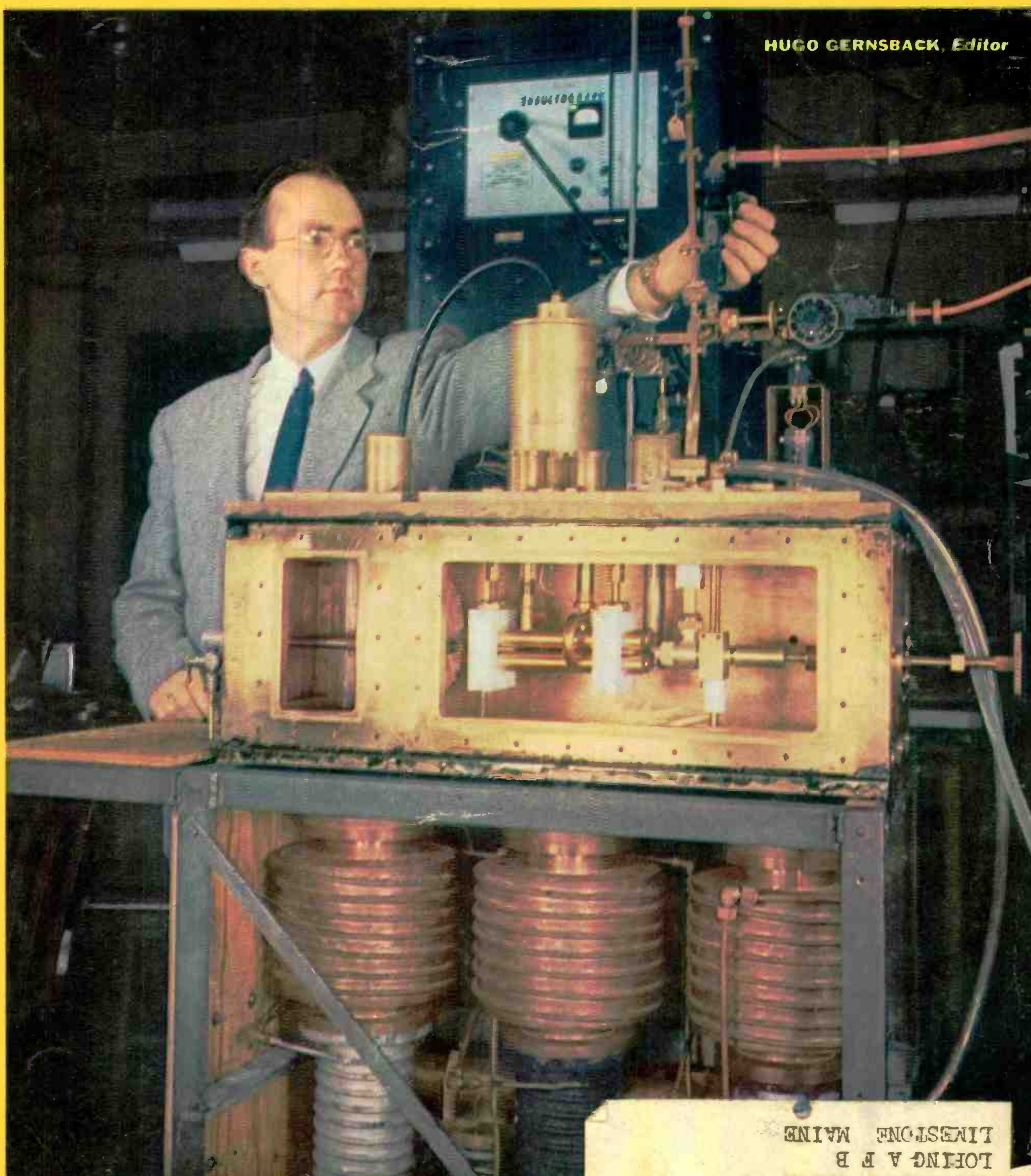
An Unusual Speaker Enclosure

•

What Is a Load Line?

•

Transistorized Signal Injector



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(See page

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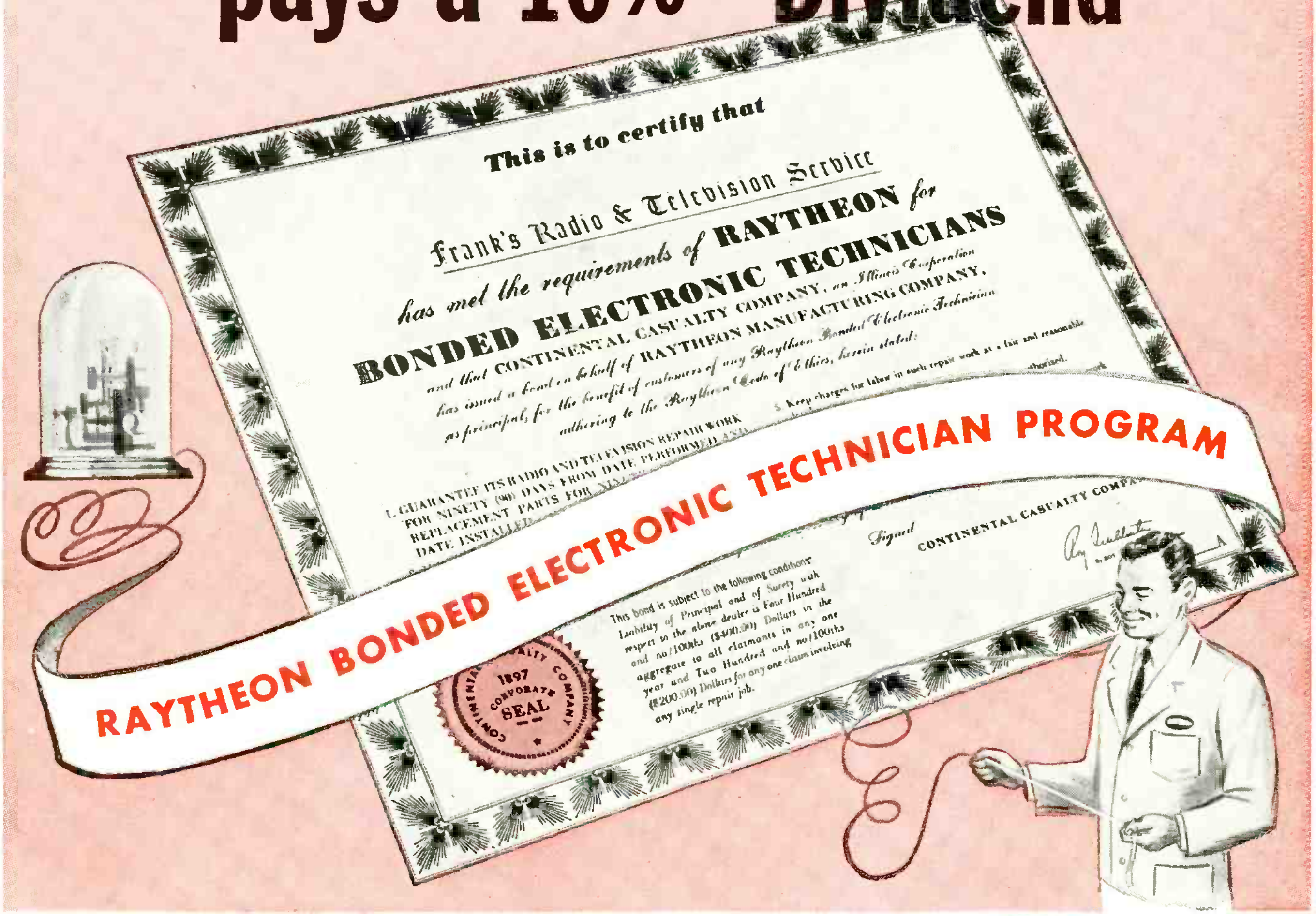

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ON THE COVER:

(Story on page 56) Professor Townes and one of the two existing models of the maser. The large cylindrical objects below are pumps.

Color original by Dan Rubin

JUNE 1955 Vol. XXVI, No. 6

Editorial (Page 29)
Check Your TV Set Annually! ....by Hugo Gernsback 29

Audio—High Fidelity (Pages 30–42)
A New Loudspeaker Enclosure ....by George A. Coates 30
What Is a Load Line? ....by Norman H. Crowhurst 33
New Developments in Tape Recorders ....by Sol Heller 36
High-Fidelity Dictionary, Part V ....by Ed Bukstein 38
For Golden Ears Only: The Regency HF-80 amplifier; Pickering cartridge; New Records Review ....by Monitor 39

Television (Pages 43–53)
Simple TV/FM Antenna ....by Paul F. Loveless 43
Television Station List—to April 18, 1955 44
TV Signal Circuit Feedback ....by Robert G. Middleton 46
Television—it's a Cinch: (Sixteenth Conversation, second half: Radio-frequency high-voltage supplies; when vice finally becomes a virtue! the bootstrap circuit ....by E. Aisberg 48
TV Service Clinic ....Conducted by Jerry Kass 50
Low-Frequency Compensation in Video Amplifiers ....by Joseph F. Sodaro 52

Electronics (Pages 54-62)
IRE Attains New Heights 54
Revolutionary New Oscillator–Amplifier (Cover Feature) by Fred Shunaman 56
Electronic Vacuum Gauges ....by A. A. Schulke 58
Magnetic Tape Recorder Aids Industry ....by James R. Cornelius 62

Test Instruments (Pages 63-76)
Midget Transistorized Signal Injector ....by Elliott A. McCready 63
U.H.F. Bar Generator and Sweep Adapter ....by Bruce Morrissette 65
Capacitor–Resistor Analyzer 72
A Dependable Gas Test ....by H. B. Conant 76

Radio (Pages 77–85)
Perk Up the Little Set ....by Wayne E. Lemons 77
460-Mc Radio ....by Leo G. Sands 80
Electronic Load ....by Don M. Wherry 84

DEPARTMENTS
Books 124
Business 118
Correction 126
Correspondence 14
Miscellany 96
New Devices 86
New Tubes and Transistors 92
Patents 110
People 121
Question Box 107
The Radio Month 6
Radio-Electronic Circuits 98
Technical Literature 123
Technicians' News 105
Technotes 103
Try This One 114

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the Radio month

MINIATURE ELECTRONIC BRAIN promises to open a new era in computers; it operates flawlessly in planes flying at supersonic speed. The new computer, known as *Tradic* (*Tran*sistor-*di*gital-*c*omputer), was developed for the U. S. Air Force by Bell Telephone Labs.

The digital computer eliminates vacuum tube failure and heat, jet aircraft's greatest electronic problems, by the use of transistors. Nearly 800 of these are used in what is believed to be the first all-transistor computer designed for aircraft. The entire unit will probably occupy less than 3 cubic feet and require less than 100 watts to operate. In addition to the transistors, the computer contains nearly 11,000 germanium diodes.

Tradic can do 60,000 additions or subtractions, or 3,000 multiplications or divisions per second; it can handle simultaneously as many as thirteen 16-digit numbers. Mathematical instructions are placed into Tradic by a plug-in unit, set up beforehand with interconnecting wires to represent problems at hand.

The laboratory model of Tradic provides answers to trigonometric problems with a series of dots on an oscilloscope (see photo). The dots of light appear as geometric diagrams on the face of the scope.

FM ECONOMIES were the subject of a speech by FCC Commissioner Robert E. Lee at the High-Fidelity Fair in Washington. He urged that established AM broadcasters, especially the larger ones, consider the economic advantages of FM.

Lee said, "It is no secret that radio network revenues have been declining while television network revenues have been gaining. Inevitably, radio network affiliates will look favorably on means of reducing operating expenses. In that light, FM, which can be broadcast from a single tower occupying a building roof or lot and even share space with TV, might look more attractive than a multiple-tower AM array tying up many acres of expensive, heavily taxed suburban real estate.

"I don't suggest that this is an immediate problem, or even one for the near future. But I do think it adds a further practical reason for approaching with extreme caution any proposals for reducing or eliminating the FM band."

TV INTERFERENCE was responsible for a bill proposed by the Vermont House of Representatives. The legislation would prohibit any person or firm in that state from causing unnecessary interference with television reception.

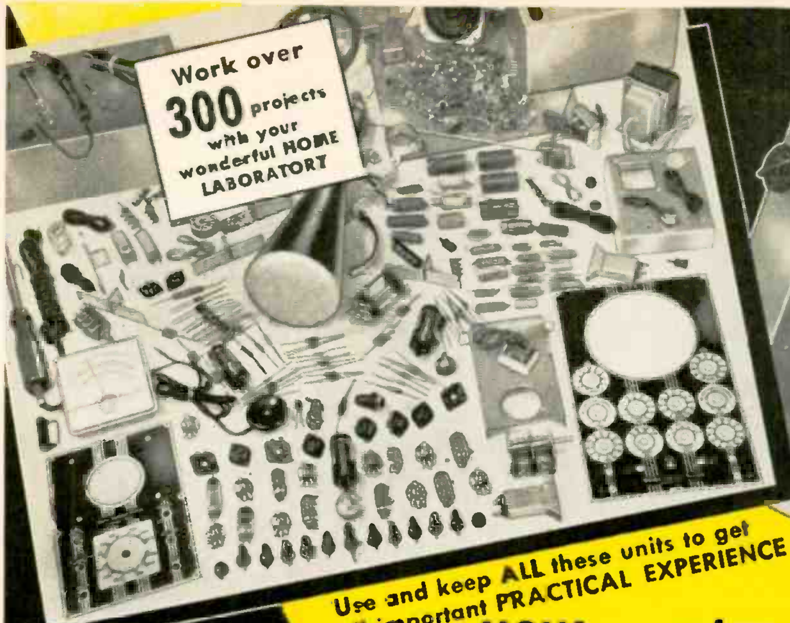
Offenders would be compelled to pay up to $50 to correct the trouble. In cases where corrective measures do not eliminate the interference, the complainant would have to bear the expense of corrections.

GLOBAL NAVIGATION AID is planned as a result of experiments with a new system called Navarho, according to reports from the Air Research and Development Command Headquarters.

First station in the new experimental setup is to be erected at Camden, N.Y., near the Rome Air Development Center. It will supply position information to pilots of jet and other aircraft at all points within about 2,500 to 3,000 miles from the station.

The station is composed of three 15-kilowatt transmitters using three 625-foot towers, plus a master timing unit with a stability of one part in one billion. Exact method of operation is not revealed, but it was stated that a plane 1,000 miles from the station would receive information accurate to within 10 miles in any direction. It would direct planes to within 100 miles of their destination, at which point local navigation aids would take over for a more precise fix.

If the experiment is a success, a world-wide chain of installations completely covering the globe will be established.



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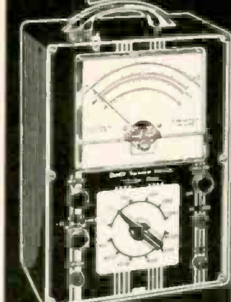

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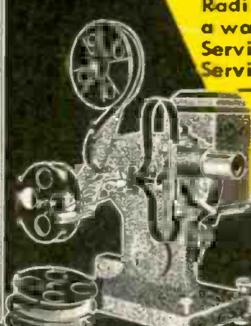

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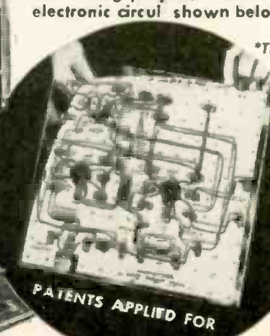

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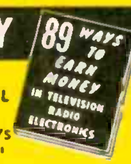

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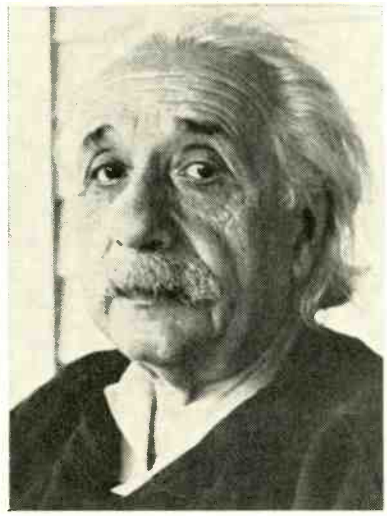
ALBERT EINSTEIN, greatest theoretical physicist of our age, died on April 18, at the age of 76. Famous as the discoverer and exponent of



the theory of relativity, he postulated his field theory in 1905. Since that date Einstein developed his basic formulas, culminating in his unified field theory announced a few years back. In 1921 Einstein was awarded the Nobel Prize for physics (discovery of the law of the photoelectric effect).

Much of Einstein's life was devoted to the contemplation of the relationship of energy to mass. His theories based on the conversion of matter into energy ($E=mc^2$, the Einstein theorem), formed most of the groundwork in the development of the atomic bomb.

Einstein arrived in the United States in 1933 from Germany. At the time of his death Einstein was a life member of the Institute for Advanced Study, at Princeton, N. J.

ROBOT RADAR ANTENNAS monitored at a central station could be set up to detect an enemy attack, using a new system revealed at a meeting of the Institute of Radio Engineers. The system involves squashing the radar screen signal so it can be transmitted on ordinary telephone lines. At present, coaxial cables or expensive microwave relay systems are needed to carry radarscope pictures.

Taking advantage of the inherent repetition of radar signals from rotating antennas, the system can code the picture to fit in the limited bandwidth of a telephone circuit. Suspicious blips could be transmitted for analysis from the central station to higher authorities anywhere in the world where there are telephone lines.

RADIATION DETECTOR can be made from an ordinary camera, as the result of a recent patent. The invention converts conventional cameras into detectors without interfering with their use for normal photographic purposes.

The detector uses a photosensitive sheet which records a light spot on a black background when subjected to X-ray or gamma radiations. The inventor, W. A. Shurcliff, of Cambridge, Mass., uses a Polaroid type camera, permitting rapid determination of the intensity of the radiation.

In operation, the shortwave radiations pass through an intensifier which emits a fluorescent light that causes the light spot. This spot can be easily distinguished from normal film fogging or light leaks.

STANFORD C. HOOPER, Rear Admiral USN, retired, a pioneer in developing radio for the Navy, died on April 7 at the age of 70. Admiral Hooper (see photo) became the first radio officer of the United States Fleet in 1912. He later became Director of Naval Communications.

Admiral Hooper was known as the Navy's top engineering specialist on radio communications from the days before World War I until World War II. Among the many honors bestowed on Admiral Hooper are the Franklin Institute's Elliott Cresson Gold Medal

for "pioneering leadership and practical utilization of discovery in the field of radio . . ." and the Veteran Wireless Operators Association's Marconi Memorial Medal of Merit for improving the Navy's radio system.

NEW SOUNDTAPE which plays up to 8 hours of uninterrupted music is now available in a 6 x 5½-inch cartridge about 2 inches thick. Developed by the Tefifon company in Germany, the unit does not use a conventional tape. The sound is recorded by an engraved process on pure vinylite, with an average of 82 grooves on a ½-inch band. Sound is reproduced on a special playback machine using a stylus that is set against the soundband.

FINANCIAL EGG was laid in Broadway's first presentation of live, closed-circuit television. The telecast of the ANTA (American National Theater and Academy) Album was viewed by theater audiences in New York and 30 other cities.

Although featuring top-flight entertainers, the box-office results showed receipts of $195,000 and expenses of $200,000. A sellout crowd would have brought in $400,000. ANTA produced the 2-hour show, and CARE underwrote the network costs. END

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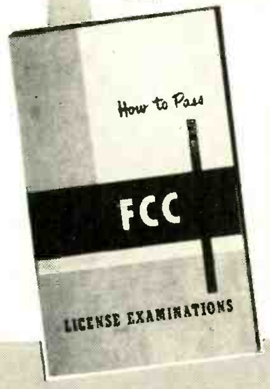

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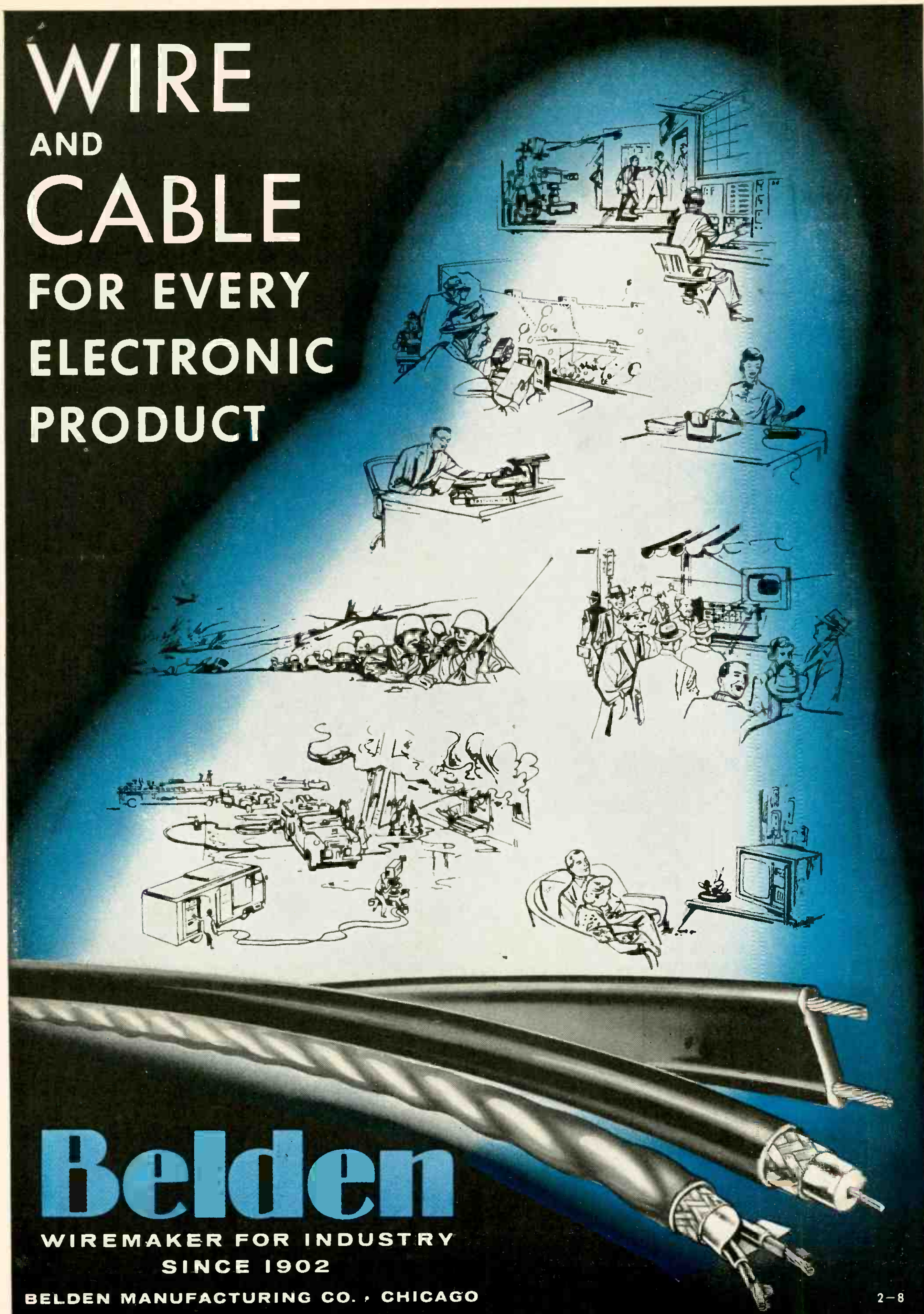
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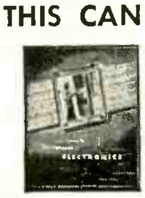

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TRANSISTOR SYMBOLS

Dear Editor:

You have certainly noted—as have we—that transistors are represented by a varied group of symbols (Fig. 1). This causes confusion. I believe it possible to have some agreement on the subject. Please note the following:

Fig. 2—The present symbol widely adopted for the point-contact transistor.

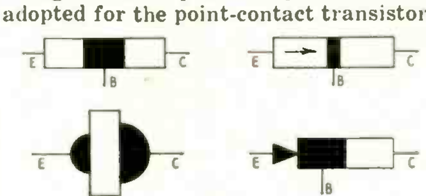


Fig. 1

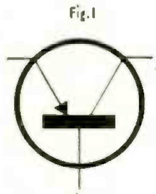


Fig. 2

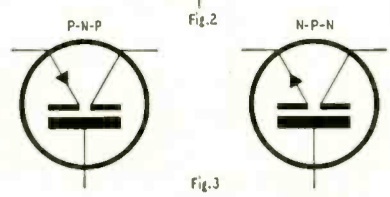


Fig. 3

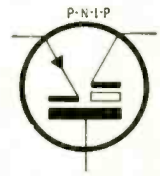


Fig. 4

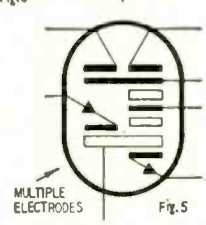


Fig. 5

Fig. 3—Proposed symbols for junction transistors.

Fig. 4—The same as Fig. 3, with an intrinsic layer (p-n-i-p transistors).

Fig. 5 — Multiple-electrode junction transistors (1960 types . . . .).

We are sure you will see the value of adopting uniform symbols.

E. AISBERG
Director, Toute la Radio
Paris, France

(We are reasonably happy with our present transistor symbols and would certainly not like to use a circle—representing the glass envelope of a vacuum tube—around them. But what do our readers think?—*Editor*)

ROSIN FLUX

Dear Editor:

Like most readers I wait until I take exception to some statement before I make any comment on your excellent publication RADIO-ELECTRONICS.

In the article "Techniques for Servicing Printed Wiring" (October, 1954) the statement is made on page 90, "An activated rosin liquid flux may be used."

Printed circuitry is used extensively at the research and development lab where I work, and we have proved that activated rosin flux leaves metallic salt deposits on most materials that are used as bases for printed circuits.

This deposit can sometimes be removed by chemical flux removers or by rinsing thoroughly in cold water and then baking. The leakage resistance produced with the activated flux is in the same order as a pencil mark.

W. C. NEUENDORFF, JR.
North Hollywood, Calif.

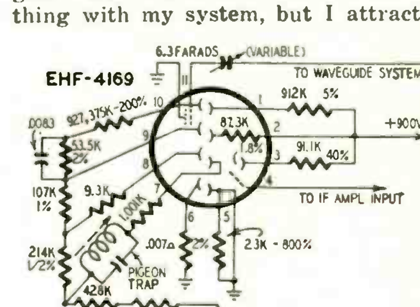
S.S. MODIFICATION

Dear Editor:

I read the article "Silent Sound" in your April issue and was very much interested. I could not obtain the EHF-4155 tube (Transitime) locally, so I used the EHF-4169 which is electrically interchangeable but has a standard 11-pin loktal base.

I am using a Craftsmen C-800A FM-AM tuner. I invented an adapter so the system can be used on AM. It demodulates the signal and uses a type 6L7 reactance modulator. I measured the IM (taken off my temples with an electroencephalograph and fed into a Heath IM analyzer) and found it to be .00159%. Could you explain this distortion? (Dandruff?—*Editor*)

I am using an r.f.-operated power supply to develop the 900 volts for the Transitime tube. I figured out my own resistor values (see diagram) and waveguide dimensions. I can't hear anything with my system, but I attracted



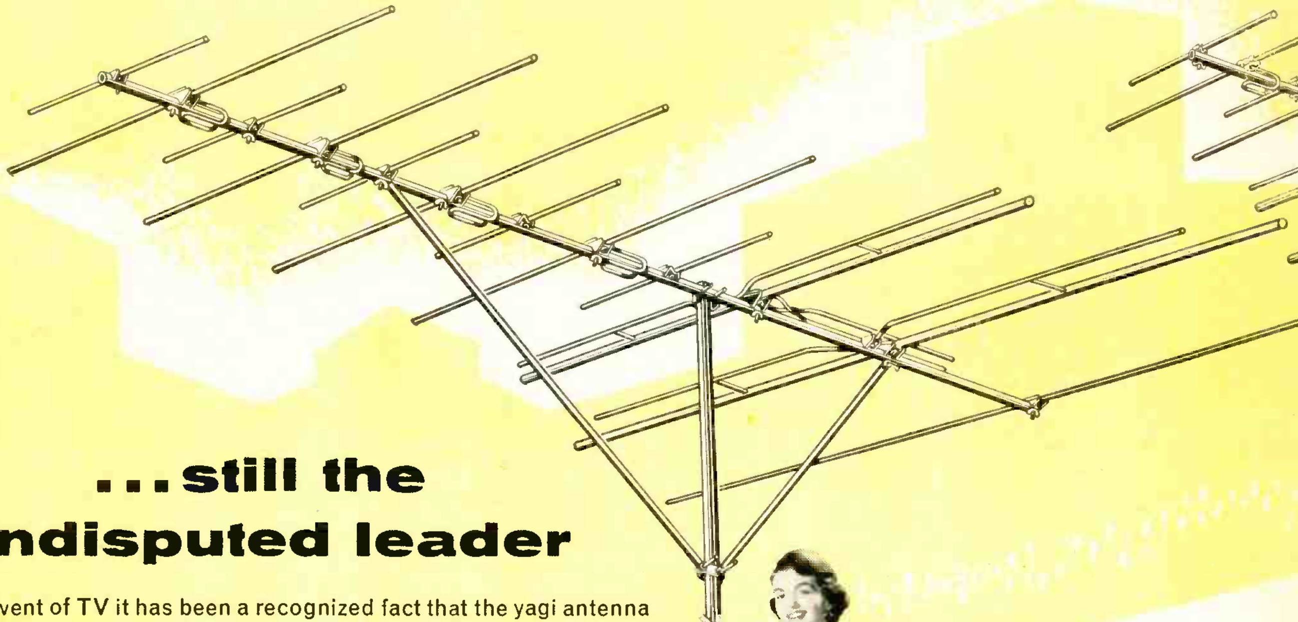
a hell of a lot of carrier pigeons. Could my resistor values be wrong? I would appreciate any suggestions from RADIO-ELECTRONICS readers.

HUGO SNARK
University of Miami, Miami, Fla.

(Try salt on the pigeons' tails.—*Editor*)

(*Continued on page* 18)

WINEGARD *started the*



...still the undisputed leader

Since the advent of TV it has been a recognized fact that the yagi antenna was the most desirable basic antenna design for distant fringe area reception. Mechanical simplicity, neat appearance, sensational sensitivity and almost perfect horizontal polar pattern are the reasons. The only objection to the yagi type antenna has been its limitation to one or two channels because of inherent frequency sensitivity of this design. Almost every manufacturer at one time or another attempted to remove this one limiting factor for all channel use, but each time they met with failure. So they turned their engineering efforts to large, bulky antennas, figuring this was the only way to get acceptable all channel performance. Early in 1954, Winegard startled the industry by announcing they had overcome the difficulties of using a yagi for an all channel antenna, and had at last developed a yagi antenna covering all channels from 2-13 *that really worked.*

The impact of this triumph became more and more self evident as manufacturer after manufacturer joined THE ALL CHANNEL YAGI PARADE started by Winegard and their Interceptor with exclusive Electro-Lens Focusing. Today Winegard still leads the Parade with a complete line of yagi antennas for TV set owners no matter where they live—even in the most extreme fringe areas.

Miss Super 'Ceptor 1955*

Here's Why Winegard Leads in Sales Gains

Calendar of all channel yagi events (shown below)

NOTE: Winegard months ahead of nearest competition with real all channel yagi antenna.

WINEGARD CALENDAR

THIS! Winegard announces Interceptor. First all channel yagi that really worked.

THEN THIS! During these months . . . Interceptor outperforming . . . outselling other antennas. Literally taking market by storm.

FINALLY THIS! Winegard—gives industry "Super 'Ceptor" . . . new yagi antenna with super sensitive Electro-lens . . . gives sensational performance even up to 200 miles on all channels (VHF). (To keep Winegard well out in front in the Yagi parade)

Jan. — May — **1954** — Dec. — **1955**

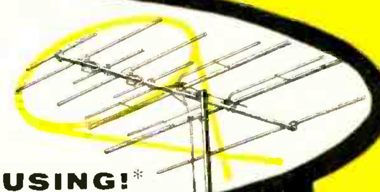
COMPETITION'S CALENDAR

Jan. — During this period . . . competitive manufacturers still making large wind resistant arrays.

Oct. '54-early '55 — Dates when most other manufacturers started to join the all channel yagi parade.

ALL CHANNEL YAGI parade in 1954!

Only Winegard features a complete line of Antennas with **Exclusive ELECTRO-LENS** FOCUSING!*



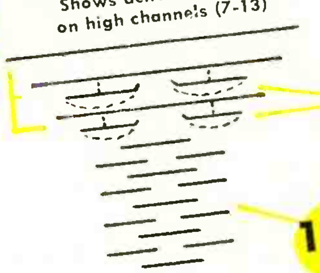
*Patent No. 2700105

Look! Here's Proof that Winegard leads in 1 ENGINEERING 2 PERFORMANCE

- . . . The "Super 'Ceptor" has more working elements on all channels
- . . . The "Electro-Lens"*, the patented director system that works efficiently on *both* bands with NO interaction and without needless bulk. (Exclusive with Winegard.)
- . . . The full length of Winegard antennas works on all channels—(many competitive antennas use only the back half for low band—only the front half on the high band.)
- . . . Multi Resonant Driven Elements—a modified Tee matched dipole that works on the low channels as a ½ wave dipole . . . on the high band as "full wave" dipoles. (Another Winegard engineering first.)

"Super 'Ceptor" **DIAGRAM A**

Shows active elements on high channels (7-13)



3 passive reflector elements

MODEL SL4 **4**—½ wave Driven elements

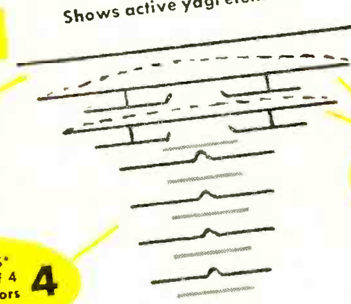
ELECTRO-LENS* **13** Gives action of 13 ½ wave—resonant director elements on high band—

TOTAL 20 active elements working together in perfect phase on channels 7-13.

NOTE: dotted line on driven element to show current formation on channels 7-13.

"Super 'Ceptor" **DIAGRAM B**

Shows active yagi elements on channels 2-6



Full dimension reflector **1**

2 multi-resonant T matched Driven elements

ELECTRO-LENS* Gives action of **4** ½ wave directors of low band

TOTAL 7 active genuine yagi elements on low band 2-6.

NOTE: dotted line on driven elements show current formation on channels 2-6.

For Further Information Regarding **Winegard Antennas** See Your Jobber or Write Us.

WINEGARD COMPANY

3000 Scotten Boulevard, Burlington, Iowa

LIKES GOLDEN EARS

Dear Editor:

As a long-time audio fan and experimenter I would like to give three rousing electronic cheers for Monitor and his "For Golden Ears Only" series.

These articles seem the only honest evaluation of audio equipment based on actual tests, in which the test data is openly presented, to be found in any radio magazine commonly available. In most audio equipment reviews each piece of equipment is presented as being simply wonderful and out of this world in construction and performance.

The wise reader merely deplores the waste of good space given to such equipment reviews, which might better be used much more productively. Many are a little tired of seeing an amplifier of the bargain-counter variety written up in glowing terms by equipment reviewers when they know it shouldn't be fed into a good-quality loudspeaker system if one wants to hear good lows, not hum.

All things considered, "For Golden Ears Only" calls an audio spade a spade, a refreshing innovation, especially when it is based on actual testing and experience. It gives confidence to the reader and stature to your magazine.

FRED H. SCHELLMAT
Detroit, Mich.

DUE CREDIT GIVEN

Dear Editor:

Looking over George Augspurger's article "Horn-Type Speaker Systems" (April, 1955), I find that I am being "quoted" as being in the "opposing" camp from Maximillian Weil.

My first paper on corner horns cites "Weil, U. S. Patent 1,820,996 (1931)," and I might add this patent was applied for in 1925. As far as I know, this is the first material on corner horns ever written to be eventually published.

A perusal of the patent in the light of present knowledge is not too revealing, but its non-use notwithstanding, Weil must be granted priority in the absence of further historical findings.

PAUL W. KLIPSCH
Hope, Ark.

FILING SYSTEM

Dear Editor:

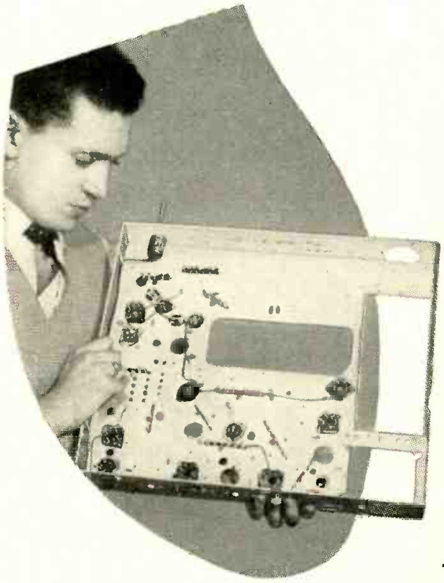
In my possession are many, many volumes of RADIO-ELECTRONICS. For years there was always a jumbled mess when I tried to find an article I was hunting. I finally devised a very simple, effective method of clearing this confusion—clipping the contents (index) page and filing it with an index card. On the card I write special notes concerning articles of interest to me.

I especially enjoy reading your magazine because it is divided into sections according to main subjects. In keeping with this setup may I suggest that you insert a new heading Color TV, since each succeeding issue contains more and more articles on that subject.

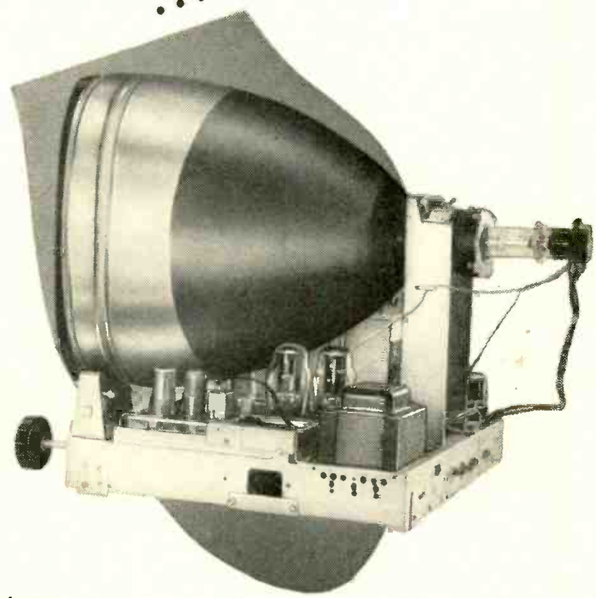
L. B. KLINGLER
Miami, Fla.

END

. . . from start



. . . to finish



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START to build with a TV Kit developed by one of America's foremost radio-tv schools—RCA Institutes. LEARN with simple step-by-step instruction how to build a modern, large-screen receiver. TEST each stage, *as you build*, and see how it works. Learn how "trouble-shooting" is applied. FINISH your Home Study Course ready and able to service all make and model sets!

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- *Horizontal magnetic reaction scanning.*
- *Latest deflection circuits.*
- *FM sound discriminator.*
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(Please print)

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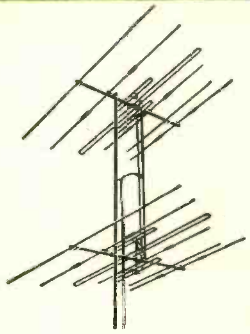

NEW! Narrow-space stacking!

Channel Master's RAINBOW and SUPER RAINBOW can now be stacked only 60" apart. These new, extremely efficient, 2-stage, impedance-matching stacking rods permit easier installations with an absolute minimum sacrifice of gain.

model no. 331-7

Champion Rainbow 330 series
Super Rainbow 331 series
Challenger Rainbow 332 series

The weather's warmer! Days are longer! *This* is the time of year to go after that gold mine in your own backyard: the replacement of the antennas in your area that are damaged, worn, and obsolete.

Channel Master's RAINBOW is the favorite replacement antenna of America's TV installation men — and here's why:

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- Regardless of competitive claims—Channel Master's RAINBOW antennas are *still* the most powerful antenna series available today! Advanced engineering and the exclusive Tri-Pole make the difference!
- Featuring the fastest and strongest of all preassemblies: trigger-fast "Snap-Lock" action, Channel Master's fabulous preassembly that *snaps* open, *locks* open, without hardware or tightening.
- All-aluminum construction. Rugged, durable, reinforced at all stress points.

Today's greatest all-channel antenna value — bar none!

CHANNEL MASTER'S RAINBOW*

the ideal replacement antenna

*Patent No. 2,691,730
Other Patents Pending

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Build Repeat Sales

Use Genuine

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Unexcelled research plus better materials and advanced production methods make Philco receiving tubes leaders in the field . . . assure top performance . . . build complete customer satisfaction and *repeat sales* for you!

Advanced Philco engineering and production methods insure mechanical and electrical superiority, uniform operation and trouble-free performance. Rigid quality control, exhaustive tests and extensive performance checks guarantee that every Philco tube you install is right and ready for sale.

Philco Receiving Tubes Improve the Performance of any Radio or TV Receiver

Built-in Philco quality is the reason why. Now you can eliminate costly call backs and build solid future business that means greater profit.

Millions of Philco set owners and millions of owners of other make receivers demand the full measure of performance that Philco tubes provide. Stock the Philco line of conveniently packaged tubes that assure you this ready-made market. Call your Philco Distributor today.

PHILCO TUBES IMPROVE THE PERFORMANCE OF ANY TV OR RADIO RECEIVER

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When Godfrey tells the ladies ... There are no finer tubes than CBS tubes... More women than ever are going to ask for the tubes with the Good Housekeeping Guaranty Seal.

Be sure YOU have CBS tubes in your tube caddy.

Arthur Godfrey's Talent Scouts to sell CBS Tubes
on both TV and Radio
every other week starting in June

Quality products through *ADVANCED-ENGINEERING*

CBS-HYTRON, Danvers, Massachusetts . . . A DIVISION OF COLUMBIA BROADCASTING SYSTEM, INC.

PUT YOURSELF IN THE *High-Paying* TELEVISION PICTURE.....

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T Television
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Today, when demand for trained men is higher than ever before, pay is higher than ever before, you can train AT HOME in your SPARE TIME to become a Television Technician.

L. C. Lane, B.S., M.A.
President, Radio-Television Training Association. Executive Director, Pierce School of Radio & Television.

PREPARE FOR A BRIGHTER FUTURE AS A TV TECHNICIAN

You can hold down a full-time job and still train AT HOME by the same successful methods I used to help hundreds of men—many with no more than grammar school training—master television!

NO EXPERIENCE NEEDED . . . I'LL TRAIN YOU AT HOME IN YOUR SPARE TIME

VETERANS!

My School fully approved to train veterans under new Korean G.I. Bill. Write discharge date on coupon.

GOOD SPARE TIME EARNINGS

Almost from the very start you can earn extra money while learning by repairing radio-TV sets for friends and neighbors. Many of my students earn up to $25 a week . . . pay for their entire training from spare time earnings . . . start their own profitable service business.

EXPERT FM-TV TECHNICIAN TRAINING

My FM-TV Technician Course can save you months of training if you have previous Armed Forces or civilian radio experience! Train at home with kits of parts, plus equipment to build BIG SCREEN TV RECEIVER. ALL FURNISHED AT NO EXTRA COST!

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(For men with previous radio & TV training) I train you at home for an exciting big pay job as the man behind the TV camera. Work with TV stars in the TV studios or "on location" at remote pick-ups! Available if you want it . . . one-week course of practical work on TV studio equipment at Pierce School of Radio & TV, our associate resident school in New York City.

OPTIONAL: 2 WEEKS TRAINING IN NEW YORK CITY AT NO EXTRA COST

You get two weeks, 50 hours, of intensive laboratory work on modern electronic equipment at our associate school in New York City — Pierce School of Radio and Television. And I give you this AT NO EXTRA COST whatsoever, after you finish your home study training in the Radio-FM-TV Technician Course and FM-TV Technician Course. However, your home study course is complete even without this two-week laboratory session. It is only one of the many Extras available to you from RTTA if you want it.

C-W Telephone Transmitter

RF Signal Generator

Super-Het Radio Receiver

Public Address System

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ENOUGH EQUIPMENT TO SET UP YOUR OWN HOME LABORATORY

As part of your training, I give you all the equipment you need to prepare for BETTER PAY TV job. You build and keep a professional GIANT SCREEN TV RECEIVER complete with big picture tube (designed and engineered to take any size up to 21-inch) . . . also a Super-Het Radio Receiver, RF Signal Generator, Combination Voltmeter-Ammeter-Ohmmeter, C-W Telephone Transmitter, Public Address System, AC-DC Power Supply. Everything supplied, including all tubes.

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Contains 20 assorted jars.
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NEW! SIGNAL GENERATOR #324

KIT $26.95 WIRED $39.95

★ Expanded frequency range: 6 fundamental bands: 150–400 kc, 400–1200 kc, 1.2–3.5 mc, 3.5–11 mc, 11–37 mc, 37–145 mc, 1 harmonic band 111 mc–435 mc.

★ ± 1.5% frequency accuracy; 6:1 vernier tuning knob & excellent spread at most important alignment frequencies.

★ Etched tuning dial, plexiglass windows, edge-lit hairlines.

★ Variable depth of int. mod. 0 to 50% by 400 cps Colpitts osc.

You could pay scores of dollars more and not get all the advances EICO gives you in the new Model 324—today! Compare . . . and you'll buy EICO!

★ Variable gain ext. mod. ampl.; only 0.8 v for 30% mod.

★ Colpitts RF osc., directly plate-modulated by cathode follower for improved modulation.

★ Turret-mounted, slug-tuned coils.

★ Fine & Coarse (3-step) RF attenuators; 50-ohm output Z.

★ RF output 100,000 uv; AF output to 10 v.

★ Uses 12AU7, 12AV7, sel. rect.; xfmr-operated.

★ Supplied with shielded output cable.

★ Satin aluminum panel and grey wrinkle steel case.

You could spend 2 and 3 times more and not get all the advanced engineering features of these VTVMs. Compare . . . and you'll buy EICO!

THE BEST VTVM BUYS IN THE WORLD

EICO

NEW! PEAK-TO-PEAK VTVM #232, complete with Uni-Probe (Pat. Pend.)

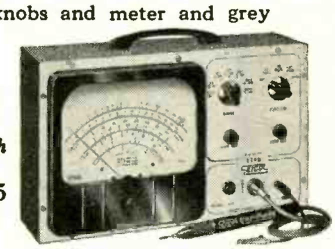
KIT $29.95 Wired $49.95

★ Zero-center for TV-FM discriminator alignment.
★ One zero-adjustment for all functions and ranges.
★ Frequency response: 30 cps-3mc (up to 250mc with PRF probe).
★ 1% precision ceramic multiplier resistors.
★ Exceptional circuit stability and accuracy.
★ New compact size for extra-easy portability (8½x5x5")
★ Smart professional styling—new satin finish etched panel with contrasting knobs and meter and grey wrinkle steel case.
★ Leather handle.

★ Measures directly p-p voltage of complex and sine waves: 0-4, 14, 42, 140, 420, 1400, 4200 volts p-p.
★ DC/RMS sine voltage ranges: 0-1.5, 5, 15, 50, 150, 500, 1500 volts. Reads up to 30,000 V. with HVP probe.
★ Resistance ranges: 0.2 ohms to 1000 megs in 7 ranges.
★ 7 non-skip ranges on every function.
★ 4 functions: +DC Volts, -DC Volts, AC volts, Ohms.
★ Uniform 3 to 1 scale ratio for extreme wide-range accuracy.
★ Large 4½" meter in can't-burn-out circuit.
† Calibration without removing from cabinet.

NEW! DELUXE PEAK-TO-PEAK VTVM #249 with 7½" Meter and exclusive UNI-PROBE* (pat. pend.)
KIT $39.95 WIRED $59.95

All the outstanding & exclusive features of Model 232—plus the extra convenience and readability of its big 7½" meter. An ideal bench instrument.



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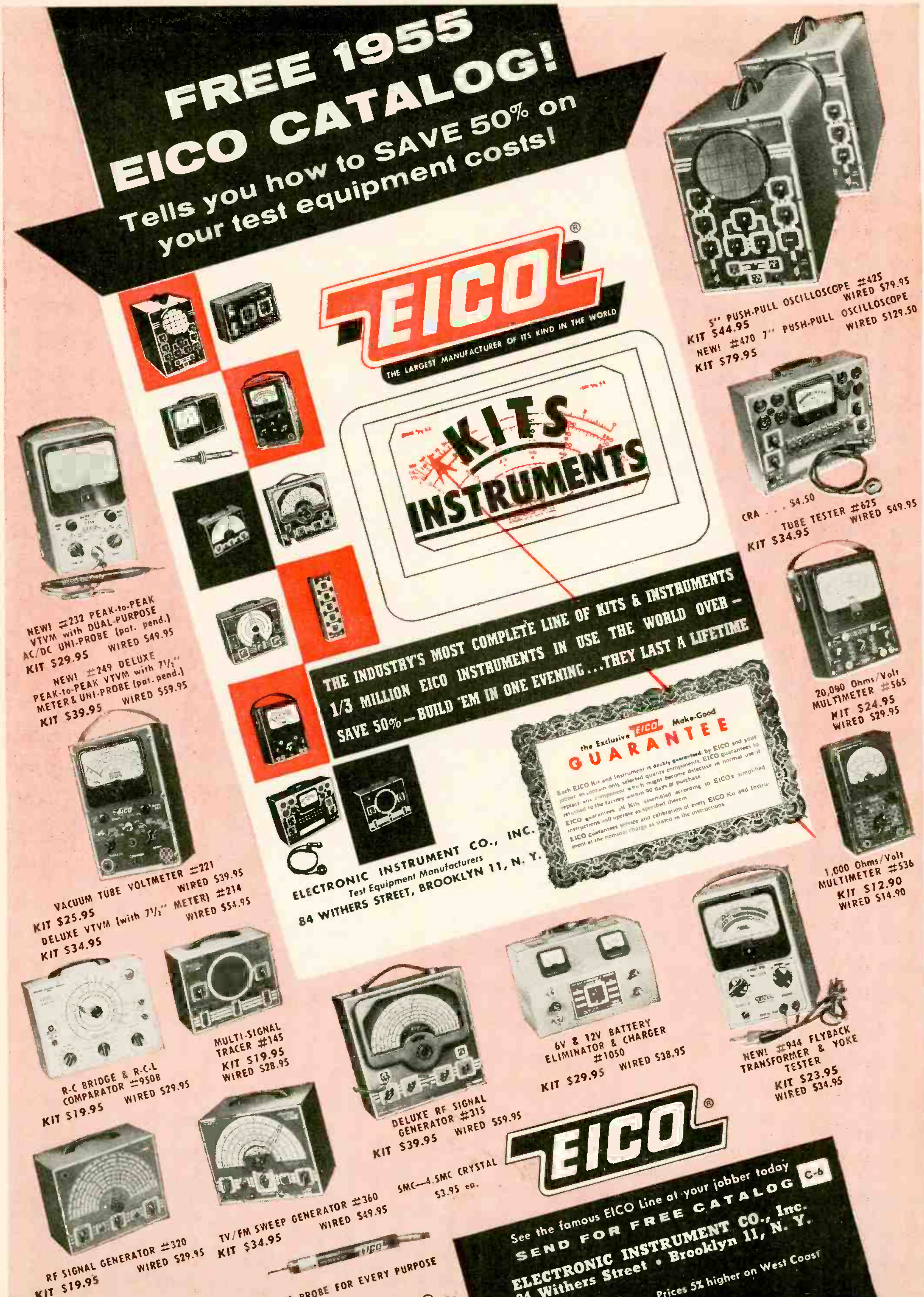

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THE INDUSTRY'S MOST COMPLETE LINE OF KITS & INSTRUMENTS
1/3 MILLION EICO INSTRUMENTS IN USE THE WORLD OVER —
SAVE 50% — BUILD 'EM IN ONE EVENING...THEY LAST A LIFETIME
the Exclusive EICO Make-Good GUARANTEE
Each EICO Kit and Instrument is doubly guaranteed by EICO and your jobber to contain only selected quality components. EICO guarantees to replace any component which might become defective in normal use if returned to the factory within 90 days of purchase
EICO guarantees all Kits assembled according to EICO's simplified instructions will operate as specified therein
EICO guarantees service and calibration of every EICO Kit and Instrument at the nominal charge as stated in the instructions
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KIT $44.95 WIRED $79.95
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RADIO-ELECTRONICS

Hugo Gernsback, Editor

CHECK YOUR TV SET ANNUALLY!

Preventive Maintenance Operates Your TV set at top efficiency . . . .

MODERN man is healthier and lives longer because he has learned to have an annual medical checkup. The human machine is exceedingly complex—that is why a checkup on it pays ever increasing dividends.

Your car, too, is a complex machine. The smart car owner knows from sad experience that a yearly, or better, a half-yearly check and tuneup is cheap insurance in the long run.

A modern television receiver has anywhere from 1,500 to 2,000 parts, but the average owner apparently never gives this a thought. He uses his set constantly, never realizing its great complexity. Then one day when he least expects it—usually when he wants to enjoy a special program, or when he has company—one of the set's thousands of parts fails and the receiver goes dead. Worse yet, this usually happens late at night when a service technician is unavailable. When the owner really has a streak of bad luck, the breakdown occurs on a Friday evening and he is without television for three nights in a row—particularly in the summer when many service establishments close over the weekend.

When a TV set fails, the result is so obvious that the technician is called at once. Not so obvious is the gradual decline in performance which occurs in all TV sets over a period of time. Picture brightness drops, pictures become fuzzy, controls become critical to adjust, sets take minutes to come up to normal brightness and picture size. This is where the tuneup can do wonders.

For this reason, common sense dictates that TV set owners should have their sets tuned up and checked periodically—at the very least, once a year. In the end, it is cheap insurance.

If the set owner will only remember that literally hundreds of things can go wrong in the best TV set, he will understand that it does not pay to expect that his receiver will go on forever without the inevitable breakdown.

The periodic radioelectronic checkup is not a new thing to the servicing industry. It has been going on at least since the early 30's, long before the establishment of modern television—which is only nine years old. In those days the checkup usually concerned itself with the vacuum tubes of the radio set, and also that most important feature, "a check of your antenna." For the past few years, a "Preventive Maintenance Month" for TV sets has been current in the Harrisburg area of Pennsylvania by progressive service technicians. This movement has since spread to other parts of the state and country.

Usually the up-to-date servicing establishments circularize their customers with letters or circulars calling their attention to the necessity of periodic TV checkups.

Some of the larger TV set manufacturers also routinely advise "TV tuneups" and checkups through their servicing outlets and affiliates.

Thus, for instance, the RCA Tube Division instituted a nation-wide campaign among independent service technicians to alert TV receiver owners to the value of TV tuneups.

Their recommended tuneup is a quick and simple seven-point adjustment and examination of the set by the service technician to restore it to peak performance or discover needed servicing. The TV Tuneup Special charge, which varies somewhat in different localities, includes TV tube focus adjustment, adjustment of automatic gain control, frequency, and horizontal and vertical linearity controls, inspection and adjustment of tuner oscillators; also a performance check of the low-voltage rectifier and power-output tubes. Such a seven-point check can be made in approximately 30 minutes in the home of the set owner, without removal of the chassis.

Other servicing establishments have their own checkup and tuneup routines, some including a complete test of all tubes.

Outdoor antennas, too, should not be neglected by the set owner. Storms, sleet, ice, rust—all endanger the average antenna structurally, decrease its efficiency and consequently the quality of the sound and the clarity of the picture. The antenna lead-in is particularly vulnerable and should be replaced every 18–24 months. Storms also play havoc with exposed antennas. Not only have falling antennas frequently damaged property, but have also maimed or seriously hurt passers-by. *This, in turn, has often caused embarrassing and expensive lawsuits to TV owners,* particularly in crowded centers.

Moral: Have your TV antenna inspected regularly.

Remember also that the hot season is upon us now. Note that every television set generates a good deal of heat—equivalent to burning three 100-watt incandescent bulbs. But—unless you have airconditioning—80–90° summer heat in the room will make it practically impossible to dissipate the heat normally generated by your TV set. Consequently, it often heats up excessively during hot summer nights. The heat usually is accompanied by high humidity, too. *Hence summer failures of TV sets are common.*

One more reason to have your set checked *before* the hottest weather sets in.

To sum up: *Your TV set is no better than the intelligent servicing it gets!* —*H. G.*

NOTE: Copies of this editorial for distribution to TV set owners by the service industry are sold at cost by RADIO-ELECTRONICS. *100 copies — $.75; 500 copies — $2.75; 1,000 copies — $5.25 prepaid.*

A NEW LOUDSPEAKER ENCLOSURE

By GEORGE A. COATES*

SINCE the start of radio broadcasting and phonograph recording, designers have worked to reproduce the received signal with the same fidelity as at the point of origin. The earlier loudspeakers were nothing more than the adaptation of an earphone or headphone to a hearing aid trumpet. From this humble beginning a long line of horn, cone and baffled speakers have evolved.

Today's deluxe corner horns, bass-reflex and infinite-baffle speakers are all due to the work of engineers and designers striving for a loudspeaker system that will produce a "reasonable facsimile" of the source material. Amazing performance has been achieved, that from the listeners' and consumers' point of view, is very acceptable. With every high-fidelity installation (I use the term loosely) some type of loudspeaker system is used.

Let us analyze the listening public for a moment. Are they all critical listeners? Are they all engineers satisfied with only tone-for-tone and note-for-note perfection? Are they all mu-

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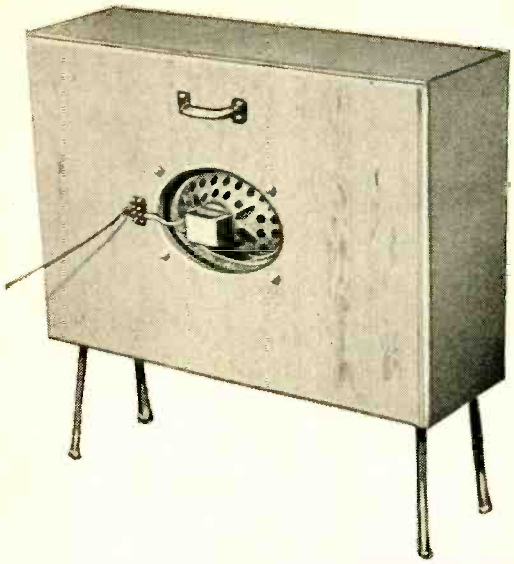
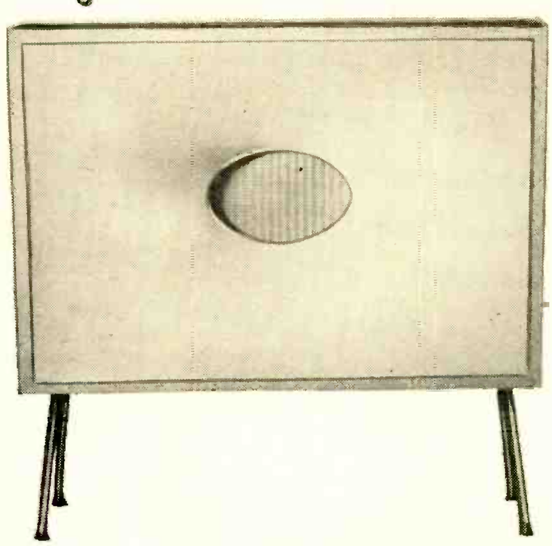


Rear view shows loudspeaker mounting.



Front view of the loudspeaker enclosure.

sicians with ears sensitive to the slightest fault in a reproducing system? No. The buying public is made up of all kinds of people with varied hearing tastes. They are people who enjoy good music and are purchasing sound systems for their homes so they can satisfy their tastes, whether with jazz or symphonic music, hillbilly songs or opera.

Just as their choice of amplifier and preamplifiers, tuners and turntables varies, so does their choice of speakers and speaker enclosures. They buy what is acceptable to their own ears and pocketbooks. I am no exception, and through the years I have had a motley assembly of transducers from Western Electric 3-foot cone speakers to bass-reflex, infinite-baffle, corner-horn and multiple-speaker installations. I have experimented with speakers in tubes and tubs, both wooden tubs and bathtubs. I have constructed parchment cones mounted on lamp-shade frames and dropped speaker units into expensive vases, ruined our old Victrola, screwed driving units to piano sounding boards, excited Japanese rice paper screens and bass drum heads. Why? Just because I have never been satisfied with the reproducers available. Much of my experimentation was prior to the present hi-fi era and I still find myself trying odd combinations in the search for one thing, *presence*.

Even with the present array of enclosures, woofers and tweeters I am too conscious of the source and the music-in-a-box quality of the sound. Amazing strides have been made and with an unlimited pocketbook it is possible to re-create the sound of an orchestra in one's own home with nearly perfect fidelity. To some, even this is far from perfection. The critical listener pays the price and is happy for a while. Then he palms his equipment off on his friends, at a price, saying it is more than he can afford and all the time planning on that new and better system he just heard.

I want to present an unorthodox approach to this thing referred to as presence.

Presence as used by the followers of Williamson and Klipsch, Armstrong and Pickering is not defined in Webster. Future issues may include presence as "that quality in music reproduction that gives the listener the illusion that the musician or orchestra is in the room with him." This means that it is not coming from a hole in the wall nor from a well-padded box.

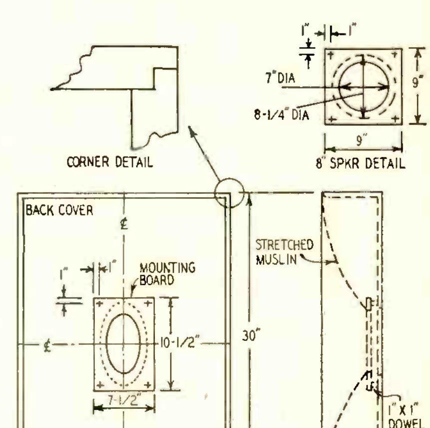
Enclosure construction

My enclosure approaches a state of presence that has amazed me and my friends. The construction is simple, inexpensive and so functional in design that the basic unit can be used without hiding it behind grille cloth and period furniture design. It consists of an open box with a small mounting ring or platform for the loudspeaker (see drawings and photographs).

From the inside edge of the speaker opening in this platform, bleached or unbleached muslin is stretched to the four front edges of the box to form a shallow horn-shaped diaphragm. Unbleached muslin of 80 to 100 count is preferred, the count being the number of threads per square inch. Bleached muslin is satisfactory but I am afraid the fibers are weakened in bleaching and may tear out if excessive dope is applied. However, I have successfully stretched some 15 diaphragms using both bleached and unbleached muslin.

This diaphragm is coated with two coats of airplane dope and then finished with any color lacquer desired. Clear lacquer is also good, and if an all-over patterned cotton material is used, an interesting appearance results. I have found that two coats of dope and one or two coats of lacquer are sufficient to give a strong resonant diaphragm. If applied with a spray gun, the coating will not load the diaphragm too heavily. In fact, in one experimental model approximately 3/64 inch of lacquer was built up without seriously impeding diaphragm operation.

The loudspeaker is mounted through the larger opening in the rear of the box. If a small piece of grille cloth is placed over the face of the speaker as in the photo, an additional cardboard shim should be added so that the excursion of the cone does not strike the grille cloth. Some loudspeakers have



Front and side layouts of enclosure using a 6 x 9-inch oval speaker.

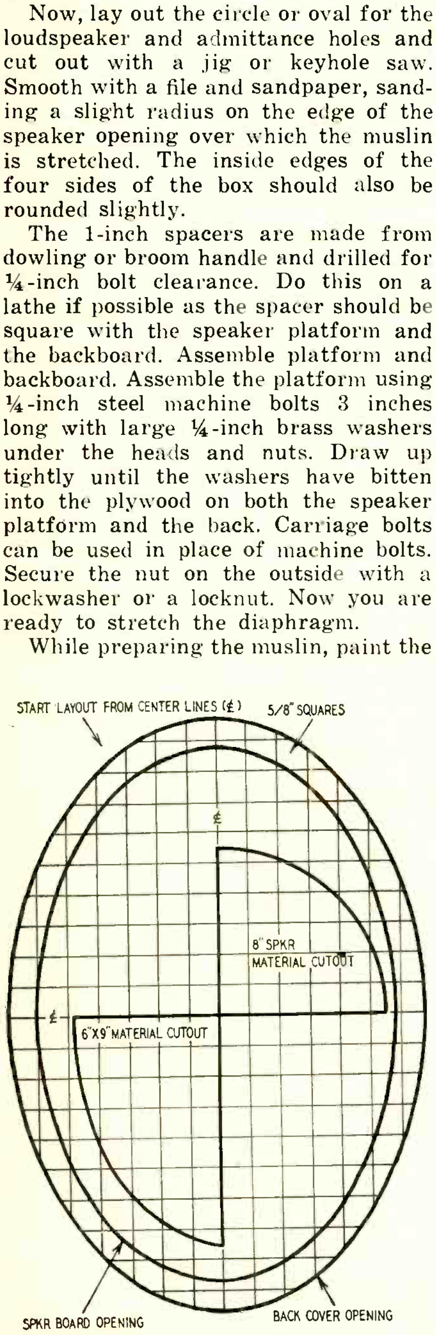
sufficient space between the cone edge and the mounting ring, in which case the additional shim will not be needed. A cardboard shim can be purchased from any shop that recones loudspeakers.

The box is assembled with a few finishing nails and Wel-Hold or similar glue; all joints must be well fitted and glued. In laying out the speaker admittance hole in the back, find the exact center of the backboard and then fasten the speaker platform center to this point with a nail. With the speaker platform square with the sides of the back, drill the four ¼-inch platform mounting holes, using a drill press if possible. Before removing, make a pencil mark so that you can assemble the platform with the correct hole lineup.

Now, lay out the circle or oval for the loudspeaker and admittance holes and cut out with a jig or keyhole saw. Smooth with a file and sandpaper, sanding a slight radius on the edge of the speaker opening over which the muslin is stretched. The inside edges of the four sides of the box should also be rounded slightly.

The 1-inch spacers are made from dowling or broom handle and drilled for ¼-inch bolt clearance. Do this on a lathe if possible as the spacer should be square with the speaker platform and the backboard. Assemble platform and backboard. Assemble the platform using ¼-inch steel machine bolts 3 inches long with large ¼-inch brass washers under the heads and nuts. Draw up tightly until the washers have bitten into the plywood on both the speaker platform and the back. Carriage bolts can be used in place of machine bolts. Secure the nut on the outside with a lockwasher or a locknut. Now you are ready to stretch the diaphragm.

While preparing the muslin, paint the



Layout of templates for cutting openings in muslin and cabinet.

edges of the box and the edge of the speaker opening with airplane dope and let dry. Two coats should be sufficient. This is so the muslin will adhere to the edges and give you a smoother edge to paint or cover when the speaker is finished. Now, take 1⅓ yards of muslin 36 inches wide and fold it two ways to find the exact center. Using the template, draw a pencil line and—without disturbing the folds—cut out the center with scissors. This should give you an opening ¾ inch smaller all around than the opening in the speaker platform.

If this is done carefully, you can now staple or tack the material to the inside of the speaker opening with the opposite edge as a guide and using all the material without any surplus. It is better to stay on the small side as the material can be stretched to conform with the inside of the hole. Care at this point will result in a diaphragm free of wrinkles or surplus material. A Bostick staple gun and ¼-inch staples are ideal for fastening the cloth to the box. If tacks are used, use copper-coated ones if possible.

Now you are ready to stretch the diaphragm. Starting at the center of one side, pull the material over the edge of the box and secure with at least three staples side by side. Do the same at the center of the adjacent side. Pulling on first one side and then the other, staple the muslin to the box, working toward the corner. Pull the muslin taut and watch for wrinkles. You will end up pulling the muslin on the bias where the greatest amount of stretch is available. As you stretch the material, it will begin to take the shallow horn appearance of the finished diaphragm. Be sure it is uniformly taut, feeling the surface with the tips of your fingers. Restretch and staple as needed to remove any soft spots.

When one corner is finished, repeat the directions until the diaphragm is complete. It should be free of soft spots or wrinkles over the entire surface. Don't be concerned too much with the lines of the thread. It is not necessary that the muslin be extremely tight, just free of wrinkles and of uniform tension over the entire surface. Let the diaphragm stand for about 12 hours before proceeding, to allow the muslin to adjust itself.

Before doping, pull all excess material over the outer edge of the box and secure with a few staples to the sides. This will insure a smooth outer edge to the diaphragm after doping. You will find that the rear edge of the material fastened to the speaker platform will tend to curl. With scissors, notch the curled edge and cement to the sides of the opening with Duco cement. Allow it to dry before continuing.

Apply one coat of dope and let it dry thoroughly. The diaphragm may appear to loosen, but if stretched carefully, it will shrink out free of wrinkles. Apply a second coat of dope and allow it to dry. After the second coat, the diaphragm will be as tight as a drum and fairly high pitched when thumped. If any wrinkles appear, they can usually be shrunk out with additional dope applied to that area or one more overall coat.

The dope used is nitrate dope and was brushed on without thinning. One coat was put on and a second coat was applied immediately, brushing at right angles to the first. This was allowed to dry thoroughly, then a second such treatment was applied, using the same procedure.

Before the final lacquer coat is applied, go over the surface with fine sandpaper (No. 320) to remove the small fibers that will raise up. Now apply one or two coats of lacquer, sanding lightly between each coat. When the last coat of lacquer is thoroughly dry, trim the surplus material with a sharp knife or razor blade. If the material pulls away along the outer edges, cement again with Duco cement. However, if the wood was painted with dope, the two coats of dope should soak through the material or the edge and give a good bond.

Sheet cork, available at auto supply stores, 1/16 inch thick and usually 12 inches wide by 36 inches long, makes an easy method of covering the speaker. Cut to size to fit the top and sides, and use ¾-inch strips to cover the stapled edges. A substitute for the cork strip for covering the stapled edges is a belting material available at most dry goods stores called E-Z belting. This is the material I used on the painted enclosures. It is applied with Wel-Hold cement, the same as the cork. Wel-Hold cement is also used to apply the sheets. After it is thoroughly dried the cork can be sanded like wood, using fine sandpaper. It is best to use butt joints in the corners rather than a mitered joint when covering the stapled edges. I have found that the cork will break away when cut to a fine point.

Finish the cork with either clear lacquer or shellac and mount the enclosure on wrought-iron legs or wood blocks.

With the speaker mounted and operating, you will find that the diaphragm will be parasitically driven and vibrating. Due to its shape, it will respond to a wider band of frequencies than would be possible with a flat diaphragm and standing waves do not form within the enclosure. Just what action is taking place is still under study. Free-field tests using the same speaker in both bass-reflex cabinets and my enclosure show from 3 to 6 db more energy radiated with my enclosure.

Used with a good audio amplifier and source, you will note a terrific transient response and a remarkable feeling of presence. The bass response will surprise you. With a tweeter to extend the range of the oval speaker or by using a Dia-cone or coaxial 8-inch speaker, you will have a system which stands up against others costing a great deal more. END

What is a Load Line ?

An explanation of the static and dynamic characteristics of triodes and pentodes

By NORMAN H. CROWHURST

RECENT correspondence from readers shows that many are hazy about the significance of a load line. I still remember when I first saw a senior engineer take a set of tube characteristics, lay a ruler across them and draw a line with a pencil on the curves. From this he produced some mystifying data about the gain of the tube, its distortion, etc. At that time it all seemed rather wonderful but mystifying. Since then I have met many who have studied the subject in their technical courses but who remain rather vague on the true significance of a load line.

The first thing to understand is the different ways in which tube characteristics can be presented. Taking first the simple triode, there are three quantities that can vary: grid–cathode potential, plate–cathode potential and plate current. The tube characteristics are usually shown in one of two ways: by taking fixed plate–cathode potentials, curves are plotted showing the way plate current varies with grid voltage (Fig. 1-a); by fixing the grid–cathode voltage at various values and plotting curves of plate current against plate voltage (Fig. 1-b). In the triode the curves produced by both methods are similar, probably one reason for the confusion that often exists about them.

The best method of proving to yourself the difference between the two kinds of curves is to use one set of curves to produce the other (Fig. 2). Here the curves of Fig. 1 are repeated but corresponding points on the two sets of curves are indicated by corresponding numbers. In Fig. 2-a a particular grid voltage is represented by a vertical line while in Fig. 2-b it is represented by a curve. Thus the points numbered 1, 2, 3 are all at a grid voltage of zero on both diagrams; the points numbered 8, 9, 10, 11, 12 are all at a grid voltage of −2. In Fig. 2-b a plate voltage is represented by a vertical line, while in Fig. 2-a it is represented by a curve. Thus the points numbered 7, 11, 15, 18, 20 are all at a plate voltage of 200 on both diagrams. You can trace out the correspondence of other points on both graphs for yourself.

The grid-voltage plate-current curves are not very helpful in showing the characteristics of a tube when operated with a plate load, because each curve represents the change in plate current *for constant plate voltage* as the grid voltage is changed. If the tube is operated without any resistance in the plate circuit, so that only the current fluctuates and not the plate voltage, these curves can be very useful. The waveform of the plate current for a sinusoidal grid voltage can be plotted using one of these curves by the method illustrated in Fig. 3.

A sine wave is drawn edgewise, underneath one of the curves, and the graph lines extended to provide reference points on the sine-wave input voltage. For clarity, only a few points are shown. To get a nice accurate curve a greater number of points should be used. At the right side of the diagram, corresponding reference points are projected out and the same baseline points along the curves are identified. In this way, if the plate-voltage curve were a straight line, as represented by the dotted line, a sine wave would be repeated, due to the proportional spacings. However, because of the curvature of the tube characteristic, the plate-current variation is distorted from sinusoidal as shown by comparing the solid plate-current curve with the dotted curve.

The load line

Now we are introduced to the load line. A practical amplifier circuit in its simplest form is shown at Fig. 4. The addition of a plate coupling resistor means that when grid voltage is changed, plate voltage and plate current also *both* change. This is when the load line comes into use to plot the exact nature of plate-voltage and plate-current change with applied grid voltage.

At the top end of the plate resistor a fixed B plus voltage is applied. If the tube does not pass any current, there will be no current flow through this

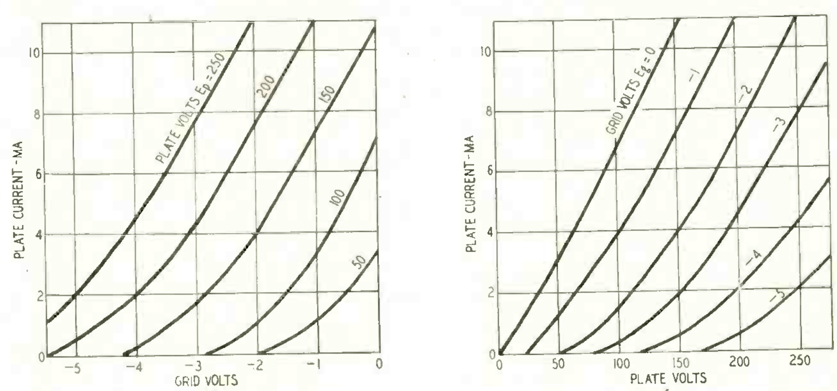


Fig. 1—Two ways of representing the characteristics of an electron tube.

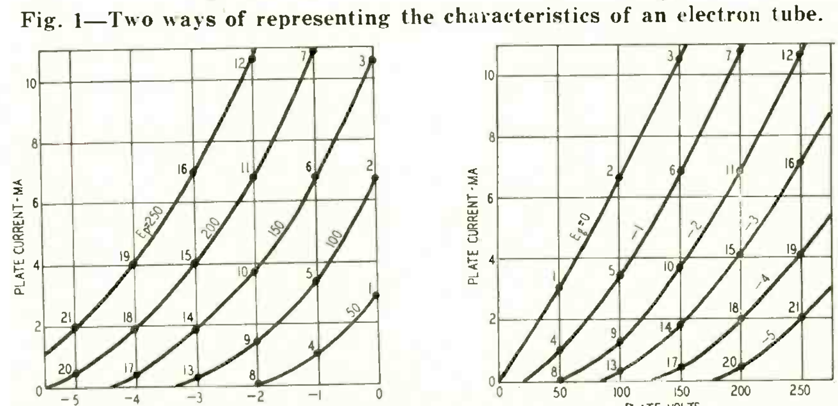
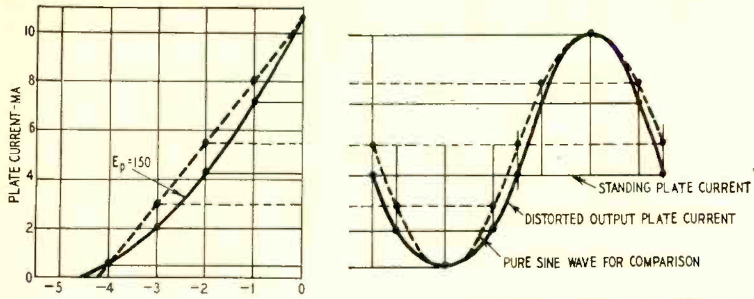


Fig. 2—Points on curves show correspondence between the sets of curves.



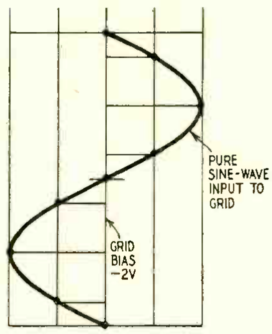


Fig. 3—E_g-I_p curve shows distortion in stage with constant plate voltage.

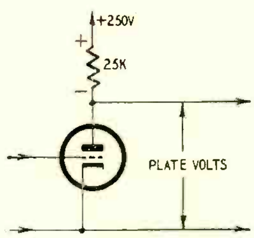
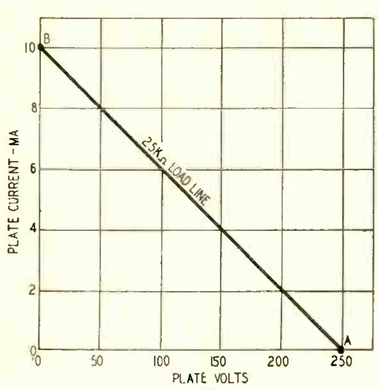


Fig. 4—A basic amplifier circuit.



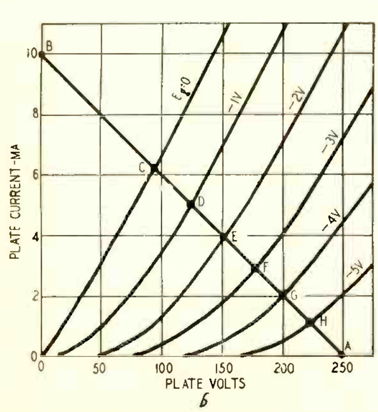


Fig. 5—Showing load line principle.

resistor, and the plate voltage will be the same as B plus, 250 volts in this case. But if the tube draws 10 ma, there will be a drop of 250 volts across the 25,000-ohm resistor—which means that the plate voltage will have dropped to zero. If the tube draws say 6 ma, there will be a drop of 150 volts across the resistor, leaving the plate at 250 − 150 = 100 volts positive. A lot more points could be taken, representing different plate voltages according to the current drawn by the tube, but they will all be found to fall in the straight line AB of Fig. 5-a.

Whatever happens in the grid circuit the plate current and voltage must be given at some point along this line because of the voltage drop across the 25,000-ohm resistor. For this reason such a line is called a "25,000-ohm load line." In Fig. 5-b the curves of Figs. 1-b, 2-b are redrawn and the 25,000-ohm load line drawn through them.

Suppose that the grid voltage is −1: The combination of plate current and plate voltage must be somewhere along the curve marked "grid volts −1." It must also be somewhere along the load line AB which represents the only possible plate voltage and current combinations in the circuit of Fig. 4.

The values when the grid voltage (E_g) is −1 are given by point D in Fig. 5-b—about 120 volts and 5 ma. Similarly other points C, E, F, G, H, along the load line, where the grid voltage curves cross it, give the plate voltage and current for the value of grid voltage represented by each curve.

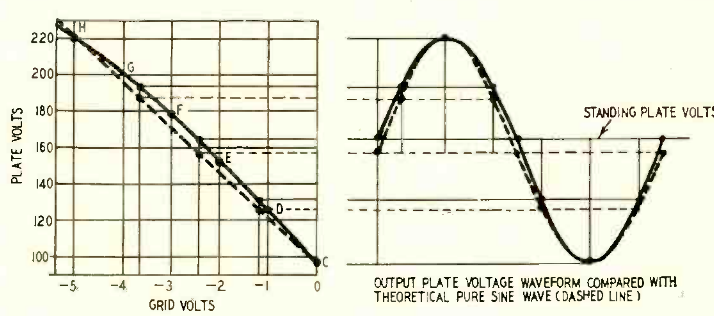
Load line shows distortion

Using a method similar to that used to show distortion of the plate current without any plate load in Fig. 3, a curve is plotted using the plate-volts–grid-volts points of Fig. 5-b. This is shown in Fig. 6. The dotted line represents a truly linear result while the slightly curved line is obtained by plotting the values obtained from the actual points C, D, E, F, G, H.

From Fig. 6 the reference lines are again extended downward and to the right so that a sine wave can be drawn as the input to the grid and a corresponding output waveform can be drawn by reference to the curve. The dotted and solid curves on the right side of Fig. 6 show the plate-voltage output waveform as compared with a pure sine wave. The difference between the dotted and solid curves here is much less than in Fig. 3, which indicates much less distortion from true sinusoidal.

The simple circuit of Fig. 4 can represent part of a direct-coupled amplifier. The method just described may be used to find the best value of coupling resistor to use. To do this, a number of different load lines can be drawn across the same set of plate-current–plate-voltage curves for the particular tube being used.

Fig. 7 shows how the slope of the load line depends upon the resistance value it represents. Three values of resistance are shown drawn through the same B plus voltage of 250. A simple way of drawing each load line consists of determining what current will flow if the plate is short-circuited to ground and then marking off this current value on the current scale at the left, where voltage is zero. This point is then joined to the B plus voltage point along the voltage scale, which



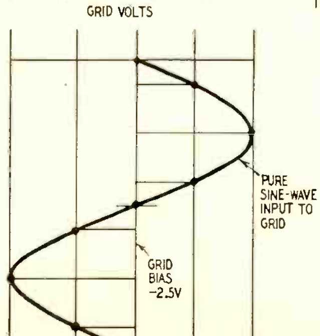


Fig. 6—Using load line information to determine amount of distortion.

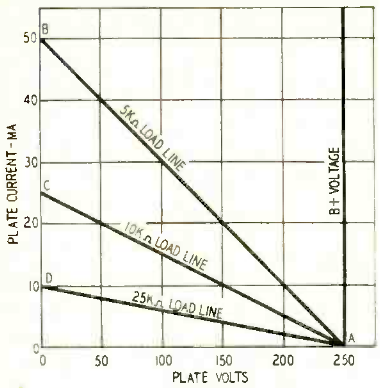


Fig. 7—Comparing load line slopes.

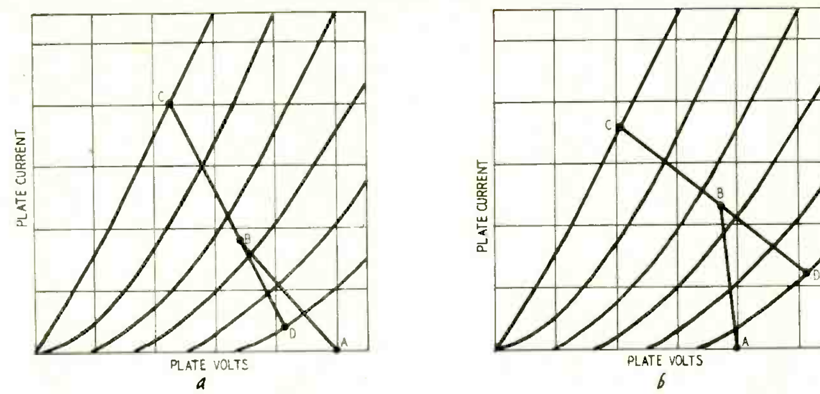


Fig. 8—Practical dynamic load lines for various type coupling circuits.

corresponds with the plate current being zero, as was explained in reference to Fig. 4. When no current is flowing, the plate voltage is equal to B plus. When the plate voltage is at zero, the whole B plus voltage is dropped across the load resistor.

An examination of Fig. 7 shows that lower resistance values are represented by steeper sloped lines, while higher resistance values correspond with lines nearer the horizontal.

This principle enables us to visualize the effect of other kinds of circuit in producing a *working* load line, including the effect of other circuit components. Actual values can be calculated quite simply and a load line drawn in to represent any particular kind of circuit. Fig. 8 shows practical load lines for (a) resistance–capacitance coupling and (b) choke or transformer coupling. In each case the line AB represents the d.c. drop from B plus to the plate under the condition of normal static bias, while the load line CD passing through the point B represents the dynamic load line when an alternating signal is applied to the grid.

In the case of Fig. 8-a—due to a further resistor (R_g of Fig. 9-a) coupled a.c.-wise in parallel with the plate load resistor by the coupling capacitor—the effective resistance in the plate circuit is reduced. Its value can be calculated by the simple parallel-resistance formula. Hence the load line AB, as determined by the value of load resistor R_L in Fig. 9-a, determines the operating position B, according to the grid bias applied to the tube.

If the scales for current and voltage are the same as in Fig. 5, AB would represent 22,000 ohms. When alternating signal is applied, the load line CD (a resistance equal to R_L and R_g of Fig. 9-a in parallel) represents the "dynamic" behavior of the tube as signal voltages are applied. The slope of CD, according to scale, is 12,000 ohms, which means R_g must be 27,000 ohms. Points along load line CD can be used after the manner of Fig. 6 to determine the degree of distortion and also to determine the effective amplification of the tube.

When choke or transformer coupling is used, the resistance from B plus to the plate is small, being merely the winding resistance of the choke or transformer primary. This is represented by the section AB in Fig. 8-b. The position B is determined again by the static value of bias applied to the grid of the tube. In this case however, the effective a.c. resistance of Fig. 9-b is considerably higher than the d.c. resistance of the choke winding. Thus it is represented by a load line less steep, such as CD in Fig. 8-b.

Using the same scales AB represents a resistance of about 3,500 ohms, while that of CD represents about 32,000 ohms.

A similar construction applies for the direct-coupled transformer coupling of Fig. 9-c. In the case of transformer coupling the actual value of resistance applied across the secondary of the transformer must be "referred" by multiplying it by the square of the turns ratio to get the effective a.c. resistance presented by the primary of the transformer in the plate circuit of the tube.

Figs. 10 and 11 show a whole family of characteristics for typical triode and pentode tubes. In each, a series of load lines has been drawn through the same static bias operating point. In the case of triodes (Fig. 10) the spacing of points where the grid-voltage curves intersect the individual load lines, lines nearer the horizontal, representing higher resistance values, produce the more even spacing, representing lower distortion. Load lines approaching the vertical and representing lower values of load resistance result in unevenness of spacing, stretching out toward the top end and second-harmonic distortion similar to that present in the plate-current curve shown in Fig. 3.

For pentodes (Fig. 11), the effect of variation of load resistance is reverse. A low value of resistance, represented by a load line that crosses the curves almost vertically, results in comparatively low distortion, while a high value of resistance, represented by a line that crosses the curves almost horizontally, produces a high degree of distortion. This is because all the grid-voltage curves converge together to the left of the "knee" of these curves and the spacing to the right spreads out.

Another useful feature of load lines, as shown in the article "What Is Optimum Load?" (March, 1954), enables the correct operating conditions to be chosen from the viewpoint of staying within various boundaries of tube operating characteristics. END

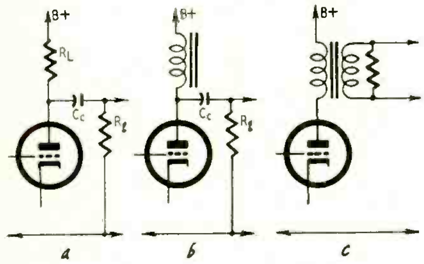


Fig. 9—Typical coupling circuits.

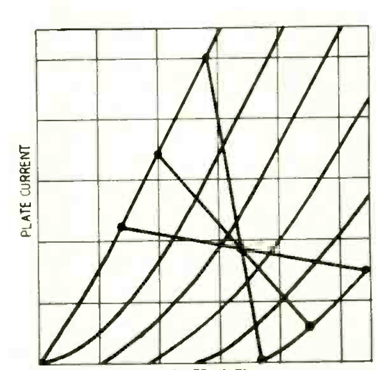


Fig. 10—Typical triode characteristics.

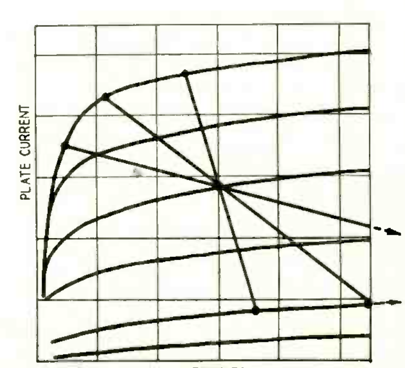


Fig. 11—Pentode characteristic curves.

A new tape transport system;
a pocket tape recorder

New Developments in Tape Recorders

By SOL HELLER

MECHANICAL problems in magnetic tape reproduction have proved harder to solve than electronic ones. These problems have centered about the tape transport mechanism. The most critical function of this assembly is to maintain constant tape speed. Speed stability is essential in avoiding distortion.

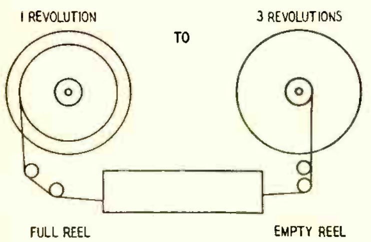


Fig. 1—Reels must travel at different speeds to maintain constant tape speed.

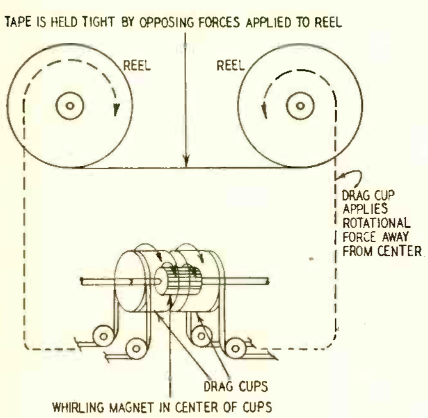


Fig. 2—The Isimetric Drive system.

Tape cannot be made to travel at a constant speed by simply rotating the takeup reel at a constant rate. The amount of tape rolled up per revolution—and therefore the tape speed—varies with the reel diameter. This diameter is not constant; its value depends on the amount of tape on the reel. When a reel has only a few windings, it must make several revolutions to gather the same amount of tape as a full reel does in one revolution (Fig. 1). The speed with which the tape moves will thus not be constant unless some compensation is made for the effect of the reel's changing diameter.

The conventional solution has been the use of a constant-speed shaft called a *capstan*, acting in conjunction with a mechanical *slipping clutch*. The clutch corrects for the nonuniform speed caused by the varying reel diameter. The clutch, however, prevents an optimum torque (rotational force) from being simultaneously applied to the two reels. In other words, if the rotational force applied to the full reel is proper, it will not be as good for the empty reel, and vice versa. This usually necessitates compromise adjustments that at best provide fair rather than perfect uniformity of tape speed.

A separate torque motor is used in more expensive machines to get around the difficulty, but here again a problem is present: the speed–torque characteristic of the takeup motor must vary in accordance with the quantity of tape on the reel.

A solution offered by International Scientific Industries is the *Isimetric Drive.* The central component of this system is a single, gear-shaped, motor-driven magnet (Fig. 2) that whirls freely within two copper-lined steel cups. Each cup is coupled to one of the reels. The rotating magnetic field produced by the magnet causes the two cups to revolve in the same direction. The connection of the drive cups to the reels is such that the rotational force applied to one reel opposes the force applied to the other. The tape, as a result, is held taut between the reels.

When the magnet is centered with respect to the drive cups (Fig. 2), equal forces are applied to the cups and the reels they drive. When the magnet moves farther *into* one drive cup and correspondingly *out of* the other, the torque applied to one reel increases, while the torque for the other reel is proportionately decreased (Figs. 3, 4). The reel with the higher torque takes up tape; the reel with the decreased torque releases tape and acts as a brake.

Due to the symmetry of the system—the drive to one reel is a mirror-image of the drive to the other—a smooth transport system results. The tape reverses smoothly and easily and is capable of going from extremely slow to very high speeds with no tendency

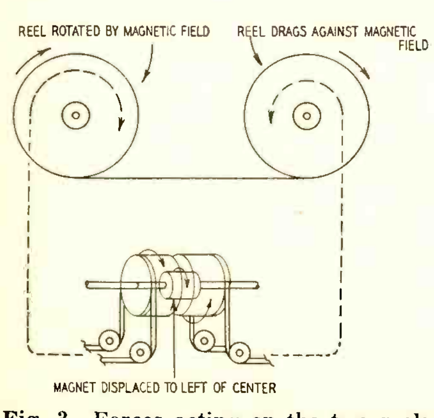


Fig. 3—Forces acting on the two reels when magnet is displaced *left* of center.

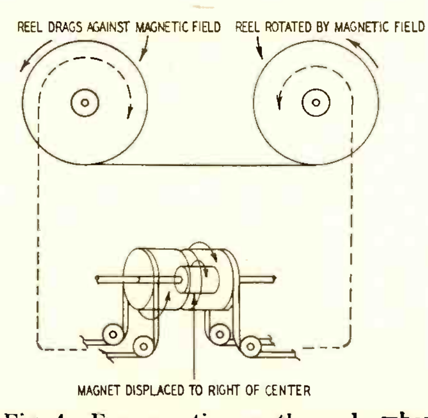


Fig. 4—Forces acting on the reels when magnet is displaced *right* of center.

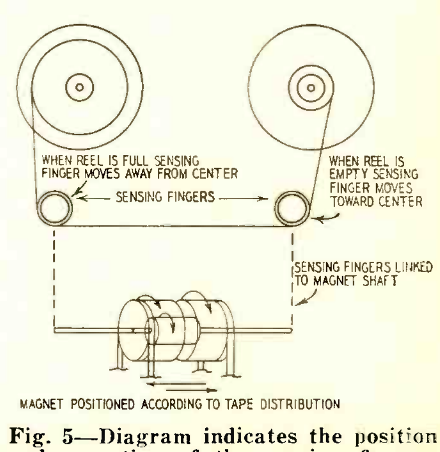
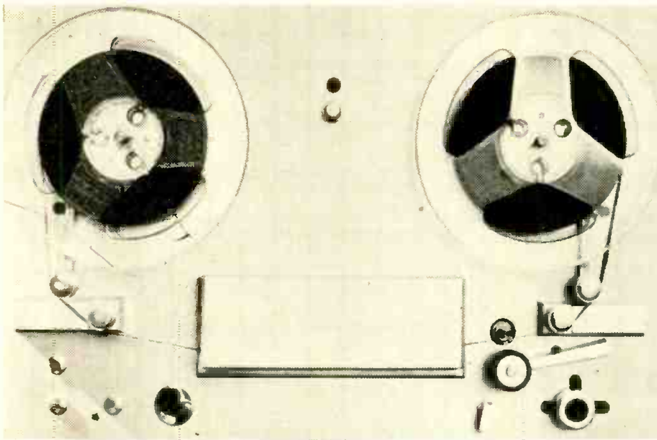
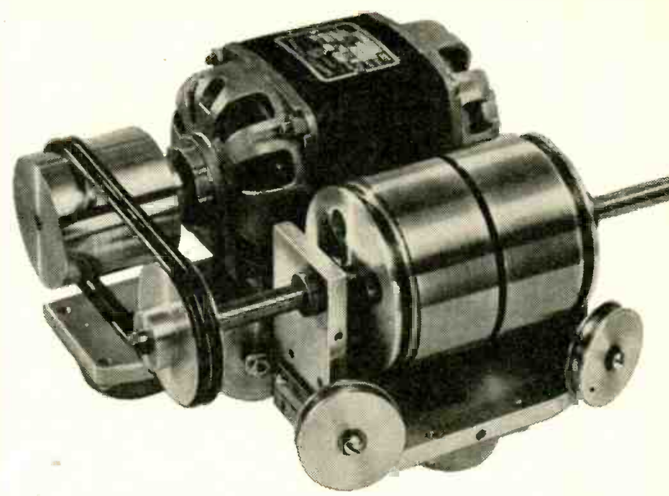


Fig. 5—Diagram indicates the position and operation of the sensing fingers.

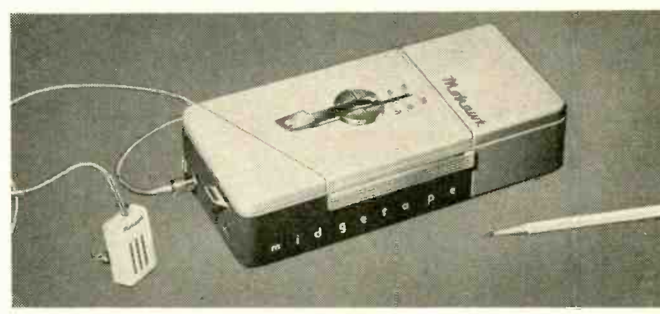




Above, surface view of the tape transport mechanism in the Isimetric Drive system.

Above right, the mechanism used in Isimetric Drive system.

Right, the Midgetape model BR-1 pocket tape recorder, showing microphone attached.



to develop slack, snap off or spill.

As previously stated, the reel which is accumulating tape should rotate slower as its effective diameter increases, to maintain a constant tape speed. This is achieved in the Isimetric Drive system by *sensing fingers*. These fingers, due to their placement (Fig. 5), automatically move in the direction of the tape-accumulating reel. The distance they move is proportional to the amount of tape on the reel. Since these fingers are mechanically linked to the magnet shaft, they cause the magnet to move farther and farther into the drive cup of the tape-gathering reel as its effective diameter increases. At the same time the magnet moves proportionately out of the cup linked with the tape-losing reel. The result is that the torque remains proper and correctly balanced at all times. The tape thus moves at a highly constant speed and remains under uniform tension.

A specially designed synchronous motor is used to "meter" the tape. This capstan motor, as it is called, is used only as a speed regulator—the Isimetric Drive system supplies most of the energy needed to pull the tape.

Isimetric Drive eliminates problems associated with the braking used in conventional tape recorders. Braking is necessary in all tape transport mechanisms to prevent the free-wheeling reel from spilling tape. In conventional machines a frictional brake of some kind is commonly used, often requiring adjustments for satisfactory operation. In better-grade machines using a separate torque motor for drag braking, braking may still be imperfect unless

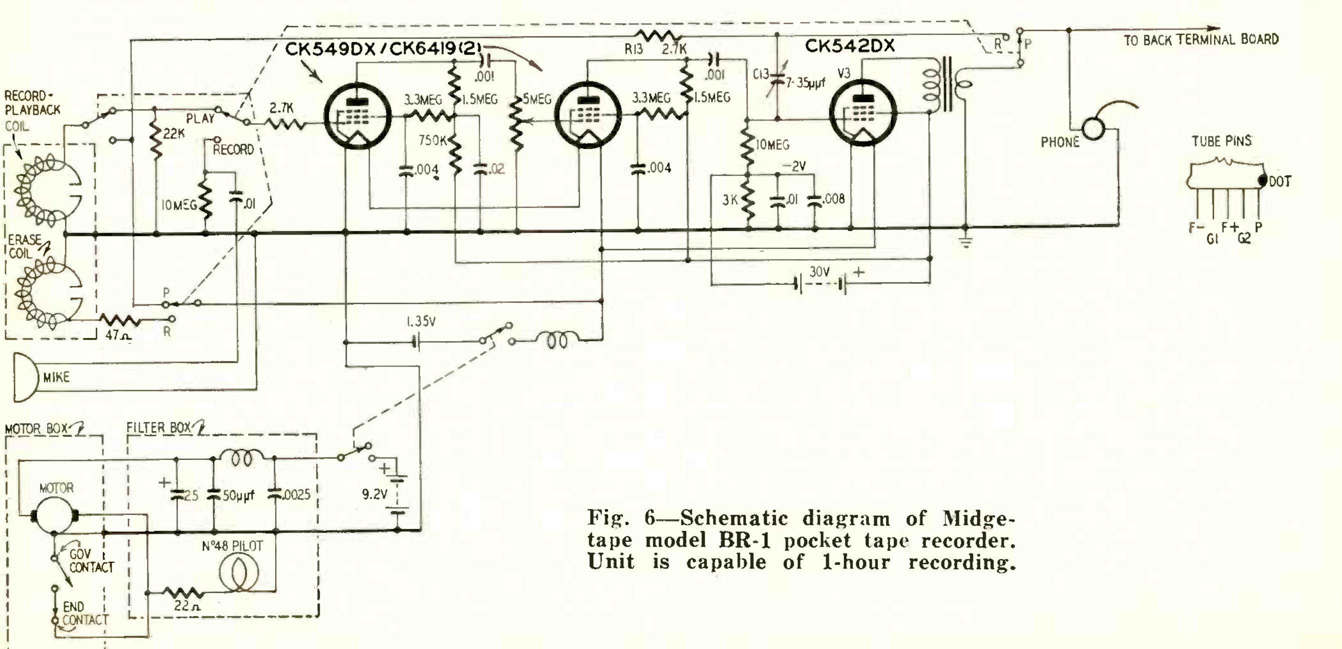


Fig. 6—Schematic diagram of Midgetape model BR-1 pocket tape recorder. Unit is capable of 1-hour recording.

the speed-torque characteristic of the motor varies in step with the amount of tape on the reel. Isimetric Drive provides a frictionless magnetic type of slipping clutch, eliminating adjustment problems. No adjustments are ever required for this system throughout the life of the mechanism, according to the manufacturer. Another important problem eliminated by Isimetric Drive is the deforming of tape due to the setting up of nonuniform tensions in the tape by the tape transport mechanism. When wide variations in wind tightness occur—a common happening with conventional machines—the tape is often stretched or temporarily deformed. This deformation is generally due to the fact that the torque affecting the takeup and supply reels (in conventional tape recorders) is different for each reel at every speed of operation. This causes different degrees of tension on the tape. The deformation introduced becomes permanent if the tape is subsequently stored on a reel where the winding is uneven, egg-shaped or curled, since the tendency of the plastic to return to its original shape is sabotaged.

In most reels of tape, there is some uneven overlapping of successive layers of tape. Edges of the tape may overhang at certain points. If the recorder used introduces an uneven wind tightness, these edges curl, causing flap and flutter of the tape when it is going through the head units. Much hard-to-trace flutter, wow and other distortions are due to this. In the Isimetric Drive system, the very uniform tension under which the tape is held at all times tends to prevent temporary defects from developing in the tape and keeps them from becoming permanent if they do occur.

No pressure pads are needed when Isimetric Drive is used. Because the tape pressure is perfectly constant, tape pressure against the head remains constant without any pad. Pressure pads are undesirable because they require relatively frequent adjustment and tend to introduce frictional variations that produce undesired pitch and loudness changes.

Pocket tape recorder

A battery-operated pocket tape recorder—the first such machine on the market, according to the manufacturer—is being produced by Mohawk Business Machines Corp., Brooklyn, N. Y. The unit makes it possible to make inconspicuous recordings anywhere—in cars, trains, planes, etc.—up to a distance of 30 feet from the source of the sound. There are smaller recording machines on the market, but these use wire as the recording material. Wire is inferior to tape in that it is weaker, as well as very much harder to handle.

Midgetape, as Mohawk calls its unit is 8½ inches long, 1⅞ inches deep and 3⅞ inches wide. It weighs 3¼ pounds. The selling price of $229.50 includes the recording cartridge, batteries, crystal mike and earphones. Accessories include wristwatch mikes, throat mikes, shoulder holster carrying case and a two-way telephone recording adapter. The speed is 1⅞ inches per second.

The recorder is cartridge-loaded—a system of loading provided in no other recorder. Only a single reel is used for the tape, with the tape wound over the reel and both its ends joined together. The tape is enclosed in a cartridge the size of a pack of cigarettes. The cartridge is simply inserted into the machine; no threading is necessary.

Midgetape is capable of recording for one hour on a dual-track tape. It erases old material at the same time it makes a new recording.

Snap-in hearing-aid type batteries are used. The motor battery life is 45 hours, according to the manufacturer; the amplifier battery is rated at 100 hours. When battery aging has reached the point where it will permit only 2 hours more of recording, a small red light goes out, warning the operator.

Midgetape has a recording time indicator that tells how much of the 1-hour recording time has been used up and how much time remains. The indicator permits the easy location of any portion of a recording for playback.

The machine is geared for swift, unobtrusive operation. Flick a switch and it starts; push the switch again, and the unit plays back. The unit has only three controls.

A manual rewind is provided to conserve battery life. Rewinding takes less than 1 minute.

An a.v.c. circuit (Fig. 6) is used to insure a proper recording level at all times.

At the PLAYBACK setting of the selector switch a conventional three-stage amplifier is in operation. In the RECORD position of the switch, V3 acts as an oscillator and modulator, as well as an amplifier.

In conventional tape recorder systems either a separate oscillator and amplifier are used, or else a tube is used as an amplifier on PLAYBACK and as an oscillator on RECORD. In this circuit, V3 is used as an amplifier on PLAYBACK and as an amplifier *and* oscillator on RECORD, permitting a saving of one tube. The output transformer serves a dual purpose: it functions as a tank coil and controls the frequency of V3 as an oscillator; it acts as a conventional output transformer for the audio signal.

Variable capacitor C13 provides in-phase feedback between the output transformer secondary and the grid of V3. Oscillator V3 operates at a frequency of 11,000 cycles. The oscillator output is used for bias purposes.

At the plate of V3, the audio signal amplified in this tube is superimposed on the bias signal developed by oscillator action. The combined voltages are fed through current-limiting resistor R13 to the PLAY-RECORD coil. END

HIGH-FIDELITY DICTIONARY

PART V

By ED BUKSTEIN

Tweeter

A loudspeaker designed specifically for the higher audio frequencies and used where one or more additional speakers are available to reproduce the other portions of the audio spectrum.

Two-way loudspeaker system

A sound-reproducing system using two separate loudspeakers, one for the high frequencies and one for the lows. A filter circuit, known as a crossover or dividing network, channels the signal frequencies to the proper loudspeakers.

Ultra-linear

A push-pull output circuit in which the screen grids are connected to taps on the primary winding of the output transformer. This circuit is characterized by increased power and linearity.

Variable-reluctance pickup

A type of cartridge whose magnetic reluctance varies with movements of the stylus. The lateral movements of the stylus are imparted to a strip of magnetic material known as the armature. As the armature moves back and forth between two pole pieces, it varies the air gap and consequently the reluctance of the magnetic path. Since reluctance in a magnetic circuit corresponds to resistance in an electrical circuit, an increase of reluctance results in a decrease of magnetic flux, and a decrease of reluctance permits an increase of flux. The changing magnetic field cuts through a coil, inducing a voltage—the cartridge output. Although the variable-reluctance cartridge has a relatively low output, its frequency response is excellent.

Volume expansion

In a sound-reproducing system, the process of making the loud sounds still louder and the quiet sounds still quieter. (See Compression.)

Volume unit

A unit of measurement of power level. The volume unit is equal to the decibel, but is based on a reference level of 1 milliwatt across 600 ohms.

Editor's Note: This dictionary will be concluded in our next issue. It will be followed by a glossary of purely tape terms, selected from a list put out by the makers of *Scotch* brand magnetic recording tape. It will cover a number of audio terms not previously given, and may redefine in purely tape terms some of those already covered.

FOR GOLDEN EARS ONLY

The Regency HF-80 amplifier; Pickering cartridge and tone arm; new records review

By MONITOR

RAPID expansion of the high-fidelity market into the mass consumer field has accelerated the design and production of simple, small, inexpensive units combining equalization, tone control and amplifier functions. They require only speakers, tuner and record player to make a complete system. Some of this equipment meets the standards of genuine high fidelity for home use surprisingly well. An excellent example is the Regency HF-80 (Fig. 1), the lowest-priced unit in Regency's new line of hi-fi components.

The essential performance factors are shown in Fig. 2. Curve A is obtained by positioning the controls as follows: volume, full on; bass, a third on; treble, a quarter on. This "flat" position was determined by feeding 200- and 2,000-cycle square waves into the amplifier and adjusting the controls for flattest tops. Curve B was obtained with the bass and treble controls in the center position. Curve C is for maximum boost of bass and treble and curve D for maximum cut of bass and treble. The range of the tone control is clearly very wide.

Four square-wave responses (Fig. 3), taken in the flat position with 500-mw output, are shown and indicate a very acceptable transient response within the audio range. There was no sign of ringing or any other type of instability.

The power output curve (Fig. 4) was obtained by feeding an input signal at 15 different points in the frequency range from 20 to 30,000 cycles, increasing input until the scope trace showed clipping or distortion. The curve is flat from 50 to 30,000 cycles. Below 50 cycles the power output falls off to 8 watts at 30 cycles and just under 4 watts at 20 cycles before distortion shows up. This might limit the usefulness of the amplifier in applications—such as schools or small cafes—requiring high average power levels. But it is fully adequate for average home use and will take care even of the occasional demonstration at "full concert-hall level," particularly since almost no records or broadcasts produce anything below 30 cycles.

Fig. 5 shows the distortion curve from 100 mw to 10 watts. In comparing these figures with those of quality amplifiers *without* control units, keep in mind that these curves give the overall distortion, including that contributed by the tone-control stages—everything but the phono preamp, in fact. This is the lowest distortion I have registered on any commercial 6V6 amplifier.

These are excellent curves; indeed as good or better than those obtainable with top components and designs a brief two or three years ago. They are improved upon in higher-priced equipment, principally in a flatter power curve below 50 cycles and a better square-wave response. The practical utility of both improvements for average home use is debatable and is obtainable only at a much higher price and larger size.

The amplifier listens as well as it tests. It is very clean in the high end and the definition and transient response are very good throughout the range. A slight deficiency in the very low bass end, at very high outputs, is evident when highest-quality speakers are used. With run-of-the-mill systems which are "flat to 50 cycles" and cut off below 40 cycles, the sound is excellent all the way and I would judge that it is completely acceptable to all but the crankiest of listeners.

The HF-80 provides three high-level input channels for tuners, tape recorders or TV, and a single input with a two-position equalizer for magnetic pickups loaded with a 47,000-ohm resistor. The curves of Fig. 6, obtained with a Pickering turnover cartridge and the Dubbings 101 test record, give the response of the phono channel. Position 1 yields excellent results with all four standard American curves. The bass-boost curve apparently is on the AES slope, which accounts for the small boost at the low end and the slight dip around 250 cycles. Most G-E cartridges will show a little more slope at the high end, just about flattening the LP and NARTB curves and producing slight rolloffs with the RIAA and AES. A rumble filter can be actuated by a switch on the chassis and is very effective without much effect on the musical range.

Some readers may be at a loss to account for this excellent performance since there is nothing remarkable about the circuit. The answer is very simple: although the resistors are standard 10% and 20% units, the pairs in push-pull stages are matched on comparison bridges to 1% or better, and the output tubes are also matched closely.

The unit is very compact, light and dissipates little heat; can be put in a restricted space easily. The craftsmanship is excellent for a production unit. Despite the shallow and small chassis, individual components are easily accessible for replacement. All in all, the HF-80 is an excellent example of how much real high-fidelity quality can be provided at low cost by good design and care in manufacture.

Pickering turnover cartridge and new tone arm

The critical problem in the design and production of highest-fidelity pickup cartridges is providing a flat, smooth and clean response above 10,000 cycles. One of the earliest cartridges to offer a response extending to 20,000 cycles was the Pickering, and its success is well attested by its wide acceptance. Not long ago Pickering issued a model 260 turnover version (see photos) which provides facilities for playing both 78-r.p.m. and microgroove recordings at the turn of a lever. This is actually a combination of two cartridges mounted back to back. The cartridges can be disassembled in a few seconds for use independently if desired. Their performance is exceptional both by measurement and listening.

Fig. 7 is the response, without an equalizer, directly off the pickup ter-

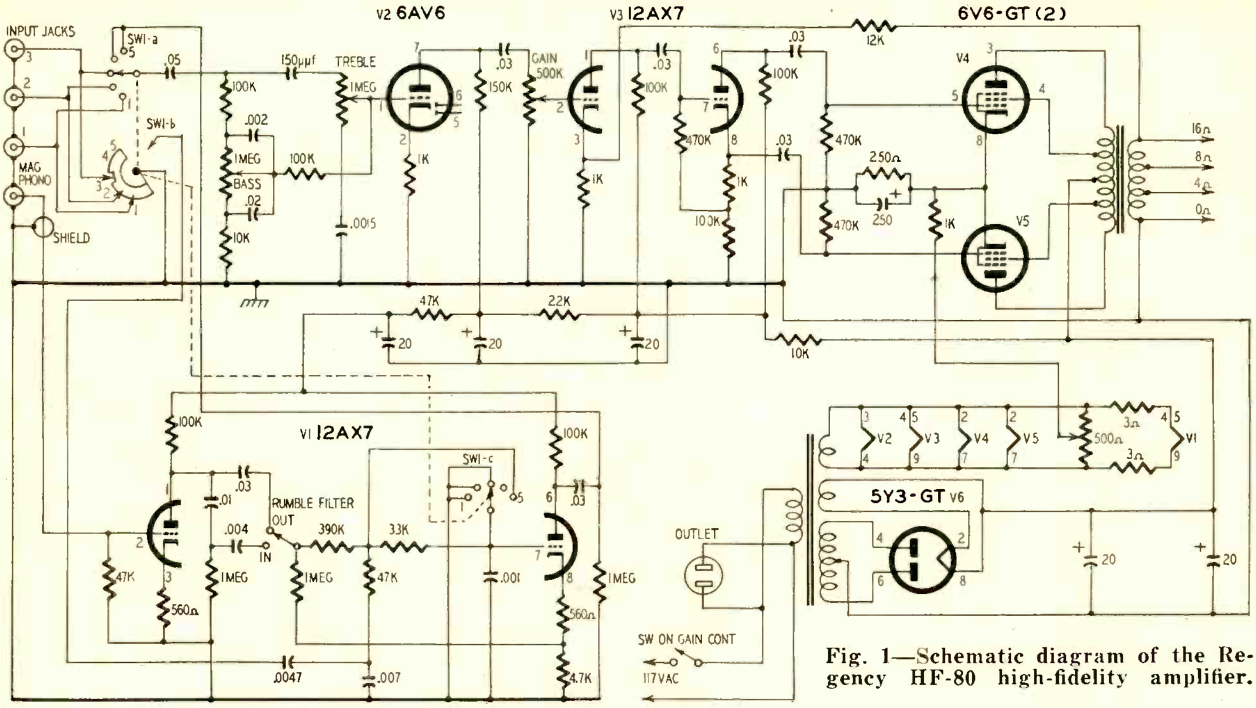


Fig. 1—Schematic diagram of the Regency HF-80 high-fidelity amplifier.

minals on a Cook 10-LP test record into a Heathkit a.c. v.t.v.m. The notable thing about the curve is the extreme linearity. The variations on the curve are largely variations on the test record which varies ±1 db at various points. You will note that response is down only 1.5 db at 15,000 cycles, 6 db at 17,000 and 8 db at 20,000. Measurements in the range above 10,000 cycles with test records are difficult since various effects due to groove loading may occur. However, it is an entirely safe assumption that the Pickering is at least as good as indicated on the curves and possibly a few db flatter beyond 15,000 cycles.

The linearity is borne out by the curves (Fig. 8) taken with a 27,000-ohm load on the pickup, at the output of a preamplifier. To be sure, such curves are measures of the equalizer as well as the pickup. Nevertheless, they indicate the results which proper equalization can deliver. Again the linearity is very notable. The rise between 10 and 12 kc is not significant and probably represents the result of needle coupling to the grooves on this specific record. This coupling can vary with different record materials and even from day to day on the same record.

The curves speak for themselves. The only thing I need add is this: The sound of the Pickering in the high-high end—beyond 10,000 cycles especially—is exceptionally clean, smooth and sweet. Thoroughly pleasant to listen to, it is free of shrillness when used with tweeters which are themselves clean and sweet. I have used the pickup with several amplifiers and a number of speakers and, as near as I can determine, the pickup has no influence on the character of the high-highs, which will be determined by the characteristics of the tweeter. On clean records, even those which have been played scores of times with diamond points at low pressures, I found no need for rolloffs. Indeed, it is possible to boost the high end severely and still maintain a clean, sweet sound. This is by no means true of all wide-range cartridges.

I made no measurements at 78 r.p.m. (my available test records stop at 10,000 cycles and up to that point the response was almost an exact duplicate of the microgroove cartridge). But listening tests reveal an exceptionally fine quality and a gratifyingly low scratch level, excellent evidence of a smooth, flat response free from peaks. Clearly the Pickering belongs in the top category of pickups and I can't imagine anyone, even the goldenest ear, being unhappy with it. Models 220 and 240 are available separately for 78- and 45–33⅓-r.p.m. records, respectively.

I was able to test the cartridges not only in my tone arms but also in the new Pickering arm (see photo). It is a worthy complement to the cartridges, makes no difference in the quality of reproduction, and is very convenient to mount and to use.

It provides an adjustment for the height over the record. With most cartridges this adjustment can be made so that the needle will just miss the turntable when no record is on it and yet provide good tracking with a record. Pressure is adjustable with a knurled knob underneath the arm (but above the turntable), and the adjustment can be easily made. Incidentally the cartridges tracked with as little as 3 grams, though 5 or 6 grams seem optimum and produce least distortion.

The arm is made in two sections, rather like the G-E in principle. The cartridge mounts on a light small front section with very low vertical friction. In lifting the pickup off the record, only the cartridge and its mount are raised; the arm remains fixed. The vertical loading is therefore very slight and the arm will track extremely warped records with no difficulty whatever and practically no risk of damaging either record or needle.

The whole arm moves horizontally on fine bearings and has a large counterweight at the rear which tends to damp out resonances, maintains a uniform

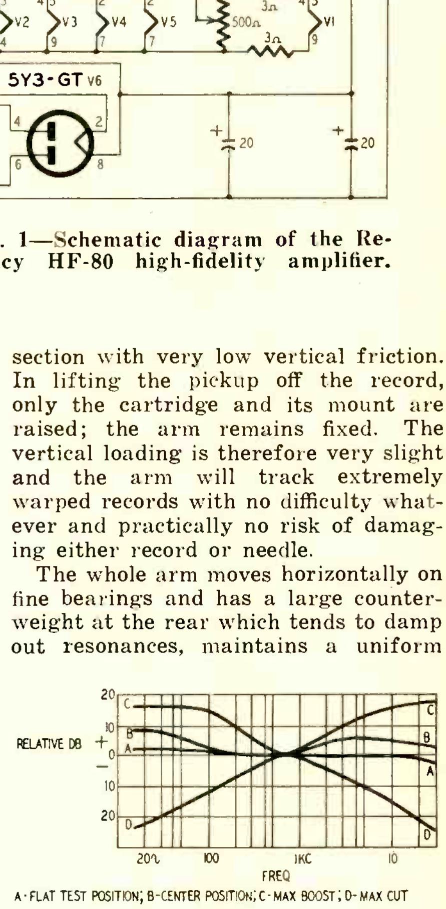


Fig. 2—Range of bass–treble controls.

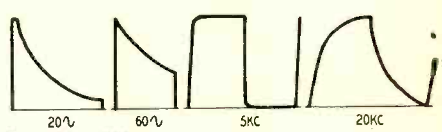


Fig. 3—HF-80 square-wave responses.

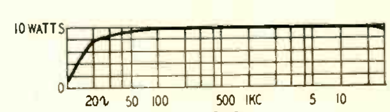


Fig. 4—Power output curve of HF-80.

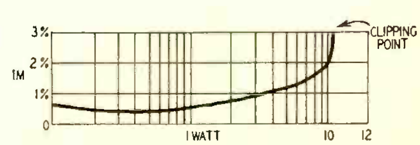


Fig. 5—Distortion curve of the HF-80.

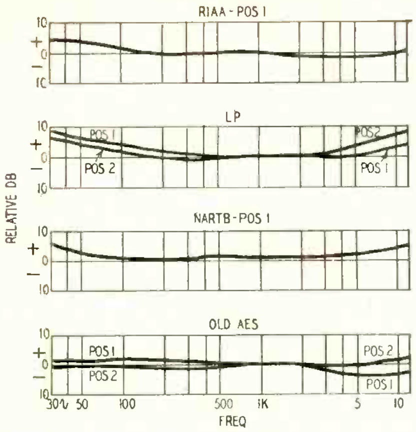


Fig. 6—Response of the phono channel.

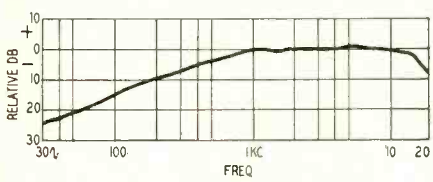


Fig. 7—Response of Pickering cartridge.

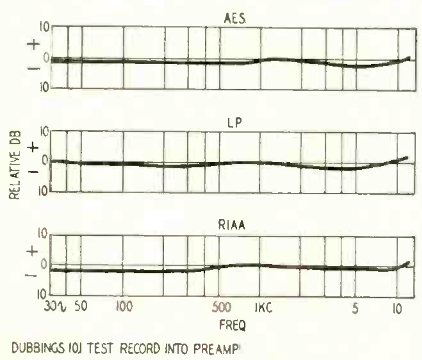
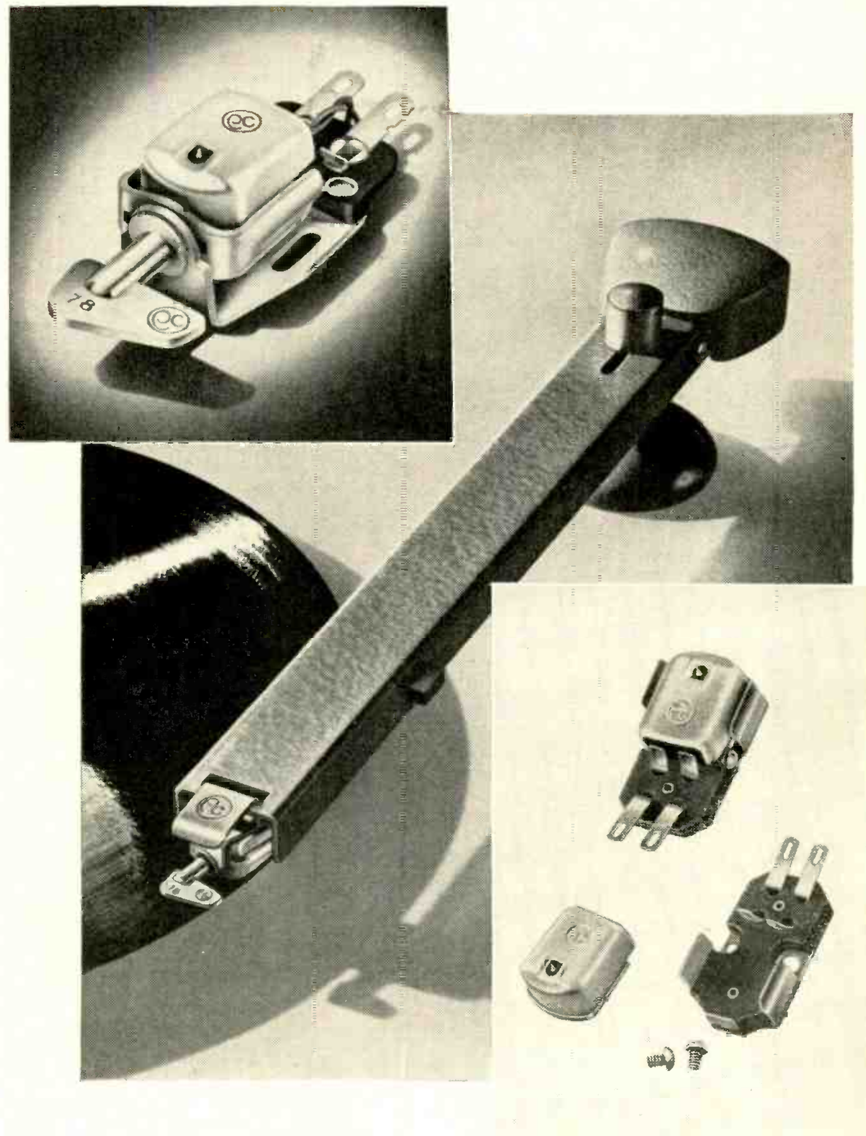


Fig. 8—Curves of the Pickering cartridge at the preamplifier output.



The Pickering turnover cartridge (top left) installed in its arm (center). At right below, single-unit cartridges are also available, with 1- or 3-mil styli.

rhythm of movement as the arm travels toward the inside, offers considerable resistance to violent movement imparted by shock vibration, etc. The arm mounts with three screws which can be adjusted to level the arm. The method of holding the arm in the rest position is very clever and convenient. A small bar magnet mounted on the arm attracts it to the "holder" post and keeps it there firmly enough to resist any but the most violent accidental shock. The arm can be used with various other cartridges in permanent or slide mounting.

New records

NOTE: Practically all American records pressed since Sept. 1, 1954, use the standard RIAA curve or some modification of it which will be equalized to within 1 db by an RIAA equalizer. They can be equalized on the bass end exactly by the new RIAA equalizer and very closely with either the LP, NARTB or AES equalizer. Treble equalization is identical with the RCA ORTHO and calls for a slope of 13.7 db at 10,000 cycles. An LP treble equalizer will be −2 db at 10,000 cycles and an AES will be +2 db at the same point. The departures at intermediate points will be smaller. Therefore, in a pinch the new records can be equalized within 1 or 2 db by almost any of the four American playback curves: LP, NARTB, AES or ORTHO. Henceforth in my reviews I will not mention the recording curves unless the specific recording departs from the RIAA.

An Adventure in High Fidelity
RCA Victor LM-1802

RCA Victor left the pioneering in high-fidelity test records to others. But having at last risen to the challenge, it gives us a really remarkable test recording. Here in one disc is just about everything one needs to test, demonstrate or show off any high-fidelity system.

It starts with *An Adventure in High Fidelity*, a special composition by Robert Russell Bennett. Whatever one may think of it as music, it is certainly deliberately composed to bring out almost every possible hi-fi effect. The second band, *The Orchestra in a Nutshell*, is a unique test of realism and naturalness, presenting most of the instruments of the orchestra in solo passages from the *Nutcracker Suite*, ending with a short but very fine demonstration of the percussives. The recording of the instruments is extremely faithful to the natural sound and, given a low enough noise level, one can hear not only the characteristic tone of each instrument but often many of the noises which accompany its production. Listen especially for the valving and breathing of the tuba player.

The first band on side B presents an excellent test for frequency range. It gives three switch bands, each succeeding one having a narrower bandwidth. Each test starts with a fast sweep of sine waves over the range covered. This is followed by a portion of *Adventure in High Fidelity* reproduced in the same bandwidth. A comparison of the effect of the three bands will quickly reveal the real range of any system and also demonstrate the difference between hi-fi and ordinary reproduction. However, the comparison is somewhat unfair to hi-fi since the 200–5,000-

cycle band still maintains the excellent definition and low distortion of the previous higher-fidelity bands. No table radio sounds like that.

The second band is of solo voices, also extremely natural. Finally there are some selections of popular music concluding with *Eddie and the Witch Doctor* by the Sauter-Finnegan group, unquestionably the most terrific recording of percussion instruments so far put on discs and a severe test of transient response. Here we have not only the drums and other percussives individually and en masse, but we have them in counterpoint four or five layers deep. If on your system you can discern the separate drums throughout, even when they are layered, you can be sure that your system has a fine transient response and is free from hangover.

The record's only marring note is a rumble, apparently from the cutting lathe; but the result would be cheap at the price of several times the rumble. For an extra premium RCA includes a foam-rubber turntable pad and a well written and illustrated brochure.

BACH: *Concerto for Three Harpsichords, Nos. 1 and 2*
Concerto for Four Harpsichords in A Minor
Pro Musica String Orchestra of Stuttgart — Vox PL 8670

The harpsichord is a fine instrument for testing both the dynamic range and frequency response of a system. The low amplitude of the tone and the high proportion of various noises require a very low hum and noise level for really faithful and natural reproduction. Furthermore, to bring out the wonderful color of the harpsichord's tone, the frequency response must be flat and the equipment free of distortion so that the harmonic structure is not altered. Finally, the semipercussive quality requires a good transient response, while the slight overhang requires great freedom from wow. It is difficult, therefore, to reproduce one harpsichord perfectly.

Put three or four harpsichords together and you will severely try the mettle of any system. Harpsichords differ from one another much less than pianos, at least to the listener, and recognizing any specific harpsichord calls for a very discriminating ear. When you get three or four of them playing together and in the counterpoint of Bach, you need a very, very fine ear. Needless to say, you need as a prerequisite first a recording good enough to define the difference and, second, a reproducing system which maintains the definition. This recording meets the first condition. The rest is up to your system and your ears. If, after listening several times, you can hear the separate harpsichords in this record and, better yet, more or less count them and tell them apart, you can stop haunting the hi-fi shops and start haunting stamp dealers because they just don't make no better systems no more.

Oedipus
Music by Harry Partch
The Gate 5 Ensemble and Solo Voices

Available from Gate 5 Ensemble, Box 387, Marin City, Calif.
Two 12-inch LP records. $13, including packing. AES curve.

In one of the first of these columns, I reviewed *Plectra and Percussion Dances* by the same composer and ensemble, one of the most remarkable and astonishing records I have ever heard. Now the same outfit has recorded Mr. Partch's masterpiece, the musical background to a version of *Oedipus* performed some years ago at Mills College in Oregon. A large portion of this record consists of voices reciting or singing, as you prefer to name it, the text of the play. In the background—along with the Greek Chorus—the Gate 5 Ensemble plays the unusual music on the equally remarkable and unique instruments including cloud chamber bowls, kitharas, adapted cellos, chromelodeons and marimba eroica. The music illustrates and paints up the play with wonderful appropriateness since its 42-tone-to-the-octave scale is similar to, though more complicated than, the Greek scale used in the time of Oedipus. It is impossible to describe the effect.

But the fact most likely to make this album worth its price to anyone owning a system capable of reproducing to 30 cycles or lower is that it has the finest genuine 31-cycle note on records, played by something called a marimba eroica. Given some bass boost or loudness control, the note will not only jar the china but any loose joints in the house. It is found best on the last of the four sides in the climax and finale. Nothing—not even the best organ records I have been able to lay my hands on—can compare with this 31-cycle note.

MOUSSORGSKY-RAVEL: *Pictures at an Exhibition*
Arturo Toscanini and the NBC Orchestra — RCA Victor LM-1383

This record demonstrates as no other recording the mastery of music and instruments of that incomparable and now, alas, defunct combination, Toscanini and the NBC Orchestra. This is not only, in my opinion, the finest and most spectacular version of this music, but all things considered (music, artists and recording) one of the finest recordings ever made. Moreover, it is one of the best demonstration and showoff records you can buy, if not the very best. It is so good, from its awe-inspiring bass to its clean and sharp highs, its very notable freedom from hangover and very fine inherent transient quality, that every time I hear it again I want to bow eastward in the direction of Camden, N. J. This is an absolute must for everybody from plain music lover to hi-fi addict. And if you have to go without lunch for a week to buy it, I can't think of anything better worth the sacrifice.

OFFENBACH: *Gaité Parisienne*
Boston Pops Orchestra with Arthur Fiedler — RCA Victor LM-1817

The quest for high-fidelity effects can produce some weird ones and this is one of the most conspicuous examples. If it is high-highs—the shimmer of struck and brushed cymbals, violently shaken tambourines, tinkling triangles, etc.—you want, here is a good half-hour and more in which not over 60 to 90 seconds lacks some example of high-high jinks! What's more it is a notably clean job of presenting them. Those whose systems have that "nice clean silky high end" will welcome this disc. As a demonstration piece of high-highs it is almost incomparable.

Unfortunately for those who like some music wtih their hi-fi, somebody overlooked the other end with a very sad effect. There is a modicum of bass. But those who know the music will recall the fine bass beat which accompanies the kicks of the can-cans and they will scarcely believe their ears when hearing this. Indeed, they may conclude that something has happened to the bass end of their system or the equalizers or the speakers. I hasten to reassure therefore: such fears are groundless. Apparently the boys behind the glass window were so intent on getting those high-highs in the groove they forgot the bass or were too busy to bother with it. In one spot they do show for a moment what they could have done if they'd happened to think of it. Otherwise this is one of the most lopsided pieces of music you're likely to hear. Recommended only for hi-fi shops; those who want the music are referred to several better balanced versions on other labels.

ORFF: *Catulia Carmina*
Vienna Kammerchor — Vox PL 8640

STRAVINSKY: *Les Noces, Mass, etc.*
N. Y. Concert Choir and N. Y. Concert Orchestra
Conducted by Margaret Hillis — Vox PL 8630

Because we hear voices every day and live music infrequently, well recorded choir works make excellent show-off records. These two are on the spectacular side and offer, beside the voices, some brilliant percussive effects in the orchestral background to delight the high-high addicts. Though one was recorded in Europe and the other in New York, the effects are similar and a casual listener might well suppose both were recorded by the same combination.

Both are excellent from the choral point of view, with fine definition and naturalness of voices. Played at moderately loud levels either one will bring the choir right into the house. And with the help of the texts which come with the records it is easy to follow and understand the voices even when they are massed. The Stravinsky has an excellent, sharply percussive piano and some chain-rattling effects. The Orff has brilliant triangles, etc. Both have the typically excellent Vox bass. The Stravinsky works are important in the history of modern music; the Orff is one of the recordings of a unique modern composer. Therefore, both should be of interest to musical students.

Caution: Very proficient students of college Latin will get the shock of their lives if they follow the Latin words of the Orff piece. Parents of brilliant high-school Latin scholars are urged to play this only when their offspring are in bed or out of the house and not to play it when the parish priest is around either. There are words here not fit for either young or pious ears. The text is based on the famous love poems of the Roman poet, Catallus.

STRAVINSKY: *The Rite of Spring*
Steinberg and the Pittsburgh Symphony — Capitol P-8254

Capitol has been improving its techniques, getting away from that dead, soundstage sound (sometimes called West Coast sound). This one is one of the very best of the new line labeled Incomparable High Fidelity. Most hi-fi addicts will quarrel with the claim because there are many other recordings with more spectacular hi-fi effects. In any case this is one of the most unusual modern pieces of music, recorded with great justice. However, these latest Capitol releases, for some reason I ken not, have a higher noise level than they used to.

PROKOFIEFF: *Chout*
DE FALLA: *Dances from the Three Cornered Hat*
Golschmann and the St. Louis Symphony — Capitol P-8257

I liked these very much. The Prokofieff work, very seldom heard, presents the composer at his humorous best in spots. The De Falla *Dances* have been recorded many times, in several instances more spectacularily. However, both sides provide good listening and sound good on good systems.

STARLIGHT CONCERT
Carmen Dragon and the Hollywood Symphony — Capitol P-8276

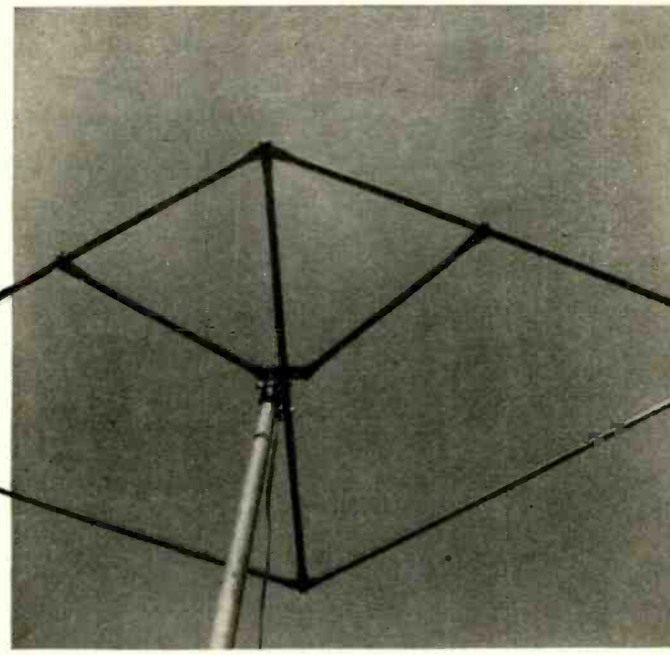
AN ENCHANTED EVENING
Mantovani and His Orchestra — London LL 766

MANTOVANI PLAYS ROMBERG
Mantovani and His Orchestra — London LL 1031

Most good hi-fi demonstration and show-off records are either loud, strident or very modern, and often all three. Many people just plain don't like the sound, even on the finest system. On the other hand, pleasant, soft and harmonic classical music usually has little material with which to test the capabilities of a system or to demonstrate its superior qualities. Hence easy-listening demonstration records are very scarce and whenever I come upon one I make sure to mention it. The above three are all recommended. None has especially spectacular demonstration or show-off material, but any will show off both ends of the range, as well as definition and naturalness.

The Carmen Dragon record is a potpourri of various classical favorites ranging from the *Flight of the Bumblebee* to *Pomp and Circumstance*. Since the music is varied, the various section of the orchestra, including the percussives, get a workout. Mantovani's sharp high strings are a trademark and provide an excellent measure of clean high-end response. Both the above examples are clean enough not to require any rolloffs, even when played with pickups absolutely flat to 20,000. They show the master at his best and with the kind of music most people like most. END

Simple TV/FM Antenna



Closeup shows construction of antenna.

Folded dipoles give broad-band wide-range pickup

By PAUL F. LOVELESS

MOST TV and FM antenna systems installed in primary and secondary areas are more complicated than necessary. This article describes a simple unit that has been used for some time. It is mechanically stable with no loose ends to cause vibration.

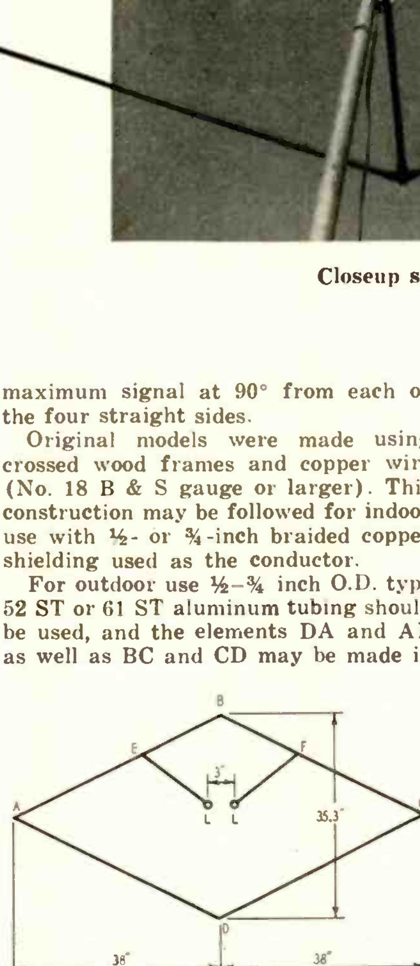
At first glance (see diagram and photo) it appears to be a rhombic, but a closer inspection will show two expanded folded dipoles. Elements AB, BC, CD and DA are each three-quarter wavelength for channel 12, and together equal approximately one wavelength for channel 4. Elements EB, BF, FL and LE are each one-quarter wavelength for channel 8. Since the 300-ohm lead-in is attached at L–L the result is a system which will operate as three full wavelengths on channel 12, one full wavelength on channel 8 and one full wavelength on channel 4, thus giving good coverage throughout the v.h.f. band.

The dimensions are: AB, BC, CD and DA: 42.75 inches each; EB, BF, FL and LE: 16.1 inches each. The diagonal or boom BD is 35.3 inches, and diagonal BL is approximately 13.3 inches. This will vary with the insulator spacing between points L–L, approximately 3 inches. These diagonal lengths are very critical for best results.

As shown in the photo the array is mounted in a horizontal plane and provides a usable 360° pickup pattern with maximum signal at 90° from each of the four straight sides.

Original models were made using crossed wood frames and copper wire (No. 18 B & S gauge or larger). This construction may be followed for indoor use with ½- or ¾-inch braided copper shielding used as the conductor.

For outdoor use ½–¾ inch O.D. type 52 ST or 61 ST aluminum tubing should be used, and the elements DA and AB as well as BC and CD may be made in one piece and bent at points A and C, respectively.



Layout of the broadband antenna.

As shown in the photo, points B and D are bolted directly to supporting boom BD, to which is also attached the terminating insulator for points L–L. A strip of electrical grade linen-base Bakelite was used for the insulator, but Lucite or "Poly" will serve.

The elements were flattened in a vise for a distance of 2 inches from either end, drilled and bolted to the boom which was also flattened and drilled at points B and D. Aluminum clamps or straps should be used at points E and F because drilling the longer elements would tend to weaken them.

This antenna, located at Ithaca, N. Y., in the hilly Finger Lakes region, gives excellent results on channels 3 and 8 from Syracuse, 45 miles, and channel 12 from Binghamton, 40 miles, without a booster.

These transmitters are located at points approximately 90° apart from our receiver location, thus proving the wide-angle pickup of this array.

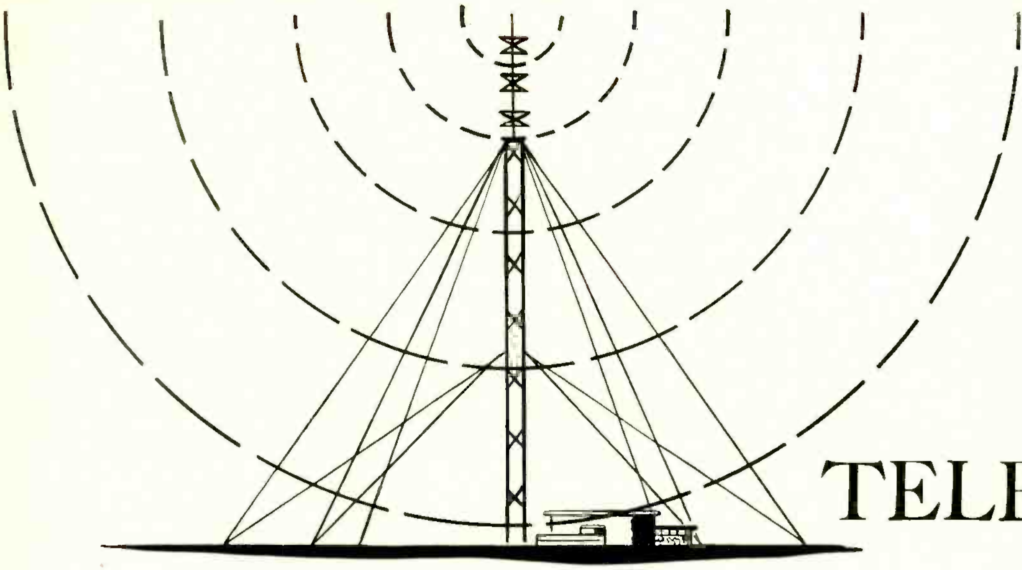
For a single channel use the layout ABCD and insert the insulator at point B or D. In this case the 300-ohm lead-in should be attached to the two insulated or open ends, and elements EL and LF are omitted.

Excellent FM reception may be obtained using the figure ABCD with element lengths of 28.25 inches and a diagonal or boom (BD) length of 23.3 inches.

For any given frequency the element lengths may be calculated as follows: One-quarter wavelength (in inches) = $\frac{2.770}{f \text{ in mc}}$. The length of the diagonal equals 0.825 times the element length.

In installing the finished array it is important to select location and orientation to give best results on the weaker high-frequency channels 8 and 13, as even a few inches change in position at the higher frequencies may result in either maximum or minimum signal levels.

For a broad-banded system this unit is ideal and requires no rotor. A short time spent in constructing it should convince even the most skeptical. END



TELEVISION

Alabama

WABT	Birmingham	13
WBRC-TV	Birmingham	6
WMSL-TV	Decatur	23
WTVY	Dothan	9
WALA-TV	Mobile	10
WCOV-TV	Montgomery	20
WSFA-TV	Montgomery	12
WEDM	Munford	7

Alaska

KENI-TV	Anchorage	2
KTVA	Anchorage	11
KFAR-TV	Fairbanks	2
KTVF	Fairbanks	11

Arizona

KVAR	Mesa (Phoenix)	12
KOOL-TV	Phoenix	10
KPHO-TV	Phoenix	5
KTVK	Phoenix	3
KOPO-TV	Tucson	13
KVOA-TV	Tucson	4
KIVA	Yuma	11

Arkansas

KFSA-TV	Fort Smith	22
KARK-TV	Little Rock	4
KATV	Pine Bluff	7

California

KBAK-TV	Bakersfield	29
KERO-TV	Bakersfield	10
KHSL-TV	Chico	12
KIEM-TV	Eureka	3
KJEO	Fresno	47
KMJ-TV	Fresno	24
KABC-TV	Los Angeles	7
KHJ-TV	Los Angeles	9
KCOP	Los Angeles	13
KNXT	Los Angeles	2
KRCA	Los Angeles	4
KTLA	Los Angeles	5
KTTV	Los Angeles	11
KMBY-TV	Monterey	8
KBET-TV	Sacramento	10
KCCC-TV	Sacramento	40
KSBW-TV	Salinas	8
KFMB-TV	San Diego	8
KFSD-TV	San Diego	10
KGO-TV	San Francisco	7
KPIX	San Francisco	5
KQED	San Francisco	9
KRON-TV	San Francisco	4
KSAN-TV	San Francisco	32
KVEC-TV	San Luis Obispo	6
KEYT	Santa Barbara	3
KOVR	Stockton	13
KTVU	Stockton	36
KVVG	Tulare	27

Colorado

KKTV	Colorado Springs	11
KRDO-TV	Colorado Springs	13
KBTV	Denver	9
KFEL-TV	Denver	2
KLZ-TV	Denver	7
KOA-TV	Denver	4
KFXJ-TV	Grand Junction	5
KCSJ-TV	Pueblo	5

Connecticut

WICC-TV	Bridgeport	43
WGTH-TV	Hartford	18
WKNB-TV	New Britain	30
WNHC-TV	New Haven	8
WATR-TV	Waterbury	53

Delaware

WDEL-TV	Wilmington	12

District of Columbia

WMAL-TV	Washington	7
WRC-TV	Washington	4
WTOP-TV	Washington	9
WTTG	Washington	5

Florida

WITV	Fort Lauderdale	17
WINK-TV	Fort Myers	11
WJHP-TV	Jacksonville	36
WMBR-TV	Jacksonville	4
WGBS-TV	Miami	23
WTVJ	Miami	4
WDBO-TV	Orlando	6
WJNO-TV	Palm Beach	5
WJDM	Panama City	7
WPFA-TV	Pensacola	15
WEAR-TV	Pensacola	3
WSUN	St. Petersburg	38
WFLA-TV	Tampa	8
WTVT	Tampa	13
WEAT-TV	W. Palm Beach	12
WIRK-TV	W. Palm Beach	21

Georgia

WALB-TV	Albany	10
WAGA-TV	Atlanta	5
WLWA	Atlanta	11
WQXI-TV	Atlanta	36
WSB-TV	Atlanta	2
WJBF	Augusta	6
WRDW-TV	Augusta	12
WDAK-TV	Columbus	28
WRBL-TV	Columbus	4
WMAZ-TV	Macon	13
WNEX-TV	Macon	47
WROM-TV	Rome	9
WTOC-TV	Savannah	11

Hawaii

KHBC-TV	Hilo	9
KGMB-TV	Honolulu	9
KONA	Honolulu	11
KULA-TV	Honolulu	4
KMAU	Wailuku	3

Idaho

KIDO-TV	Boise	7
KID-TV	Idaho Falls	3
KBOI-TV	Meridian	2

Illinois

WBLN	Bloomington	15
WCIA	Champaign	3
WBBM-TV	Chicago	2
WBKB	Chicago	7
WGN-TV	Chicago	9
WNBQ	Chicago	5
WDAN-TV	Danville	24
WTVP	Decatur	17
WSIL-TV	Harrisburg	22
WEEK-TV	Peoria	43
WTVH-TV	Peoria	19
WGEM-TV	Quincy	10
WREX-TV	Rockford	13
WTVO	Rockford	39
WHBF-TV	Rock Island	4
WICS	Springfield	20

Indiana

WTTV	Bloomington	4
WSJV	Elkhart	52
WFIE	Evansville	62
WKJG-TV	Fort Wayne	33
WFBM-TV	Indianapolis	6
WISH-TV	Indianapolis	8
WFAM-TV	Lafayette	59
WLBC-TV	Muncie	49
WSBT-TV	South Bend	34
WTHI-TV	Terre Haute	10
WINT	Waterloo-Ft. Wayne	15

Iowa

WOI-TV	Ames	5
KCRG-TV	Cedar Rapids	9
WMT-TV	Cedar Rapids	2
WOC-TV	Davenport	6
WHO-TV	Des Moines	13
KQTV	Fort Dodge	21
KGLO-TV	Mason City	3
KTIV	Sioux City	4
KVTV	Sioux City	9
KWWL-TV	Waterloo	7

Kansas

KCKT	Great Bend	2
KTVH	Hutchinson	12
KOAM-TV	Pittsburg	7
WIBW-TV	Topeka	13
KAKE-TV	Wichita	10
KEDD	Wichita	16

Kentucky

WEHT	Henderson	50
WLEX-TV	Lexington	18
WHAS-TV	Louisville	3
WAVE-TV	Louisville	11

Lousiana

KALB-TV	Alexandria	5
WAFB-TV	Baton Rouge	28
WBRZ	Baton Rouge	2
KPLC-TV	Lake Charles	7
KTAG-TV	Lake Charles	25
KNOE-TV	Monroe	8
WDSU-TV	New Orleans	6
WJMR-TV	New Orleans	61
KSLA	Shreveport	12

Maine

WABI-TV	Bangor	5
WTWO	Bangor	2
WMTW	Poland Spring	8
WCSH-TV	Portland	6
WGAN-TV	Portland	13

Maryland

WMAR-TV	Baltimore	2
WAAM	Baltimore	13
WBAL-TV	Baltimore	11
WBOC-TV	Salisbury	16

Massachusetts

WMGT	Adams-Pittsfield	19
WBZ-TV	Boston	4
WGBH-TV	Boston	2
WNAC-TV	Boston	7
WTAO-TV	Cambridge	56
WHYN-TV	Holyoke	55
WWLP	Springfield	61
WWOR-TV	Worcester	14

Michigan

WPAG-TV	Ann Arbor	20
WNEM-TV	Bay City-Saginaw	5
WWTV	Cadillac	13
WJBK-TV	Detroit	2
WWJ-TV	Detroit	4
WXYZ-TV	Detroit	7
WKAR-TV	East Lansing	60
WOOD-TV	Grand Rapids	8
WKZO-TV	Kalamazoo	3
WILS-TV	Lansing	54
WJIM-TV	Lansing	6
WKNX-TV	Saginaw	57
WPBN-TV	Traverse City	7

Minnesota

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

Mississippi

WJTV	Jackson	25
WLBT	Jackson	3
WSLI-TV	Jackson	12
WTOK-TV	Meridian	11

Missouri

KFVS-TV	Cape Girardeau	12
KOMU-TV	Columbia	8
KHQA-TV	Hannibal	7
KRCG	Jefferson City	13
KSWM-TV	Joplin	12
KCMO-TV	Kansas City	5
KMBC-TV	Kansas City	9
WDAF-TV	Kansas City	4
KDRO-TV	Sedalia	6
KTTS-TV	Springfield	10
KYTV	Springfield	3
KFEQ-TV	St. Joseph	2
KETC	St. Louis	9
KSD-TV	St. Louis	5
KWK	St. Louis	4
KTVI	St. Louis	36

Montana

KOOK-TV	Billings	2
KXLF-TV	Butte	6
KFBB-TV	Great Falls	5
KGVO-TV	Missoula	13

Nebraska

KHOL-TV	Kearney	13
KOLN-TV	Lincoln	10
KUON-TV	Lincoln	12
KMTV	Omaha	3
WOW-TV	Omaha	6

This list of United States and Canadian stations has been checked and verified with all possible sources, but may still not be perfect. We will be grateful for any corrections or additions from authoritative sources.

STATION LIST*

*To April 18, 1955

Nevada

KLRJ-TV	Henderson	2
KLAS-TV	Las Vegas	8
KZTV	Reno	8

New Hampshire

WMUR-TV	Manchester	9

New Jersey

WATV	Newark	13

New Mexico

KGGM-TV	Albuquerque	13
KOAT-TV	Albuquerque	7
KOB-TV	Albuquerque	4
KSWS-TV	Roswell	8

New York

WROW-TV	Albany	41
WNBF-TV	Binghamton	12
WBEN-TV	Buffalo	4
WBUF-TV	Buffalo	17
WGR-TV	Buffalo	2
WCNY-TV	Carthage-Watertown	7
WTVE	Elmira	24
WABC-TV	New York	7
WABD	New York	5
WCBS-TV	New York	2
WOR-TV	New York	9
WPIX	New York	11
WRCA-TV	New York	4
WKNY-TV	Kingston	66
WIRI	Plattsburg	5
WHAM-TV	Rochester	5
WHEC-TV	Rochester	10
WVET-TV	Rochester	10
WRGB	Schenectady	6
WHEN-TV	Syracuse	8
WSYR-TV	Syracuse	3
WKTV	Utica	13

North Carolina

WISE-TV	Asheville	62
WLOS-TV	Asheville	13
WUNC-TV	Chapel Hill	4
WBTV	Charlotte	3
WTVD	Durham	11
WFMY-TV	Greensboro	2
WNCT	Greenville	9
WNAO-TV	Raleigh	28
WMFD-TV	Wilmington	6
WSJS-TV	Winston-Salem	12
WTOB-TV	Winston-Salem	26

North Dakota

KFYR-TV	Bismarck	5
WDAY-TV	Fargo	6
KCJB-TV	Minot	13
KXJB-TV	Valley City	4

Ohio

WAKR-TV	Akron	49
WICA-TV	Ashtabula	15
WCET	Cincinnati	48
WCPO-TV	Cincinnati	9
WKRC-TV	Cincinnati	12
WLWT	Cincinnati	5
WEWS	Cleveland	5
WNBK	Cleveland	3
WXEL	Cleveland	8
WBNS-TV	Columbus	10
WLWC	Columbus	4
WTVN-TV	Columbus	6
WHIO-TV	Dayton	7
WLWD	Dayton	2
WLOK-TV	Lima	73
WSTV-TV	Steubenville	9
WSPD-TV	Toledo	13
WFMJ-TV	Youngstown	21
WKBN-TV	Youngstown	27
WHIZ-TV	Zanesville	18

Oklahoma

KTEN	Ada	10
KGEO-TV	Enid	5
KSWO-TV	Lawton	7
KTVX	Muskogee	8
KTVQ	Oklahoma City	25
KWTV	Oklahoma City	9
WKY-TV	Oklahoma City	4
KOTV	Tulsa	6
KVOO-TV	Tulsa	2

Oregon

KVAL-TV	Eugene	13
KBES-TV	Medford	5
KLOR	Portland	12
KOIN-TV	Portland	6
KPTV	Portland	27

Pennsylvania

WFBG-TV	Altoona	10
WLEV-TV	Bethlehem	51
WGLV	Easton	57
WICU	Erie	12
WSEE	Erie	35
WCMB-TV	Harrisburg	27
WHP-TV	Harrisburg	55
WTPA	Harrisburg	71
WARD-TV	Johnstown	56
WJAC-TV	Johnstown	6
WGAL-TV	Lancaster	8
WCAU-TV	Philadelphia	10
WFIL-TV	Philadelphia	6
WPTZ	Philadelphia	3
KDKA-TV	Pittsburgh	2
WENS	Pittsburgh	16
WQED	Pittsburgh	13
WEEU-TV	Reading	33
WHUM-TV	Reading	61
WARM-TV	Scranton	16
WGBI-TV	Scranton	22
WTVU	Scranton	73
WBRE-TV	Wilkes-Barre	28
WILK-TV	Wilkes-Barre	34
WNOW-TV	York	49
WSBA-TV	York	43

Puerto Rico

WAPA-TV	San Juan	4
WKAQ-TV	San Juan	2

Rhode Island

WJAR-TV	Providence	10
WNET	Providence	16
WPRO-TV	Providence	12

South Carolina

WAIM-TV	Anderson	40
WCSC-TV	Charleston	5
WUSN-TV	Charleston	2
WCOS-TV	Columbia	25
WIS-TV	Columbia	10
WNOK-TV	Columbia	67
WBTW	Florence	8
WFBC-TV	Greenville	4
WGVL	Greenville	23

South Dakota

KELO-TV	Sioux Falls	11

Tennessee

WDEF-TV	Chattanooga	12
WJHL-TV	Johnson City	11
WATE	Knoxville	6
WTSK-TV	Knoxville	26
WHBQ-TV	Memphis	13
WMCT	Memphis	5
WLAC-TV	Nashville	5
WSIX-TV	Nashville	8
WSM-TV	Nashville	4

Texas

KRBC-TV	Abilene	9
WDXI-TV	Jackson	7
KFDA-TV	Amarillo	10
KGNC-TV	Amarillo	4
KTBC-TV	Austin	7
KBMT	Beaumont	31
KFDM-TV	Beaumont	6
KVDO-TV	Corpus Christi	22
KRLD-TV	Dallas	4
WFAA-TV	Dallas	8
KROD-TV	El Paso	4
KTSM-TV	El Paso	9
WBAP-TV	Fort Worth	5
KGUL-TV	Galveston	11
KGBT-TV	Harlingen	4
KPRC-TV	Houston	2
KTRK-TV	Houston	13
KUHT	Houston	8
KTVE	Longview	32
KCBD-TV	Lubbock	11
KDUB-TV	Lubbock	13
KMID-TV	Midland	2
KTXL-TV	San Angelo	8
KENS-TV	San Antonio	5
WOAI-TV	San Antonio	4
KCEN-TV	Temple	6
KCMC-TV	Texarkana	6
KLTV	Tyler-Longview	7
KANG-TV	Waco	34
KWTX-TV	Waco	10
KRGV-TV	Weslaco	5
KFDX-TV	Wichita Falls	3
KWFT-TV	Wichita Falls	6

Utah

KTVT	Salt Lake City	4
KSL-TV	Salt Lake City	5
KUTV	Salt Lake City	2

Vermont

WMVT	Montpelier	3

Virginia

WVEC-TV	Hampton-Norfolk	15
WSVA-TV	Harrisonburg	3
WLVA-TV	Lynchburg	13
WACH-TV	Newport News-Norfolk	33
WTAR-TV	Norfolk	3
WTVR	Richmond	6
WSLS-TV	Roanoke	10

Washington

KVOS-TV	Bellingham	12
KEPR-TV	Pasco	19
KCTS	Seattle	9
KING-TV	Seattle	5
KOMO-TV	Seattle	4
KHQ-TV	Spokane	6
KREM-TV	Spokane	2
KXLY-TV	Spokane	4
KTVW	Tacoma	13
KTNT-TV	Tacoma	11
KIMA-TV	Yakima	29

West Virginia

WCHS-TV	Charleston	8
WSAZ-TV	Huntington	3
WOAY-TV	Oak Hill	4
WTAP	Parkersburg	15
WTRF-TV	Wheeling	7

Wisconsin

WEAU-TV	Eau Claire	13
WBAY-TV	Green Bay	2
WKBT	La Crosse	8
WHA-TV	Madison	21
WKOW-TV	Madison	27
WMTV	Madison	33
WMBV-TV	Marinette	11
WXIX	Milwaukee	19
WTMJ-TV	Milwaukee	4
WTVW	Milwaukee	12
WSAU-TV	Wausau	7

Wyoming

KFBC-TV	Cheyenne	5

Canadian

CHCT-TV	Calgary, Alta.	2
CFRN-TV	Edmonton, Alta.	3
CBUT	Vancouver, B.C.	2
CKX-TV	Brandon, Man.	5
CBWT	Winnipeg, Man.	4
CKCW-TV	Moncton, N.B.	2
CHSJ-TV	St. John, N.B.	4
CBHT	Halifax, N.S.	3
CJCB-TV	Sydney, N.S.	4
CHCH-TV	Hamilton, Ont.	11
CKWS-TV	Kingston, Ont.	11
CKCO-TV	Kitchener, Ont.	13
CFPL-TV	London, Ont.	10
CBOT	Ottawa, Ont.	4
CHEX-TV	Peterborough, Ont.	12
CFPA-TV	Port Arthur, Ont.	2
CJIC-TV	Sault Ste. Marie, Ont.	2
CKSO-TV	Sudbury, Ont.	5
CBLT	Toronto, Ont.	9
CKLW-TV	Windsor, Ont.	9
CBFT	Montreal, Que.	2
CBMT	Montreal, Que.	6
CFCM-TV	Quebec City, Que.	4
CJBR-TV	Rimouski, Que.	3
CKCK-TV	Regina, Sask.	2
CFQC-TV	Saskatoon, Sask.	8

TV SIGNAL CIRCUIT FEEDBACK

Regeneration symptoms in i.f. and front-end circuits

By ROBERT G. MIDDLETON*

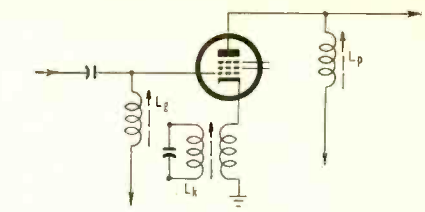


Fig. 1—Circuits containing cathode trap.

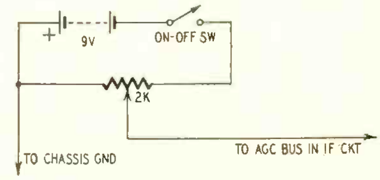


Fig. 2—Diagram of override bias box.

WHEN picture quality is impaired by feedback in the signal circuits, time is often wasted hunting for other possible sources of trouble. Feedback appears in various guises, ranging from symptoms of interference in the picture to fuzzy, blurred or smeary reproduction.

Misalignment is a common, but elusive, cause of feedback. A receiver was brought in with a complaint of poor picture quality and high-frequency interference. The stagger-tuned stages had been peaked to the specified frequencies indicated in the service data, hence it was supposed that the receiver was aligned.

Investigation of the complete signal-circuit response disclosed that the cathode trap (Fig. 1) had been tuned as an accompanying sound trap, instead of an adjacent-channel trap. This mistuning disturbed the circuit so that when L_g and L_p were peaked to their specified frequencies, the stage would oscillate weakly, causing picture disturbance.

In an arrangement like that in Fig. 1, the specified peaking frequencies may call for peaking L_g and L_p only 1 mc apart. Under usual circumstances the arrangement would oscillate because of tuned-plate–tuned-grid feedback. But trap L_k, when tuned within a suitable range, will effectively make L_p appear slightly capacitive, instead of inductive, thus converting positive feedback to negative, and effectively broadening the stage response. But if L_k should be mistakenly tuned to the other side of the channel, L_p will appear inductive and the stage will feed back positively.

Feedback symptoms

Although feedback usually shows up in the reproduction of picture and sound, the symptoms which appear during tests of the signal circuits with generator and scope are much more definite and provide more information concerning the source of the trouble. One of the most useful tests for feedback in the i.f. circuits can be made during i.f. alignment. After stagger-tuned coils and traps have been adjusted to their specified frequencies, reduce the grid bias to a very low value, using an override bias source (Fig. 2). As the bias approaches zero, the gain of the i.f. amplifier increases and the output from the sweep generator must be reduced to avoid overload. If feedback is present, it will then show up at low bias levels as a change in the shape and bandwidth of the response curve. If the feedback is substantial, the curve may collapse, indicating oscillation.

For this reason preliminary alignment of a receiver troubled by feedback should be made with a relatively high value of override bias, such as -6 volts. If a variable source of override bias is used, it is not necessary to open the a.g.c. line because the bias source has a low internal resistance, while that of a.g.c. bias line is relatively high. Hence the bias is determined by the voltage from the low-resistance source.

This test discloses the presence of feedback only in the a.g.c.-controlled stages. It frequently happens that feedback occurs in later i.f. stages which may operate at fixed bias. In such cases, other types of feedback tests must be made. One effective method consists of sliding a tube shield up and down over the i.f. tube in the suspected stage. If the stage is feeding back substantially, the shape of the i.f. response curve will change markedly as the shield is moved.

Regeneration can also be traced where the feedback is taking place from the last i.f. stage, or from the video detector, back to some earlier stage. The test setup shown in Fig. 3 permits the technician to determine the feedback loop. In this test, the scope is connected across the load resistor in the video-detector circuit, and the sweep output voltage from a sweep generator is applied through an isolating resistor R to the grid of the last i.f. tube. Resistor R is made as large as possible, the value being determined by the point at which the curve height on the scope screen begins to approach less than a satisfactory deflection. The result of this test setup is to develop the single-stage response of the last i.f. stage. But, because the sweep generator is driving the last i.f. tube through a high resistance, any feedback voltage present is able to proceed through the video detector. This is the essential feature of the arrangement.

To trace the feedback voltage, .01-μf capacitor C is shunted progressively from the grid of the second i.f. tube to chassis, from the grid of the first i.f. tube to chassis, from the grid of the mixer tube to chassis, etc. As each grid is bypassed successively in this manner, the technician watches for a change in height and shape of the response curve on the scope screen. Any change discloses the presence of regeneration and indicates that the test is being made within a feedback loop. When the bypassing moves out of the feedback loop, there will be no further changes in height or shape of the response curve.

It is thus easy to trace the feedback

*Field engineer, Simpson Electric Co.

loop in the receiver circuits, and the work of locating the faulty component is greatly eased. Without a feedback test, the job becomes hit or miss, and much more time is required to locate the faulty component.

The trouble may not be in the video i.f. amplifier; feedback trouble occurs occasionally in the sound i.f. amplifier. Here again, the type of test shown in Fig. 3 can be used to run down the feedback loop. In the sound i.f. amplifier, the scope is connected at the input of the de-emphasis network and the sweep signal applied through an isolating resistor to the grid of the sound i.f. limiter or driver tube. The bypass capacitor is then applied successively between grid and chassis of each preceding tube which carries the sound signal. It is surprising how at times the sound i.f. output voltage finds its way back to the front end of the receiver. Harmonics of the ratio-detector voltage may be picked up by front-end

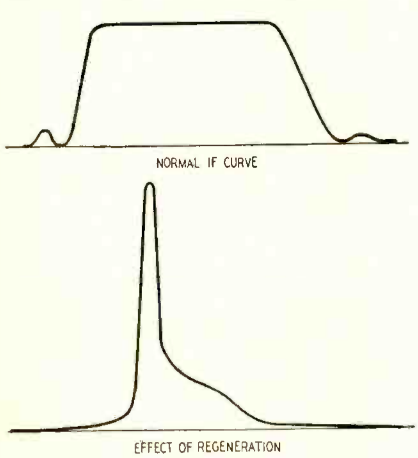


Fig. 4—Curves show effect of feedback.

circuits if shielding is not provided between the ratio detector and the front-end coils. In other cases a bias-clamp circuit is contained in the ratio detector, which may form harmonics of the sound signal that find their way back into the front end through the a.g.c. line. Better bypassing of the a.g.c. line will help clear this up.

Feedback affects i.f. response

Among other difficulties caused by feedback in the signal circuits is the inability to obtain the specified i.f. response curve. When feedback is severe, the response curve may show a very high peak (Fig. 4). Response curves of this type often separate sound and picture, with the picture appearing at one setting of the fine-tuning control and the sound making its appearance at another setting. This situation results from the fact that unless either the picture carrier or the sound carrier is run up on the curve, it will be greatly attenuated by the very low gain along the base line away from the narrow response curve.

Feedback in the ratio-detector circuit causes corresponding difficulties in obtaining a properly shaped S curve. Even if the circuits can be brought into satisfactory alignment at one signal level, the shape of the S curve will go to pieces as the output level from the sweep generator is varied. Instability of this sort is one of the outstanding symptoms of feedback in sound i.f. circuits.

Tracing regeneration

Since only one stage is usually being swept in a feedback test, and because

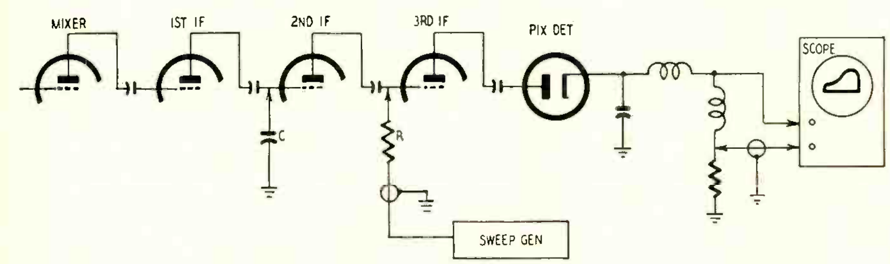


Fig. 3—Diagram of feedback test setup. Scope is connected across load resistor.

an isolating resistor or equivalent decoupling means must be used (Fig. 3), fairly high output from the sweep generator is desirable to obtain sufficient deflection on the scope screen. Even if the sweep generator output is relatively low, the instrument can often be used satisfactorily in regeneration tests if the scope has high vertical gain.

A scope for visual-alignment and regeneration-tracing applications should have high vertical sensitivity, a low-frequency response down to 20 cycles, and provision for 60-cycle sine-wave horizontal sweep.

Low-frequency response down to 20 cycles is required so that the scope will have good 60-cycle square-wave response. This may seem an odd requirement. However, a visual-response curve belongs to the same general family of waveforms as a 60-cycle square wave. In fact, when a four-stage i.f. amplifier is in good alignment, the resemblance of the response curve to a 60-cycle square wave is quite apparent. It is not true that a scope will have good 60-cycle square-wave response if the sine-wave response of the vertical amplifier extends down to 50 cycles. This is because the phase characteristic of the amplifier begins to become nonlinear before the frequency response drops off.

To maintain a linear phase characteristic through 60 cycles, it is necessary to extend the low-frequency response of the vertical amplifier down to approximately 20 cycles. Unless this is done, a 60-cycle square wave will tilt in reproduction and visual-response curves acquire the characteristics of reactive distortion—loops appear at the ends of the base line and the tops of trace and retrace are differently shaped.

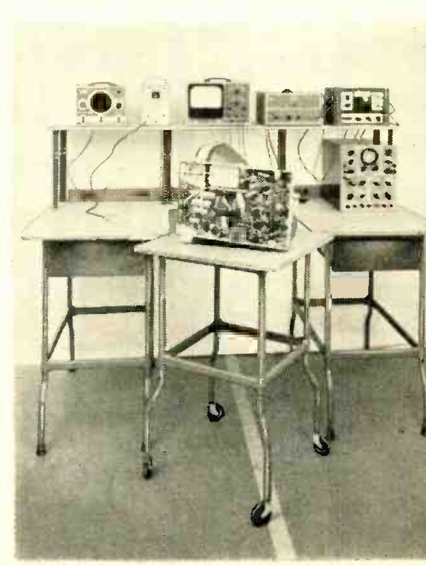
It is desirable to provide for 60-cycle sine-wave horizontal sweep in the scope because synchronizing problems are avoided. The sweep motor in a service sweep generator is almost always energized from a 60-cycle sine-wave voltage. If the horizontal sweep of the scope is also driven by a 60-cycle sine-wave voltage, the pattern will always lock in tightly on the screen, whether the output from the generator is reduced to zero or the output from the receiver falls to a very low value during circuit adjustments. END

NEW TV SERVICE BENCH

Virtually eliminating all chassis handling, a new television service bench has been designed having a movable center table (see photo). The bench, of wood and steel, is 72 inches long, 36 inches deep and 36 inches high. It has two deep drawers for tools.

The back panel is equipped with five double outlets, a master switch and a safety indicator light that glows when the power is on. The upper shelf is intended for holding the necessary test equipment.

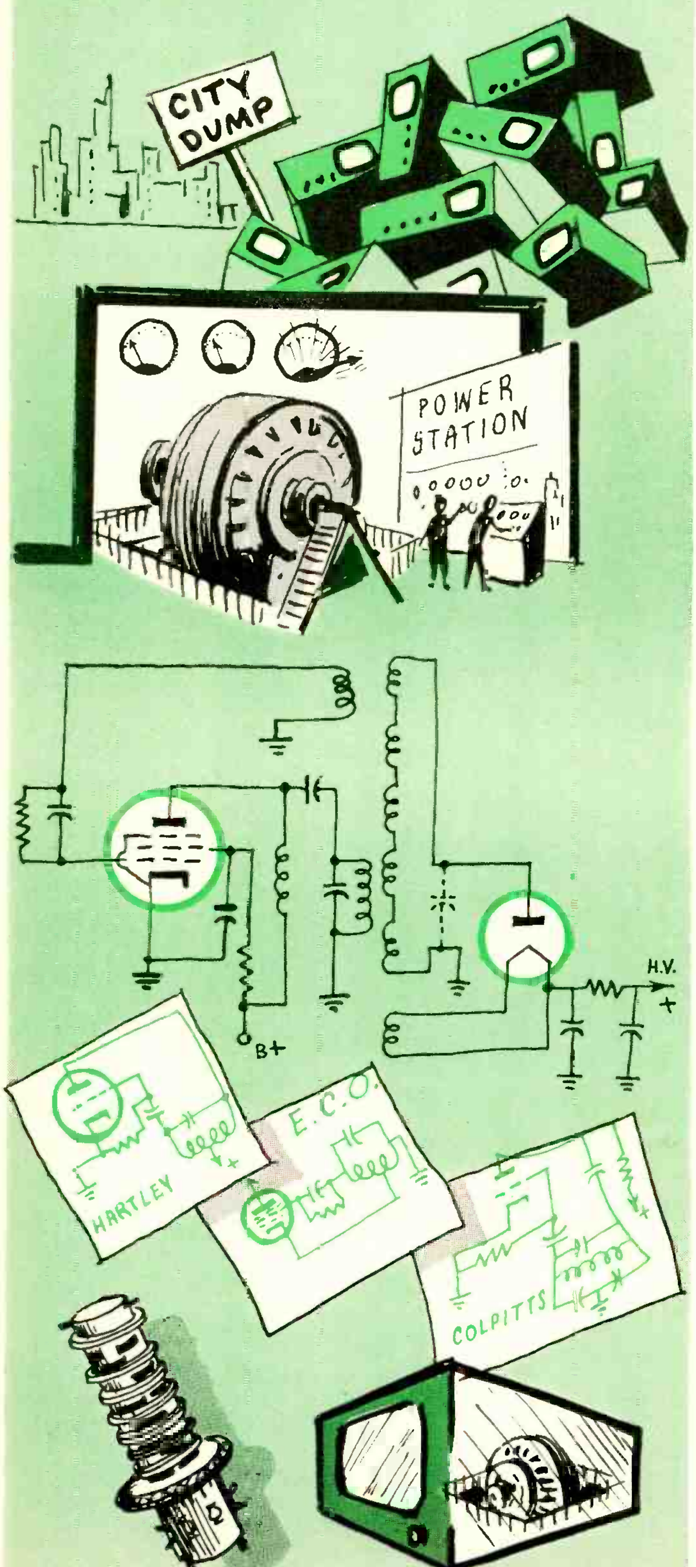
The feature of this bench, the service table, is 2 feet square and is mounted on 3-inch casters. Being square, the table can be fitted into the slot on any of its four sides, to suit the servicing technician. If a set has to be run for a long time, as in an intermittent, the table could be moved out and another receiver set in. The bench is made by the Baumker Manufacturing Co., Toledo, Ohio.



TELEVISION . . . it's a cinch

By E. AISBERG

Sixteenth conversation, second half: Radio-frequency high-voltage supplies; when vice finally becomes a virtue! the bootstrap circuit



Roll your own a.c.

KEN—Well, I think we can abandon the 60-cycle transformer as a television high-voltage supply. They pretty well all went out with the 7-inch tube.

WILL—Then what's wrong with finding out how high-voltage supplies really do work? If we don't step up the 60 cycles, what do we do? Use some other frequency, maybe?

KEN—You've said it—probably without intending to. One of the worst features of the old-fashioned system is the low frequency. Among other things, it needs big filter capacitors. A charge on even a 0.25-μf capacitor by a 16,000-volt, 60-cycle power supply can be fatal, as I've told you already. But if we had a 10,000-cycle current, for instance, we could use a proportionally smaller filter capacitor. And the capacitor discharge, while it wouldn't be exactly pleasant, wouldn't be dangerous to life.

WILL—Fine! Do you think we could call up the power station and ask them to speed up the generators to give you 10 kc?

KEN—Why bother? I can make it myself, from the low-voltage d.c. supply!

WILL—Sounds like witchcraft. But go ahead.

KEN—It's easy enough. Simply use a good big tube, supplied with voltage from the televiser's own power supply. Hook it up as an oscillator at any frequency you want. It doesn't matter much what kind of circuit—t.p.t.g., Hartley or what have you. Once you get your a.c., you treat it like any other a.c. supply.

WILL—You mean . . .?

KEN—. . . step it up with a secondary, then rectify it with a simple half-wave high-voltage rectifier tube.

WILL—In your schematic you show the heater winding on the r.f. transformer too. Are you heating the filament with radio frequency?

KEN—Why not? The tube is specially designed to use low filament power. And you can keep your high voltage well away from ground that way.

WILL—About what frequency would you use?

KEN—You could use anything from about 600 cycles up; but with lower frequencies you'd have to use iron-cored coils, and you'd have insulation problems again. It's much better to use air-cored coils and frequencies up in the radio range. Power supplies have been designed to work at various frequencies between 50 to about 300 kc.

WILL—And a radio-frequency power supply solves all the high-voltage insulation problems?

KEN—It makes them simpler. Remember, you still have big voltage differences between successive layers, even in air-cored coils. That's why they are usually wound in a number of well spaced pies, with not too many turns on each. Thus the voltage drop is distributed along the form, and no turns with large voltage differences are near each other.

WILL—I've seen those coils.

KEN—What you've seen was probably something quite a bit different—something that is used in all modern TV receivers. You see, we don't need to install an a.c. generator in our set—there's an efficient one there already.

Virtues out of faults

WILL—Surely you're not talking about the oscillator in the mixer circuit?

KEN—Not at all, though in some portable radios it has been used to supply cathode bias for the output tube. I'm thinking of something entirely different. Don't you remember when we were talking about horizontal scanning circuits—back about our eighth conversation—we found we'd get surges of several thousand volts on the retrace?

Will—I remember now. The sharp drop in current that produces the steep side of the sawtooth sets up dangerous voltages across the primary of the transformer connected to the anode of the pentode horizontal output amplifier. And—if I remember right—even then you said we could turn a vice into a virtue by using the surges as a source of high voltage for the picture tube.

Ken—With a memory like yours, you may still go far, Will! You see then that we can use the high-voltage pulses produced by the horizontal sweep circuits during the retrace period. And we can increase those voltages by adding another winding to our horizontal deflection transformer primary, making an autotransformer out of it.

Will—And then all you have to do is rectify the high voltage and filter it in the ordinary way. I notice again that you heat the rectifier filament with a little winding on the same transformer.

Ken—Yes, we have that advantage of the r.f. system, plus one that no other system has. If by accident the sweep circuits fail, the bright spot resting on one point of the tube face would soon destroy the screen around that point—make an electron burn rather than an ion burn. But with this high-voltage supply system, the high voltage goes off as soon as the sweep fails, and there is no bright spot to damage the tube.

Will—So this is efficient, economical and, on top of that, makes things safe for the picture tube. Practically a perfect system. But there's one thing that's been puzzling me. On some schematics I've seen B+, B++ and B+++. I can understand two B+ voltages, but what do you do with the middle one?

Ken—That's still another advantage of this so-called flyback system of getting high voltage. High-voltage transformers get less efficient as you wind more wire on them and stretch them out over more space. So, to get high voltage on the big tubes, you have to use good sturdy horizontal output tubes and put more voltage on them. And believe it or not—the horizontal output tube itself supplies that extra voltage.

Will—Sounds impossible. But I do remember hearing of a bootstrap voltage boost. This must be it!

Ken—You're so right, Will! Here it is. This is a simplified drawing—I've left out everything not needed for the voltage boost. Most transformers are harder to figure out because the primary, deflection and high-voltage windings all form part of one autotransformer on most modern sets. I have shown a separate winding here. (The principle is the same, of course, but the diagram is less confusing and you'll find plenty of older sets with such transformers.) And in a schematic of a complete receiver you'd find a width and linearity coil mixed up in the circuit.

Will—I can't figure this out. Looks almost as if the damper was being used as a high-voltage rectifier.

Ken—Well, what is the purpose of a damper tube?

Will—That's right! It does rectify, doesn't it? But it never occurred to me you could *use* the current that it rectifies.

Ken—And what is the source of this voltage that it rectifies?

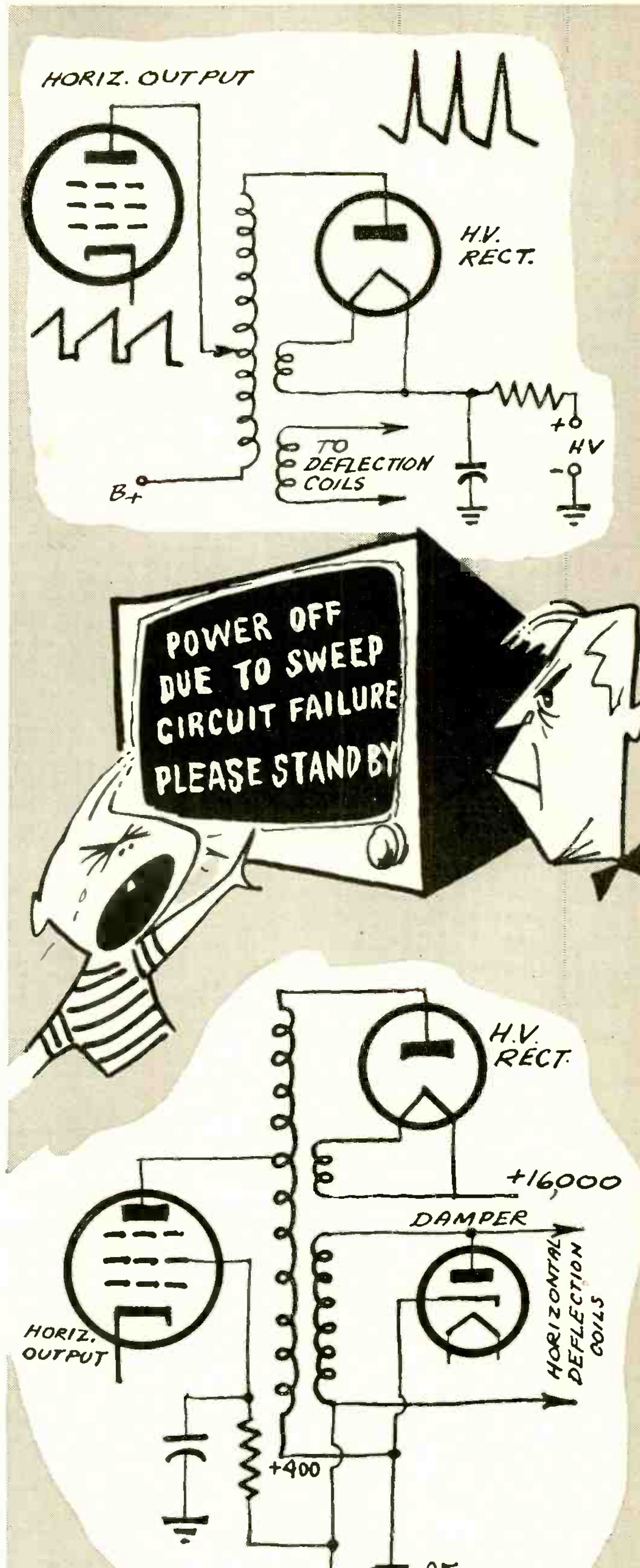
Will—That's simple enough, once you get the idea. The deflection winding is a half-wave secondary. And since its lower end is connected to the B+ supply, its voltage is added to the ordinary B+, so whenever the damper conducts, the voltage at its cathode is the rectified voltage across the deflection winding, plus the B+ voltage of the rest of the receiver.

Ken—Exactly. B++. And one more point will make your story complete. The rectified current is filtered by the .05-μf capacitor you see in the diagram.

Will—So now we have our B++ voltage. And the B+++ is, of course, the supply for the picture tube. Anything more to learn about the power supply?

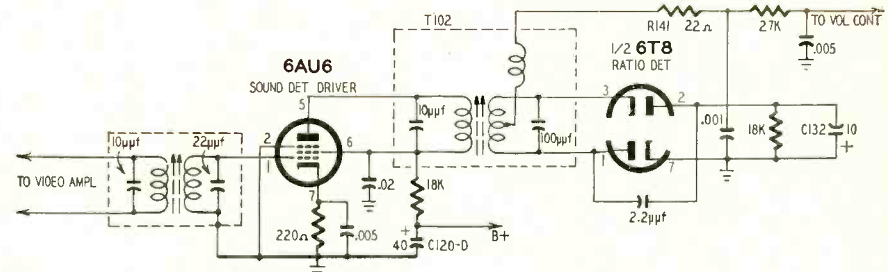
Ken—Nothing at all that we will have to bother about today, Will.

TO BE CONTINUED



TV SERVICE CLINIC

Conducted by **JERRY KASS**



Ratio detector and driver circuit.

THAT flickering salt-and-pepper effect (see photo) known as "snow" is almost invariably due to trouble in or around the front end of a TV receiver when the set is connected to a good antenna in a reasonably strong-signal area. Snow is the video equivalent of noise and its effect on the picture depends largely on the amplitude of the noise voltages at the input of the receiver as compared to the amplitude of the incoming signal.

Noise comes principally from two sources—shot effect and thermal agitation. Shot noise occurs in all vacuum tubes and is caused by the uneven flow of electrons from cathode to plate. The variations in tube current flow cause slight modulation of the plate current, producing the noise or snow effect. Shot noise increases as the number of elements in a tube increases. Thus, a triode offers the greatest protection against shot effect.

Thermal agitation is caused by the random movement of electrons in any conductor or resistor. Noise caused by thermal agitation varies in proportion to the bandwidth of an amplifier, and so becomes a major problem in the 6 mc wide r.f. amplifier. In producing this noise the antenna must be considered just as important a source as the front-end components. In fact, an antenna with a characteristic impedance of 300 ohms will produce just as much noise as a 300-ohm resistor connected across the set's input terminals.

Since noise voltages are amplified by a receiver along with signal voltages, to obtain a snow-free picture it is necessary that the signal be much greater in amplitude than the noise. This is referred to as a high signal-to-noise ratio. Signals approximately equal in amplitude to the antenna–receiver noise are masked by the noise. Thus, improving fringe-area performance consists of reducing antenna and receiver noise and increasing antenna and receiver gain.

Unfortunately the minimum usable signal is not determined by the gain or sensitivity of a receiver, but by the noise of the r.f. stages of the tuner. The noise in the r.f. amplifier is so important because it is at this point that the TV signal is weakest. Any noise voltages at the grid of the r.f. amplifier are amplified along with the signal. Any noise developed in later stages is generally much less than the noise from the r.f. amplifier.

The technician has virtually no control over shot-effect noise. About the best he can do is to substitute several tubes of the same type and check for minimum noise. This can be measured at the output of the video detector. But sometimes the difference between tubes is so slight that observing the snow condition may give a better indication. The development of low-noise front ends using tubes such as the 6BK7-A, 6BQ7-A and 6BZ7 in cascode amplifiers has done much to reduce noise effects.

With regard to antenna noise, the technician is limited to the installation of a high-gain antenna system. This includes selecting an appropriate antenna for the signal area involved; proper antenna orientation; proper impedance match between antenna, transmission line and receiver input; location of antenna in low-noise area and inspection of all electrical and mechanical connections.

In many areas of low signal strength, boosters are used to overcome snow. However, a booster—being nothing more than an r.f. amplifier—faces the same problem as the r.f. amplifier in the TV receiver—it must provide a high signal-to-noise ratio (perhaps 50:1 for a usable picture). If the r.f. amplifier of the booster does not operate at a noise level lower than that of the receiver, all the gain in the world will not eliminate snow. The best it can do is provide high contrast, but with annoying noise spots. Thus unless a booster can improve the signal-to-noise ratio it is of very little use.

Snow removal

The mixer or converter stage introduces a large amount of shot-effect noise (triodes to a lesser extent than pentodes). Thus, the snow can be used to isolate trouble as occurring before or after the mixer stage. A condition of no picture and no sound or weak picture and sound occurring only on some channels indicates a front-end defect. This trouble on all channels spreads the possible trouble area to include the i.f. amplifier.

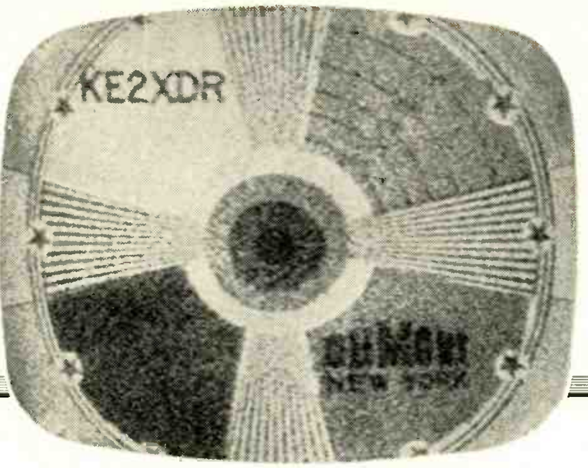
To isolate r.f. from i.f. trouble, advance the contrast and volume controls to maximum. If there is an increase in video snow and audio hiss while advancing the controls, indications are that the mixer and all the following stages are amplifying the noise. It thus locates the trouble in the antenna, r.f. amplifier or oscillator circuit. If there is no increase in receiver noise, the trouble is in the mixer stage or the following i.f. amplifiers. In general, a weak washed-out picture with lots of snow indicates loss of gain in the r.f. section.

Gain decreases and noise increases as bandwidth increases. Since the signal-to-noise ratio is so important in fringe areas it is a good idea to align the front end while observing the response curve at the output of the mixer. Aligning the front end while observing the response of the i.f. amplifiers will often result in an unwanted broadening of the front-end response, because, as the r.f. bandwidth is increased beyond about 4 mc, the overall i.f. curve looks good but the front-end curve may be too broad.

Thus, when running into a snow problem, carefully check the antenna and transmission line. Replace the r.f. and mixer tubes. Check the oscillator grid voltage. Check the a.g.c. circuit—excessive r.f. bias reduces the gain of the r.f. amplifier and increases snow. Measure the plate voltage on the r.f. amplifier. Excessive plate voltage results in an increase in shot-effect noise. Also, look for overheated resistors—they could produce noise through thermal agitation. Of less frequent occurrence is snow caused by a tuner that is not tracking properly or a poorly aligned i.f. amplifier.

Overheated output tube

In a model 9124 Silvertone receiver the 6BG6-G cathode and screen resistor become charred after operating for a very short time. When this occurs the



Excessive snow on a weak picture.

emission of the 6BG6-G is almost zero. I have replaced the horizontal output transformer and the deflection yoke as well as the high-voltage rectifier, damper and output tube.

When the trouble occurs, the picture and raster are normal and then suddenly disappear. At this time the screen and cathode resistors become overheated, the tube gets very hot and the screen voltage drops to 50. Could you tell me what causes this trouble?—G. F. G., Brooklyn, N. Y.

The symptoms indicate a defect in the horizontal oscillator. The 6BG6 operates as a class-C amplifier, developing a large bias voltage through grid-leak action. Should the oscillator fail, the bias voltage would be decreased greatly, increasing the plate and screen current through the output tube.

The heavy current flow through the screen-grid resistor and the cathode resistor is causing these resistors to overheat and char. In so doing, the screen-grid resistor greatly increases in value, lowering the screen voltage. The fact that the raster goes off is further indication of failure of the horizontal oscillator. Of course, the opening of the cathode resistor would also remove the raster.

Carefully check all components in the horizontal oscillator. Replace the oscillator tube. Check all components in the grid circuit of the output tube. Measure the grid bias on the 6BG6. If all components check good and operation is normal until the trouble occurs, it will be necessary for you to replace all components in the horizontal oscillation and output grid circuits whose failure would prevent the oscillator from functioning.

Dead oscillator

A Crosley u.h.f. Ultratuner used with a model EU-17TOB receiver has a completely inoperative oscillator. All B plus and heater voltages check perfectly and I can feed a single-frequency v.h.f. signal through the unit. However, the oscillator shows absolutely no sign of life. A v.t.v.m. check across the 10,000-ohm grid resistor of the 6AF4 oscillator shows no voltage.

I have replaced the oscillator tube and redressed the oscillator leads, but the circuit refuses to work. I have checked most of the components in this circuit and, outside of not operating, the circuit tests perfectly.—W. C., Waco, Tex.

Proper oscillation action at u.h.f. is often a touch-and-go affair and many checks have to be made that would ordinarily not be considered at lower frequencies. Before any detailed checks are made, replace the oscillator tube with a few you know to be good. Sometimes the slightest change in interelectrode capacitance can make the difference.

If the circuit remains dead, check the connecting straps on the plate and grid capacitors for proper soldering—a loose or cold soldered joint could very easily be causing the trouble. Check the oscillator trimmer capacitor for loose plates. Check the contacts and mechanical alignment of the shorting bars in the *Inductuner* unit.

Check all capacitors for open circuits by shunting them with good units of the same value and temperature coefficient, keeping all leads as short as possible. Go over all wiring carefully, checking for broken leads and shorts, and apply the soldering iron to any suspected cold solder or rosin joints.

Be very careful about redressing wires. Try at all times to keep the wiring the same as when it left the factory.

21MP4 to a 21YP4

I have a 21MP4 badly in need of replacement. It is a metal tube and I would like to replace it with a 21-inch glass tube. I understand that generally it is not a good idea to replace a metal picture tube with a glass one. However, if it can be done, I would like to know what tube to use for a replacement.—R. L. M., Youngstown, Ohio

A 21MP4 metal tube can be replaced very nicely with a 21YP4 glass tube. The two are of approximately the same dimensions and have the same deflection angle and high-voltage requirements.

You will have to install an Aquadag grounding spring to each side of the yoke mounting bracket, and be sure that the springs make good contact against the picture tube. Most brackets have holes into which self-threading screws can hold the springs. Since the conductive coating on the 21YP4 provides a high-voltage capacitor, the original unit in the set can remain or be removed. Because of the different second-anode connections, the high-voltage lead to the 21YP4 will have to be replaced.

Many technicians omit grounding the outer coating on the picture tube because the set already contains a high-voltage filter capacitor. This is dangerous and can produce a serious shock if the technician contacts the coating.

Audio buzz

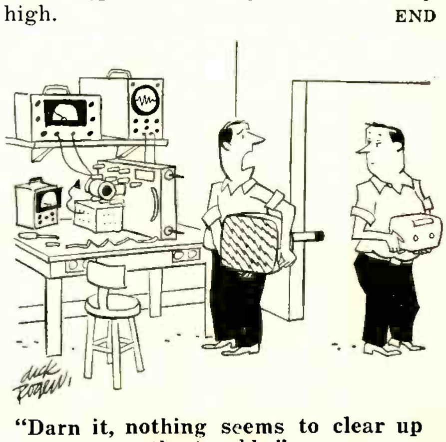
A Crosley chassis 331-1 in the shop has a persistent buzz. I have checked every component in the sound circuits, including tubes. The voltages check out pretty close to the manufacturer's schematic. I have tried adjusting the ratio detector transformer, but the best I could do was to bring the buzz to a comparatively low value. Any hints toward repairing this trouble would be appreciated.—J. M., Trenton, N. J.

Since you have checked all components in the audio circuit (see diagram), try the following checks: Make sure that the 40-μf electrolytic capacitor (C120-D) is properly grounded. To be sure, solder a wire from the chassis to one of the ground lugs of the capacitor. Check the connections of the various sections of C120 against the schematic. Proper filtering action is important in reducing this buzz.

Try shorting out R141; this often eliminates the trouble. Check capacitor C132 to see if it has dried out. If it has, chances are that it has greatly reduced in capacitance.

Adjust the ratio-detector transformer (T102) secondary for minimum hum or buzz while the set is tuned to a station. Make only a slight adjustment. If the screw is turned too far, it could result in weak or badly distorted audio output. If everything else fails, check the overall alignment as per manufacturer's instructions.

Other possibilities include a poorly grounded shield in back of the contrast control and improper a.g.c. adjustment —the a.g.c. level may be excessively high. END



"Darn it, nothing seems to clear up the trouble."

Low-Frequency Compensation in VIDEO AMPLIFIERS

By JOSEPH F. SODARO

LOW-FREQUENCY phase shift in video amplifiers may result from the grid coupling, screen bypass or cathode bias networks. Phase shift can be compensated by the plate R_pC_p network shown in the diagram. This is also a decoupling network which prevents feedback from developing across the power supply impedance. Plate circuit compensation can neutralize the phase shift produced by the grid, screen or cathode network.[1, 2, 3] Complete compensation is obtained for the grid circuit if

$$R_oC_p = R_gC_c \qquad (1)$$

where R_o is the output resistance, R_g the grid resistance and C_c the coupling capacitance. Equation 1 applies only if R_p is equal to or greater than 10 times the reactance of C_p at the lowest frequency to be compensated. Also, the shunt resistance of any following circuits, such as the grid resistor of the next amplifier, must be very large compared to R_o.

Phase shift produced by the screen network is neutralized if

$$R_pC_p = R_sC_s \qquad (2)$$

in which C_s is the screen bypass capacitance and R_s the screen dropping resistance. In the case of a voltage divider network, the a.c. resistance from screen to ground is the parallel combination of the two resistance branches.

The cathode bias network is compensated if

$$C_kR_k = C_pR_p \qquad (3)$$

$$g_mR_k = \frac{R_p}{R_o}$$

or

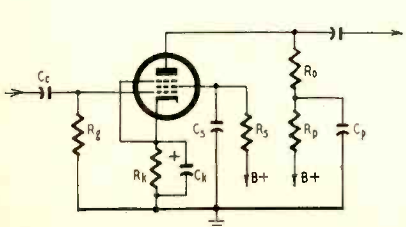
$$g_mR_kC_p = C_k \qquad (4)$$

in which C_k is the cathode bypass, R_k is the cathode resistance, and g_m the tube transconductance.

To determine circuit values for Equations 1, 2 and 3, use the nomograph shown in Chart 1. To solve Equation 1, select the value of R_g on the R scale and of C_c on the C scale. Connect these points with a straight line to determine a turning point (where this line intersects the T scale). Assume a convenient value for C_p and locate this point on the C scale. Draw another straight line from this point through the turning point to the R scale. At this intersection read the required R_o value. Conversely, R_o can be assumed and C_p determined. Also, R_g and C_c can be determined for given values of R_o and C_p by reversing the procedure. The nomograph is particularly convenient for determining equivalent R-C combinations. Thus, after establishing the turning point, pivot a straightedge about this point and you will obtain combinations of R and C which yield the same product as the first R-C combination.

As an example, determine the decoupling network required to compensate a 0.1-μf coupling capacitor and a 390,000-ohm grid resistor. Locate 0.1 on the C scale and 390,000 on the R scale. Connect these points with a straight line, intersecting scale T. Assume a decoupling capacitance value for C_p of 20 μf. Locate this point on the C scale and draw a line from this point, through the turning point, to the R scale. At this intersection read 1,800 ohms, the value of R_o. If compensation is to extend to 30 cycles per second where the reactance of C_p is 265 ohms, R_p must equal or exceed 2,650 ohms.

To solve Equation 2 follow the same procedure on Chart 1 as that used for Equation 1. In this case use R_s and C_s values to establish the turning point. Assume either R_p or C_p and solve for the other, or simultaneously observe R_p and C_p values which give the required R-C product. As an example, assume that screen dropping resistor R_s is 1 megohm and screen bypass capacitor C_s is .05 μf. Locate 1,000,000 on the R scale and .05 on the C scale. Connect these points by a straight line and determine the turning point. Pivot a straightedge about this point to find combinations of R_p and C_p that will cancel the phase distortion due to the screen-grid net-



Low-frequency-compensated amplifier.

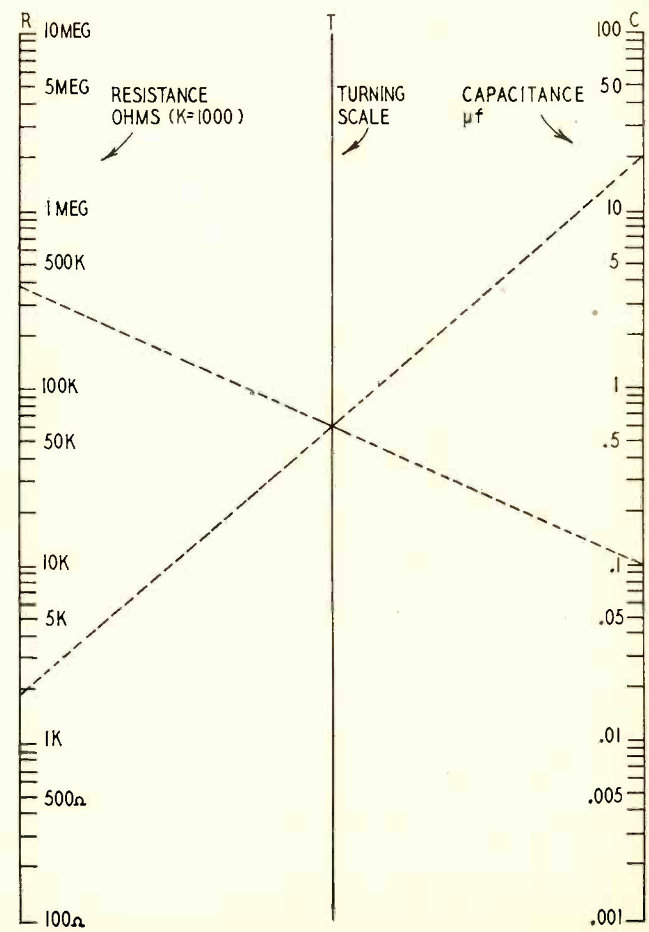


Chart 1 — Nomograph for determining video amplifier low-frequency-compensation circuit values for Equations 1, 2, 3.

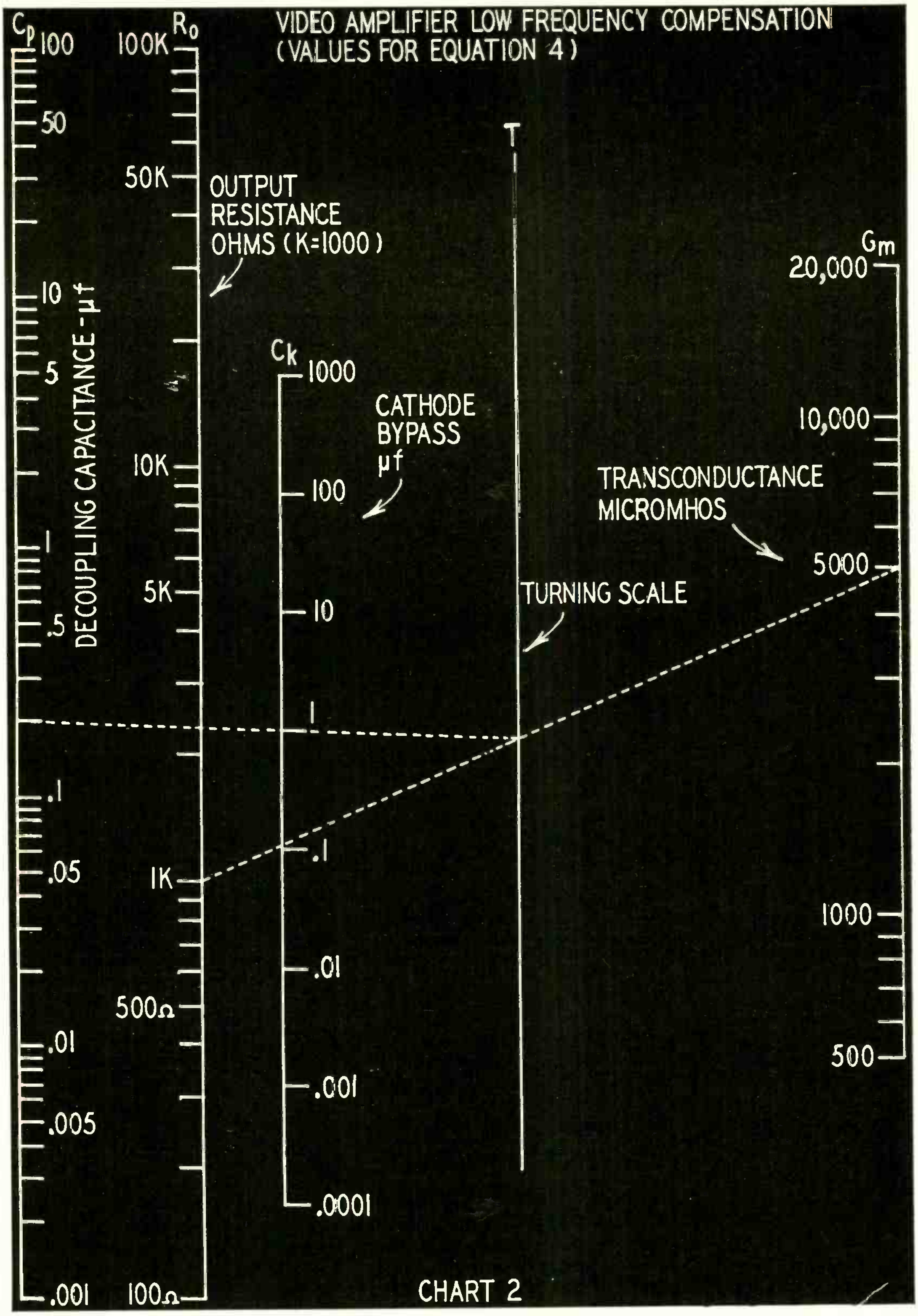


CHART 2

work. One combination is: R_p, 5,000 ohms; C_p, 10 μf.

Equation 4 can be solved by the nomograph shown in Chart 2. Select the mutual conductance on the g_m scale and the plate resistor on the R_o scale. Construct a straight line between these points. Locate a turning point where this line crosses the T scale. From the turning point to the decoupling capacitance value on the C_p scale draw another straight line. Read the required cathode bypass value where this line crosses the C_k scale. An alternate procedure would be to determine C_p by extending a line from the turning point through the C_k value to the C_p scale. Here again, a straightedge can be pivoted about the turning point to determine suitable combinations of C_k and C_p to cancel low-frequency distortion.

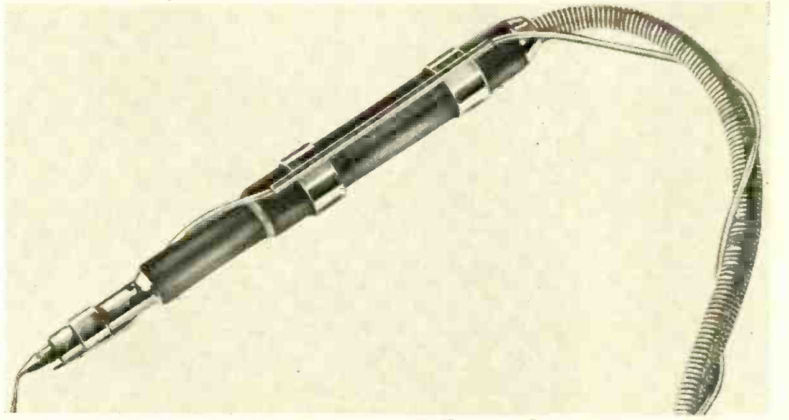
As an example determine the decoupling capacitance required for a tube having a g_m of 5,000 micromhos if the cathode bypass is 1 μf and the output resistor is 1,000 ohms. From 5,000 on g_m to 1,000 on R_o draw a straight line. The turning point is the intersection of this line with the T scale. Extend a second straight line from the turning point, through 1 on C_k, until it intersects the C_p scale. Read 0.2 μf at this intersection. END

References

[1]F. E. Terman, *Radio Engineers Handbook*, pages 414–417, McGraw-Hill, 1943.
[2]D. G. Fink, *Principles of Television Engineering*, pages 228–238, McGraw-Hill, 1940.
[3]K. R. Sturley, *Radio Receiver Design*, Part 2, pages 431–436, Chapman & Hall, 1945.

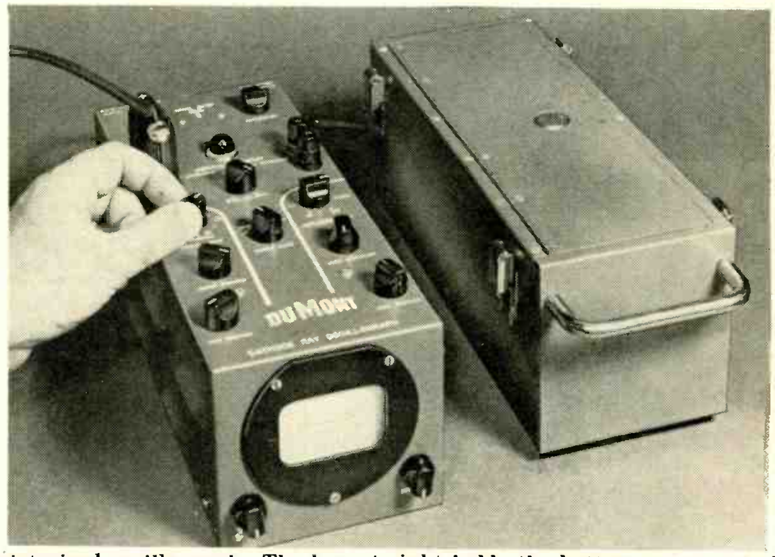
IRE Attains New Heights

Highlights of 1955 session include space satellites, ultrasonic dental drills, a transistorized scope, and new types of C-R tubes



Courtesy Cavitron Equipment Corporation

The ultrasonic dental drill differs from other types chiefly in being painless.



The transistorized oscillograph. The box at right holds the battery power supply.

LITERALLY and metaphorically, discussions soared to new heights at the 1955 convention of the Institute of Radio Engineers, held in New York. As one periodical put it, "Not even the sky is the limit." For one of the most important symposiums—that on remote control and telemetering—dealt entirely with electronically controlled space stations.

This subject was pretty much monopolized by the military, though the physical researchers were also interested, and one of the most interesting suggested applications of a satellite was as a trans-Atlantic television relay. This was proposed by Dr. John R. Pierce, director of research of the Bell Laboratories. He suggested that a satellite 100 feet in diameter, in an orbit 22,000 miles above the earth, would be large enough to reflect signals from one continent to the other.

Sending and receiving antennas 250 feet in diameter would be necessary, plus 50,000 watts of power for each transmitter. Noting that a cable to carry 30 TV channels is being laid across the Atlantic at a cost of $35 millions and that a satellite could carry 900 channels, Dr. Pierce pointed out: "That would give us about a billion dollars to play with."

Automation was the second most important feature of the convention. Most interesting to the radio-TV field were the discussions on automatic construction and assembly of electronic equipment. Included were papers on the Signal Corps' Audo-Sembly system and Admiral's automatic TV receiver chassis construction (RADIO-ELECTRONICS, January, 1955, page 71). A complete session discussed the technical, managerial, social and economic implications of the trends toward automatization of procedures and processes in business and industry.

Ultrasonics was another important subject of the year. John M. Reid and John J. Wild of a Minneapolis hospital described equipment which can discriminate between the ultrasonic echoes returned from nonmalignant tumors, liquid-filled cysts and cancers. The experimental equipment shows a high percentage of correctness in diagnosing incipient cancers and an even better score (98% correctness) when deciding that a growth was *not* cancerous. Dr. Douglas Howry of the University of Colorado—a veteran worker in the field—described equipment and work in studying and describing the form of structures deep in the human body.

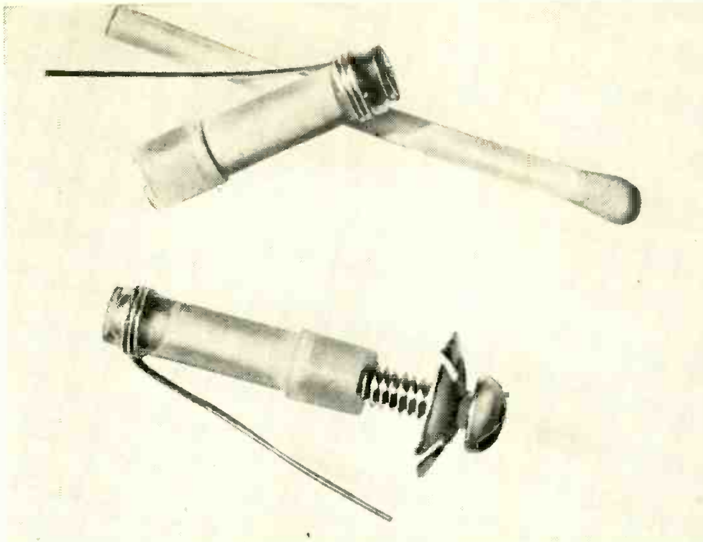
Closer home to the average man was the ultrasonic dental drill, subject of papers by Drs. Lewis Balamuth of Cavitron and Alvin E. Strock, a Boston dentist. According to Dr. Balamuth, 150 of the machines have been placed throughout the country and about 4,000 patients treated. More than 97% of them report no pain from the new drill. The ultrasonic drill is not only painless, it can make sharp-cornered cuts that hold dentures much better than excavations made by the old-fashioned drill.

Frozen television

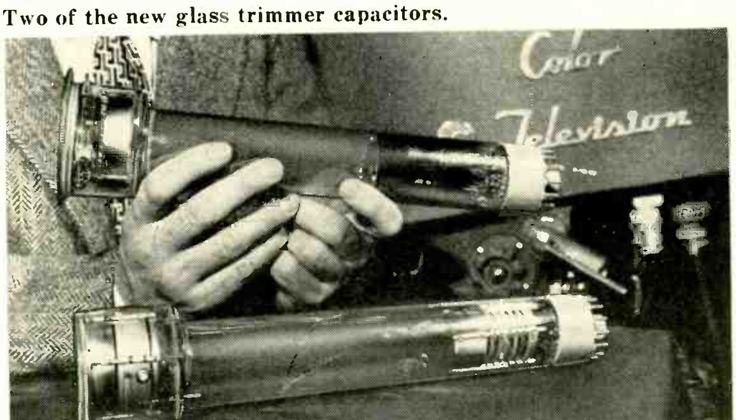
It may seem a backward step to try to stop motion in television, but that is just what Raytheon did in an elaborate display that looked like a TV set in a large rack. A camera beside the device was focused on the crowds ahead of it, and at intervals the picture on the screen was "frozen"—the images of spectators remaining fixed while they themselves walked away.

The secret of the device was a memory tube, scanned to produce the TV picture that appeared on the monitor screen. If the TV input signals were cut off after any one frame, the picture remained in the tube's memory and could be scanned or "read" up to 30,000 times. The picture could be held a week before playing back, if desired.

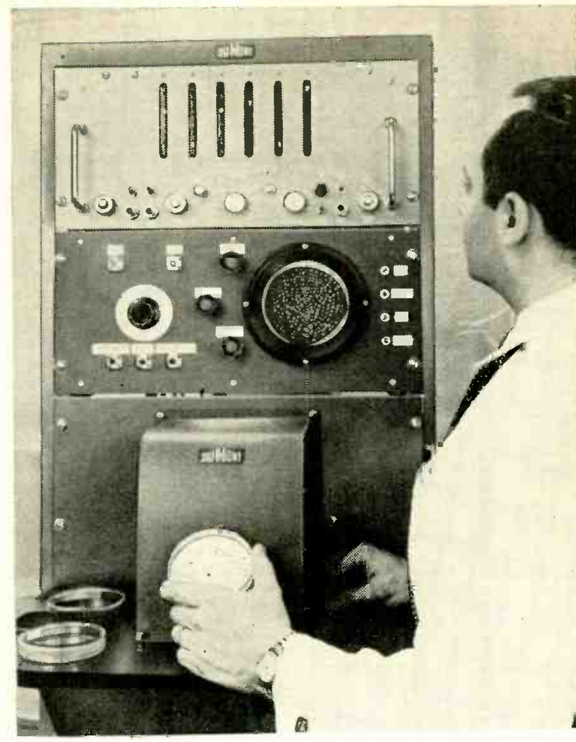
Service technicians were especially interested in an all-transistor oscillograph (the Du Mont term for what



Two of the new glass trimmer capacitors.



New RCA tricolor Vidicon camera tube.



Du Mont's *Iconumerator*, a device which can count objects of any size and shape in its field of vision. Here its subjects are similar to colonies of bacteria counted in medical laboratories, etc. The most startling feature of the instrument is that the size of the object (as long as it can be contained in the field) or its shape make no difference in the accuracy of the numeration.

many call a scope). Weighing 16 pounds —and most of that battery—it occupies only ¼ cubic foot and consumes less than 5 watts, most of which is used by the C-R tube. Du Mont engineers described it as "real cool."

From a spectacular standpoint, the various computer exhibits were particularly outstanding. With vast numbers of varied-colored lights flashing at fantastic rates and relays chattering madly, the computing devices were probably the most dramatic demonstrations of the show.

Other items of particular interest to the technician were a voltmeter which chose its own range, automatically stepping a switch around so that the indicated voltage would not only be on a range which would not overload the meter, but also on the lowest of such ranges, thus giving readings on the best half of the meter scale. Another, a "digital voltmeter" intended for factory use, used counter circuits giving a direct reading of the voltage measured.

Capacitors with a glass dielectric may also soon make their appearance in the service shop. Two types shown by Corning Glass will be distributed through Erie Resistor Corp. One was a small cylindrical trimmer. The other type was a series of subpostage-stamp fixed capacitors with a dielectric of thin glass film. Capacitors made this way are smaller than silver-mica units for any given voltage and capacitance rating. The capacitances are in the same range as those of small micas or silver-micas and the units are intended for the same type of application.

Another intriguing device exhibited by Du Mont was the *Iconumerator*, a device which counts objects placed in its field of view. The remarkable feature of the instrument is that it can count objects of different sizes and shapes. In the tests, matches and small ball bearings were among the items mixed and counted correctly.

The unit demonstrated had a field of vision adapted to counting objects in 3-inch plastic trays, strongly reminiscent of those in which bacteria cultures are grown. Its importance in counting germ colonies and blood cells and in similar therapeutic applications was stressed by its exhibitors. It uses a flying-spot scanner and special circuitry which prevents it from recounting an object counted on the previous line.

Other C-R tubes included one containing storage elements behind the screen, so that a trace on its screen might be considered permanent. Exhibited by Hughes Aircraft, the *Memotron* was described as a direct-display storage tube. Another version of the same tube used the long-term phosphor with the gun arrangement of the McNaney *Charactron* (RADIO-ELECTRONICS, December, 1949; October, 1953) together with the storage elements of the *Memotron*. Called the *Typotron*, it can display any one or any combination of 63 characters continuously till erased.

Two important television tubes were announced. One of these, the Rauland color kinescope, uses a sort of post-deflection focusing in connection with a shadow mask to get brightness three to four times as great as with former tubes. Due to the directing field, more than 80% of the electrons get through the mask to the screen.

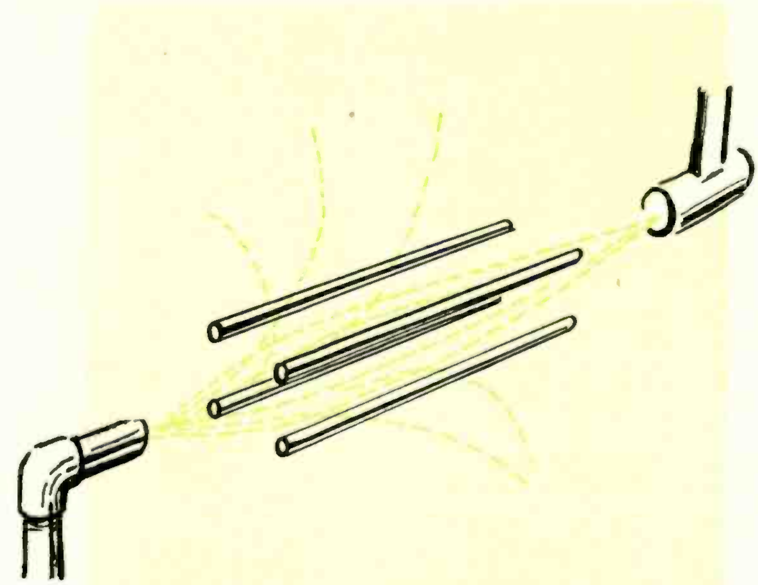
The other tube was the new RCA Tricolor Vidicon, a TV camera tube which picks up all three color signals instead of only one. It has a large number of vertical color filter strips, together with horizontal color-sensitive elements. When traversed by the scanning beam, it supplies the complete composite color signal now produced as the joint effort of three camera tubes. Adapted to work at present, under conditions of high illumination, it is possible that it may—through development of more sensitive photoconductive materials—become usable under conditions of average lighting. END

COVER FEATURE

Revolutionary new OSCILLATOR-AMPLIFIER

The maser works on a new principle to produce microwave oscillations and amplify with a practically infinite signal-noise ratio

By FRED SHUNAMAN
MANAGING EDITOR



Path of molecules, through maser, showing separation of active and inactive ones.

THE instrument shown on our cover represents a completely new method of producing electronic oscillations or amplifying radio signals. Called "Microwave Amplification by Stimulated Emission of Radiation" *(maser)* it uses ammonia molecules as a source of energy and as an oscillating medium.

The maser was developed at the Columbia Radiation Laboratory, which is jointly sponsored by the Armed Services and Columbia University. It was conceived by Prof. Charles H. Townes, executive officer of the Physics Department of the university. The work on it was carried out by him and his assistants: Dr. H. J. Zeiger, Carbide and Chemicals Co., post-doctoral fellow in physics at Columbia, and J. P. Gordon, a graduate student. The device was conceived as an aid to microwave spectroscopy, but its applications will cover a far wider field.

Oscillations produced by the maser are so steady in frequency that they can be used in an "atomic clock" 20 to 50 times more accurate than any now in use or in a simplified navigation aid similar to Loran but dispensing with some of the stations necessary for that system. As an amplifier, it has a fantastic signal–noise ratio. The noise level is practically at the theoretical minimum level of zero. Thus, while the output of the amplifier is very low (about 10^{-9} watt), it can be used to amplify signals far below the noise threshold of the best vacuum tubes, bringing them up to a level where they can be amplified by more conventional methods. In spite of its large size, the maser is a microwave oscillator, operating at 23,870 mc, the resonant frequency of the ammonia molecule. The brass box is simply a container into which ammonia gas at low pressure (10^{-6} atmosphere) may be injected. It contains the active part of the equipment—four cylindrical electrodes which form an electrostatic field, and a resonant cavity about 1 centimeter in diameter and 3 inches long. It is also fitted with airtight seals through which pass waveguides, control adjustments and pipes for admitting and removing gas, pumping the chamber to a low pressure and circulating coolants.

How it works

Operation of the maser is remarkably simple, though different from anything in the history of electronics. A stream of ammonia molecules is injected into the brass chamber and directed down the center of the field formed by the four copper cylinders. These molecules may be in one of two states—a low-energy state that may absorb energy and a high-energy one that can radiate energy. As they drift through the electrostatic field—formed by keeping two of the copper cylinders at a potential of 6 to 20 kilovolts and the two diagonally opposite grounded—the low-energy "dead" molecules are diverted and scattered while the high-energy ones are focused into a sort of beam which enters the resonant cavity just beyond the field. The process may be compared with the refining of uranium, in which the inert U-237 is removed and only the active U-235 left in a more or less pure state.

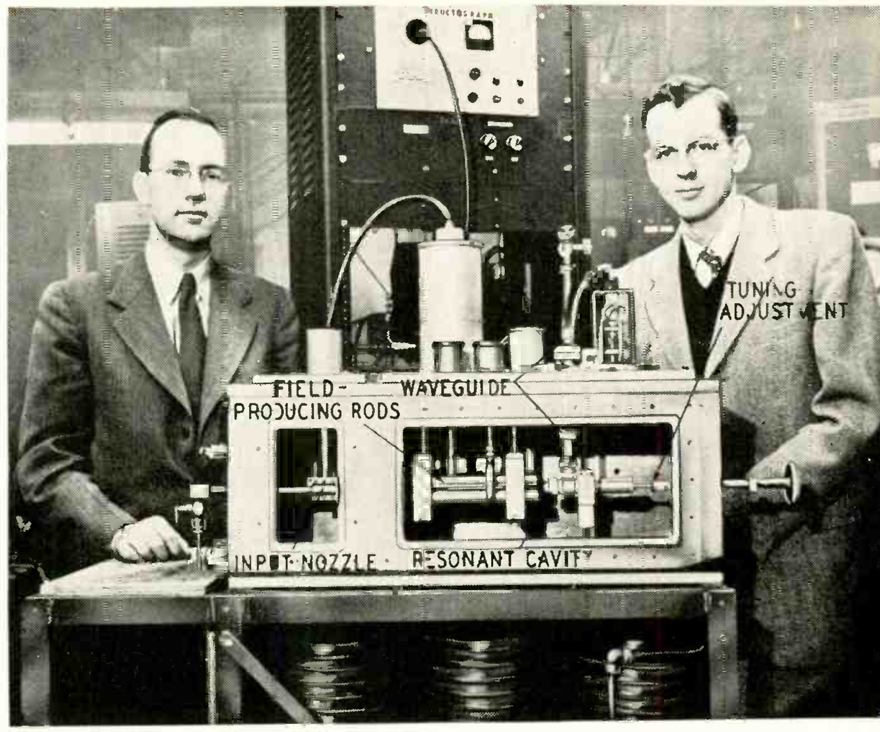
Once inside the cavity, which is dimensioned to resonate at the frequency of the ammonia molecule, some of the molecules radiate—give up some of their energy. These tiny quanta of energy trigger other molecules, building up a chain reaction which may again be compared to that of purified uranium. In a short time the molecules have produced a vigorous oscillation in the cavity. The microwave energy is piped out of the cavity in an ordinary waveguide.

This type of oscillation is unique—it is like nothing previously experienced in controlled electronic reactions. There is a local electric source—to maintain the high-voltage electrostatic field—but the energy which produces the oscillations does not come from that supply. It comes from the ammonia gas itself. Approximately 10^{14} molecules per second must be admitted into the chamber to maintain oscillation.

The maser as amplifier

If the number of ammonia molecules admitted is not great enough to sustain oscillation, the maser can act as an amplifier. An external signal may be introduced and increased in amplitude by energy picked up from the radiating molecules. The output of approximately one-billionth watt is high enough to apply to the grids of standard vacuum tubes, making the maser a preamplifier with a signal-to-noise ratio essentially equal to the limit set by fundamental thermal noise. The maser amplifier may in addition be cooled so that the fundamental thermal noise is further reduced.

Coupling the signal to be amplified to the maser is simple. Signals have been transmitted down the waveguide which enters the resonant cavity at the top and the amplified signals reflected back through the same guide. Should it prove more convenient, the signals could be admitted from a guide on one side of the cavity, passed straight through and removed by a guide on the other side. The amount of amplification is linked with the stability of the device. Operated to give very high gain, the system may break into oscillation. An amplification factor of 100 can probably be obtained without serious instability.



The first experimental maser, with Professor Townes (left) and J. P. Gordon.

Two masers were in existence when this was written. It was necessary to build the second one so that it could check the first. No other instrument is accurate enough to test a maser.

During the tests the oscillation frequencies were compared with an accuracy of one part in 100 billion. Professor Townes states that this is probably the most accurate comparison or measurement of any two physical quantities that has ever yet been made.

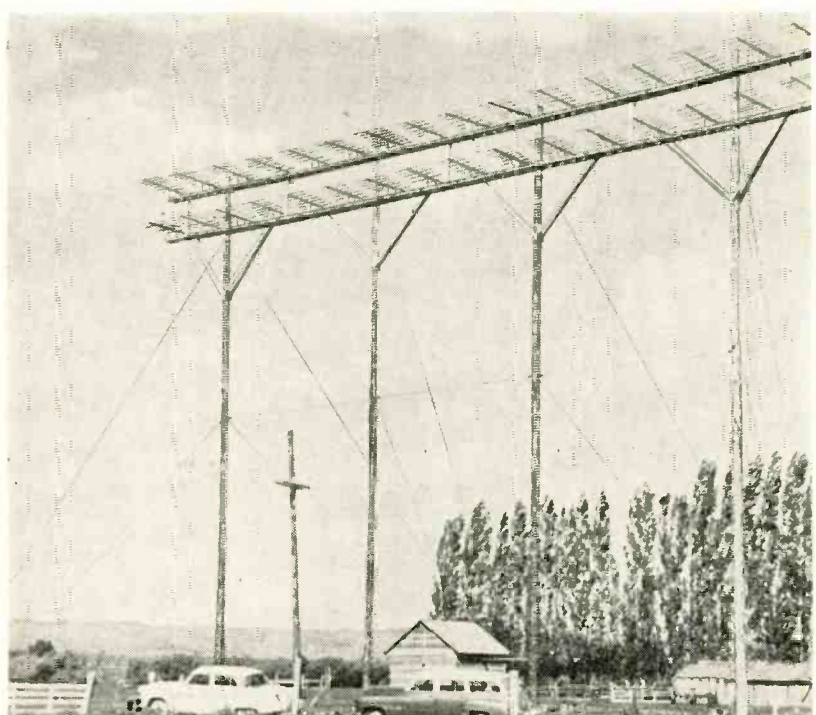
While Professor Townes and his associates were chiefly interested in microwave spectroscopy, one of the most important immediate applications of the maser is as a frequency standard. It is at least 30 times as stable as the best systems using crystal oscillators. Thus it would make an excellent atomic clock. Incidentally, it operates on exactly the opposite principle from that of the atomic clock described in this magazine in the March, 1949, issue. In that clock, ammonia gas acted as a wave-trap at the resonant frequency, absorbing energy produced by a crystal oscillator. The maser produces its own power and does not have to depend on auxiliary equipment for its oscillations.

It is expected to increase the resolution or detail which can be seen by microwave spectroscopy about 10 times, improving and extending our knowledge of the structure of molecules, atoms and nuclei.

Many other applications—such as the navigation aid mentioned before—become apparent. The maser will find applications in radio astronomy and in many uses where a radio frequency must be measured with greater accuracy than is possible with present apparatus.

But it is in directions unknown at present that the maser may find its greatest usefulness. Simply because it can act beyond our known horizons, it is difficult to assign its fields of future application. Who can say, for example, what uses there may not be for an amplifier which can amplify signals in a whole region which is now unexplored territory and whose very existence we may not suspect at present? END

AN ULTRA-SUPER-FRINGE TV ANTENNA



Ellensburg, Wash., a town of about 9,000, is located 100 air miles and a range of mountains east of Seattle. Every attempt to receive a picture from Seattle met with failure. In a final attempt, the Jerrold-Northwest Community Co. hit upon a plan for the installation of 16 stacked Yagis (see photo). Half of the antennas are designed for channel 4, the other half for channel 5. The project was successful, and the people of Ellensburg are now receiving nearly perfect pictures. The antennas used are eight-element *Baline* Yagis, made by JFD.

Theory and circuitry of instruments for measuring extremely low pressures

ELECTRONIC VACUUM GAUGES

By A. A. SCHULKE*

JUST a few years ago, the production of low pressures was an art known to only a relatively few physicists and engineers. Today, vacuum has become one of industry's most important tools. Radio and television would be impossible without it, and its uses range from the production of jet engines and atomic bombs to the manufacture of phonograph records and thermos bottles. Fig. 1 illustrates a few of these processes. It may be seen that the range of pressure used in these applications is well over 100,000,000 to 1!

The use of such a wide range of pressures has made it necessary to develop a large variety of gauges for their measurement. The most popular of these instruments are essentially electronic and because of their increasingly widespread use it is inevitable that the electronic technician or plant electrician will be called upon to service them. This article will lay the foundation for this future service work by outlining the principles of some of the most popular of these gauges.

For many years, atmospheric pressure was used as the base for vacuum measurement. Since this pressure varies with geographical location, time of day and barometric changes, it proved a poor reference line. In recent years it has become customary to make vacuum measurements on an absolute scale. A theoretically perfect vacuum is taken as the reference level. With this as our zero, any vacuum less perfect than this exists at some definite pressure above this zero level.

If we should take a long glass tube, sealed at one end, completely fill it with mercury and then, by holding a finger over the open end so that no air is admitted, carefully place it in a small cup of mercury (Fig. 2), the mercury will settle down and stand at some definite height (H). A vacuum will be created in the space above the mercury column. The height of this column will be determined entirely by the pressure of the air on the open surface of the mercury in the cup. At sea level this will be about 760 mm. If the air pressure is reduced by taking this device to some great altitude, as for example, to the top of Mount Everest, the air pressure will be able to support the mercury column to a height of only about 235 mm. If we enclose this mercury tube inside a tight box (dotted lines in Fig. 2) and attach a vacuum pump to the box to reduce the pressure further, the mercury column would fall still lower.

The height of the column is therefore a function of the pressure which may be expressed in terms of the column height as so many millimeters of mercury. This is usually abbreviated to "mm Hg." The mercury manometer (Fig. 2) is not useful for measuring pressures below 1 mm or so, other gauges being used for this purpose. Yet the unit (mm Hg) is still used to indicate the degree of partial vacuum obtained.

By using a classification system somewhat similar to that adopted for radio and television channels, we can loosely classify vacuum systems capable of producing pressures as low as 10^{-3} to 10^{-4} as "high"; those operating

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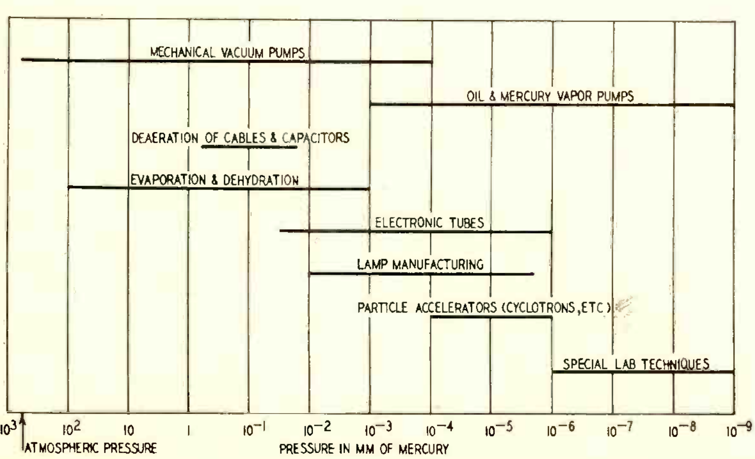


Fig. 1—Typical pressure ranges of some common pumps and processes.

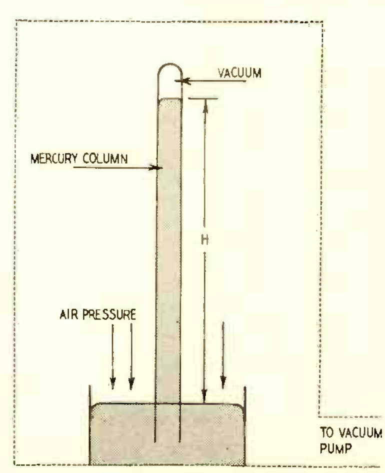


Fig. 2—Mercury-column pressure gauge.

still lower, say to 10^{-6} mm Hg, as "very high" and those few systems capable of going beyond this point, "ultra high."

To produce high vacua, it is necessary to work harder and harder to obtain less and less. The greatest effort must be applied to obtain practically nothing! Well, not quite nothing. Inside the average television tube, which is at a pressure of about 3×10^{-3} mm Hg, there are approximately 10^{14} (100 million million) air molecules per cubic centimeter. At the lowest pressure yet obtained in the laboratory, each cubic centimeter still contains more than 200 millions of these molecules.

Most vacuum gauges, certainly all those which may be classified as electronic, operate by ionizing these molecules in some way and then measuring the resultant current. Some of these gauges are listed in Fig. 3, together with the regions of pressure in which they usually operate.

McLeod and Knudsen gauges

Two nonelectronic gauges, the McLeod and Knudsen, which do not use this principle, are worth mentioning because they are the basic gauges used for calibrating all others.

The McLeod operates on the principle of taking a sample of gas of known volume V_1 from the vacuum system at a pressure P_1, which is too low to measure. This sample is then compressed into a smaller volume V_2 at a higher pressure P_2, which can be measured by a mercury column. The unknown pressure P_1 may then be easily calculated by Boyle's law, $P_1 V_1 = P_2 V_2$.

This gauge, though simple and easily calibrated, is not in general use as a vacuum gauge primarily because it is slow to read (it requires 10–15 minutes for one pressure measurement), is not continuously reading and cannot be read remotely. It is also very difficult to use at pressures below 10^{-4} mm Hg.

The Knudsen gauge consists of a thin sheet of metal suspended between two heated plates located on opposite sides and at each end of the sheet. Gas molecules entering the region between the sheet and the plates gain momentum from the heated plates and bombard the sheet with greater force than those molecules which happen to strike other areas of it. The sheet will therefore be deflected away from the heated plates and the amount of the deflection, proportional to the number of gas molecules present, will be a direct measure of the pressure in the system.

The Knudsen gauge is unique in that its action is independent of the kind of gas or vapor pressure of the gas in the vacuum system. No other gauge has this property and the Knudsen gauge is thus the only absolute gauge we have. It is also a continuous-reading device, although somewhat slow in responding to pressure changes in the vacuum system.

Unfortunately, it has several serious disadvantages which preclude its more general use. The principal ones are that it is delicate and must be rigidly mounted on a vibration-free support, it cannot be read remotely and the pressure range of any given gauge is relatively narrow. Although the Knudsen gauge principle can be used to measure pressure from about 10^{-2} to 10^{-8} mm Hg, this can be done only by using instruments with different suspensions and heater temperatures.

The Alphatron

This is the newest of the vacuum gauges and since it was placed on the market comparatively recently it is not in very general use.

The heart of the device is a sealed radium source of about 200 milligrams, placed inside an ion chamber. Alpha particles emitted from this source at a constant rate cause ionization of some of the gas molecules from the sample taken of the vacuum system. Since these ions are collected in the chamber at a rate proportional to the number of gas molecules present, the response of the gauge should be linear. This has been found to be so for a range of pressure extending from about 10 to 10^{-3} mm Hg.

The output current from is gauge is very low, about 2×10^{-7} microamperes at 10^{-3} mm Hg. A very-high-gain d.c. amplifier must be used to measure this minute current. The lower limit of pressure will measure about 10^{-4} mm Hg since, at this pressure, the ion current produced by the gauge has about the same magnitude as the grid current of the amplifier tube in the first stage. Input resistors for this amplifier range from 100 to 10,000 megohms—far beyond the range of most service shops to check.

The gauge appears to have few disadvantages and much to recommend it. The probe head containing the fairly husky radium source, although safe as constructed, should be taken apart only by someone trained in the handling of radioactive materials. Thus, it is likely that any field service done on this gauge will be limited to the d.c. amplifier. Other possible disadvantages are its comparatively high cost and the fact that it operates in a pressure region now occupied by well-established and substantially cheaper gauges.

Among its advantages are these: The source of ions requires no power supply and is self-regulating, it is very rugged and not easily broken, there is no filament to burn out and the gauge cannot be harmed by exposure to full atmospheric pressure.

In common with many other gauges, the response of the Alphatron varies with different gases. When measuring the pressure of a vessel containing helium, for example, the output current from the gauge will be only one-tenth as much as for air at the same pressure. Fortunately, however, the gauge response is almost the same for air as for water vapor. For this reason it should become a great favorite with the dehydration industry.

Thermocouple gauge

Of all the gauges available for the measurement of low pressure, the thermocouple type will probably be of greatest interest to the readers of RADIO-ELECTRONICS. Extremely rugged, simple and foolproof in operation, it cannot be damaged by operation at full atmospheric pressure. The control circuit requires only a few relatively inexpensive parts and the range of pressure measured is almost ideal for the vacuum systems used in the average shop or basement laboratory.

Its essential elements (Fig. 4) are a heated wire and a thermocouple. The operation of the gauge depends on the fact that over a certain range of pressure, the heat conductivity of a gas depends on the number of gas molecules (gas pressure) present. This means that with a constant current to the heated wire, the wire will be relatively cool when the pressure is high (poor vacuum and low output from the thermocouple) and will get progressively hotter as the pressure is reduced (better vacuum and higher output from the thermocouple).

The extreme simplicity of this gauge and of the electrical circuit used with it may be seen from Fig. 4. To operate the gauge it is only necessary to set

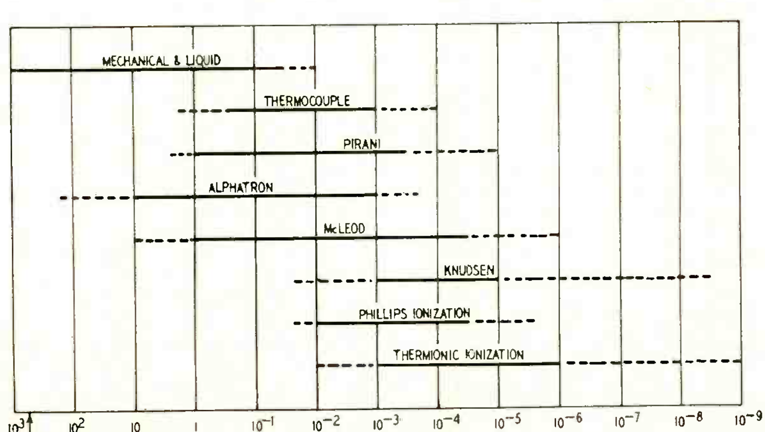


Fig. 3—Some of the various vacuum gauges and the ranges achieved by them.

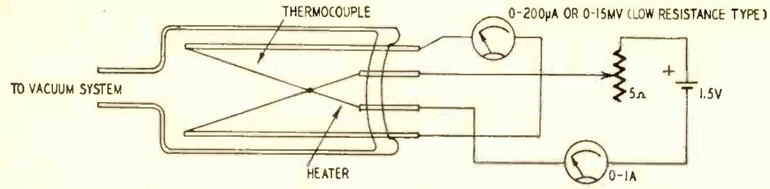


Fig. 4—The schematic and control circuit of a thermocouple vacuum gauge.

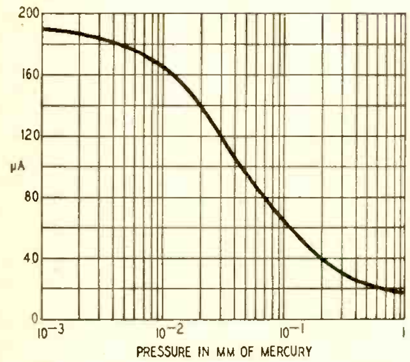


Fig. 5—The calibration curve for the model 501 thermocouple gauge.

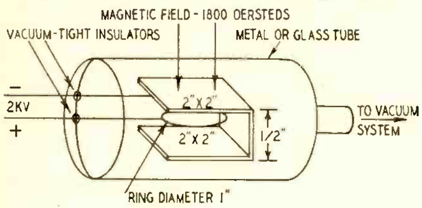


Fig. 6—Diagram of the Phillips gauge.

the heater current to the value marked on the tube (usually about 0.62 ampere) and read the output current on a microammeter or millivoltmeter.

The output current from the thermocouple is relatively high and may be read directly on a meter without intermediate amplication. The meter must be of the low resistance type, however.

One of the most popular thermocouple vacuum gauges is the model 501 all-metal tube manufactured by the National Research Corporation, Cambridge, Mass. It has a standard eight-prong octal base for the electrical connection, a threaded pipe for attaching the tube to the vacuum system and may be purchased for about $12.

The calibration curve for this gauge for dry air, and for 70-ohm impedance in the thermocouple output circuit, is in Fig. 5. This curve will not be valid for gases other than dry air, however, because the heat conductivities of these gases are not the same for the same pressure. Each gas will require its own calibration curve, but this is usually not a serious disadvantage.

The Pirani gauge, which will not be described here, is a variation of the thermal conductivity principle. In this gauge, the heated wire is part of a Wheatstone bridge circuit and the change of resistance, measured by the bridge, indicates the pressure.

Phillips ionization gauge

This extremely popular gauge overlaps the upper range of the thermocouple gauge and the lower range of the thermionic gauge, and frequently will take the place of both. It operates by maintaining a glow discharge between two electrodes in a magnetic field.

As pressures become lower and lower, the distance an electron must travel before it makes an ionizing collision with a gas molecule becomes greater and a glow discharge cannot be maintained for any reasonably low voltage between the electrodes. At a pressure of 10^{-3} mm Hg, for example, the average electron will travel about 2½ inches before making an ionizing collision. But at 10^{-4} mm Hg this distance increases to 25 inches—over 2 feet!

In the Phillips gauge the glow discharge is maintained between a circular anode and double cathode arranged in a magnetic field as shown in Fig. 6. Because of the potential difference between the ring and the cathode, an electron which finds itself near the lower plate will be accelerated upward. It misses the ring, however, and continues through the ring, traveling in a tight spiral about one of the magnetic lines. As it approaches the upper plate it is repelled and travels downward through the ring to repeat the process. This oscillation up and down may be repeated many times. This makes the path length of the electron much longer than it would normally be and the chance of an ionizing collision is greatly increased.

There is nothing particularly critical about the geometry of the electrodes, the magnetic field intensity or the voltage used with the gauge; but the calibration does depend on these factors. In general, large electrodes and high voltage seem better for low-pressure work. For pressures above 10^{-3}, lower voltage (1 kv) and smaller electrode spacing are necessary.

The purpose of the magnetic field is to cause the electrons to move in a tight spiral; the weaker the field the wider this spiral will be. As the electron spirals about one of the magnetic lines the path length is increased in the horizontal plane, just as it was increased in the vertical direction by oscillating up and down. Values of field intensity used have been reported as low as 300 oersteds and greater than 5,000. It is apparently not at all critical but it should not be so low that the diameter of the spiral path of the electron becomes large in comparison with the diameter of the ring anode. For any particular gauge there will probably be a particular field strength where the gauge reaches maximum sensitivity. But it may work well with a variation of 50 to 100% of this value.

Given a small lathe and a little shop experience, a Phillips gauge can be easily constructed. One such gauge was made of a 1½-inch diameter brass pipe. The magnet was housed inside the pipe with the ⅛ x ⅝-inch pole shoes, spaced 11/32 inch apart, also serving as cathodes. The 2-kv supply for the ⅞ x ⅝-inch anode was brought through the end of the pipe by a Kovar seal. This is a small glass-to-metal vacuum-tight insulator which can be obtained in a variety of sizes and styles from the Stupakoff Ceramic Co., Latrobe, Pa. With a field strength of 1,400 oersteds, the unit has been working very well for many months.

The electrical circuit for this gauge (Fig. 7) is also very simple. The 1-megohm resistor in series with the high voltage is a protective device used to limit the current in case of a short in the external circuit.

A typical dry-air calibration curve for a Phillips gauge is shown in Fig. 8. Since the response of the gauge will vary with different gases, the gauge must be calibrated for whatever gas is being used. The output of the gauge is high and—as for the thermocouple type—the output current may be metered directly.

This gauge is also very rugged and dependable and may be exposed to atmospheric pressure without harm. Because of its simplicity, the chances of trouble are greatly reduced and what difficulties do arise are usually due to the high voltage used.

Although the output of this gauge

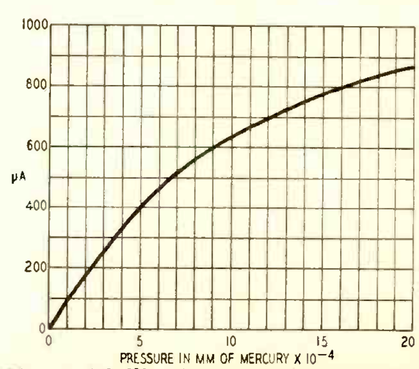


Fig. 8—Phillips ionization gauge curve.

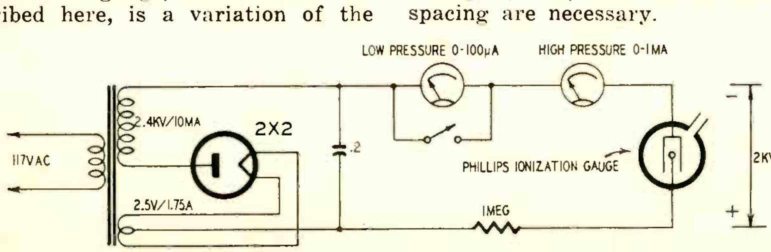


Fig. 7—Schematic shows the circuit for a Phillips ionization gauge.

is relatively high, in the higher pressure region of its range the output current will be reduced to only 10 μa or so when it is operating at pressures around 10^{-5} mm Hg. Because of the high voltage used, about 2,000, the insulation resistance must be greater than 1,000 megohms to avoid reading leakage currents comparable to the low output current. Another source of trouble is electrical breakdown of the insulators in the cable connectors at the gauge or power supply. Usually due to faulty design or damp locations, it can usually be corrected without difficulty.

Thermionic ionization gauge

The triode tube is the only device that can measure extremely low pressures, respond quickly to any change in pressure (useful for leak hunting) and still be read and operated at a considerable distance from the vacuum system.

The basic circuit for this gauge is shown in Fig. 9. Although it may seem simple, the actual device, as used industrially, may be somewhat bulky and complex. The reason for this is that the sources of voltage and current, shown on the diagrams as batteries, are replaced in the commercial form with voltage- and current-regulated power supplies. And a d.c. amplifier is almost always used to increase the output current to a more measurable value and to provide for a selection of scales so that a pressure range of more than 10,000:1 may be observed with the same gauge. Also included in the industrial version are a circuit for degassing the tube elements and a protective device for removing power from the filament in case the pressure should rise too high.

The gauge will work well with batteries, however, and a tube is frequently connected in this way to check the tube. It may also be used to calibrate other gauges.

In its original form, the thermionic ionization gauge was an ordinary triode tube, using a conventional positive plate and negative grid. When gas is collected in the tube, the positive ions, resulting from collisions between the gas molecules and the electron stream, are collected on the negative grid and the grid current used as a measure of the pressure.

It was discovered, however, that the gauge became much more sensitive when the grid was made positive and

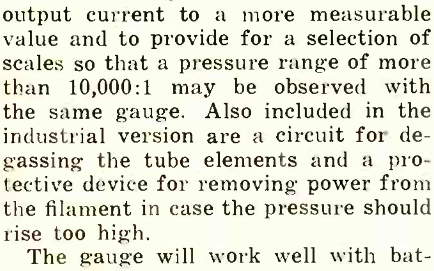


Fig. 9—The thermionic ionization gauge.

the plate negative. Under these conditions, electrons emitted by the filament are accelerated toward the positive grid. Some will be trapped there but many will pass through into the region between the grid and the plate. As they approach the plate, they are repelled back toward the grid and, when the pressure is low, this action may be repeated many times. The net result is an appreciable increase in the path length, a greater chance of collision with stray gas molecules and increased output current (greater sensitivity) from the tube.

The positive ions produced as a result of these collision are collected at the negatively charged plate and the ion current measured with a sensitive microammeter or galvanometer.

If the emission current is kept constant and the electrode potentials remain fixed, the positive-ion current (Is this an *electronic* device?) will be directly proportional to the pressure and the gauge will be linear from 10^{-3} to beyond 10^{-7} mm Hg.

Although any triode will show this effect, special tubes have been developed for use as vacuum gauges. Two of the most popular are the D79510 made by Western Electric and the VG1A made by Distillation Products Inc.

To reduce leakage currents, these tubes are made with glass bulbs and do not have tube bases for the leads. Instead the leads are brought out through glass seals at the bottom of the bulb and, for the VG1A, the leakage current is reduced still further by bringing the plate lead out at the side. Other differences are that the grid wires are farther apart than in the conventional triode, the grid-to-plate spacing is greater and the bulbs have glass tubulations for convenience in attaching the tube to the vacuum system. The price of either of these tubes is about $25 and the control circuits for these will cost approximately between $250 and $425.

The output of a thermionic ionization gauge is relatively low. The VG1A, for example, when connected as shown in Fig. 9, will produce an ion current of about 100 μa for each micron (10^{-3} mm) of mercury, when used with dry air. Thus, for 10^{-4} mm the current would be only 10 μa, and this would be reduced to only 1 μa at 10^{-5}. A sensitive galvanometer is required to measure the ion current when operating in this region and a d.c. amplifier would be necessary to measure pressures below this.

Although the response of the gauge is linear, it is not the same for all gases and the data given are correct only for dry air. For other gases a correction must be made for the molecular weight of the gas or a calibration made against a McLeod or Knudsen gauge. When used with air, however, the operation of the triode ionization gauge has been found to be so predictable that it is being used more and more for the calibration of other gauges and it is a growing practice to measure a vacuum system in terms of the microampere output from the gauge. This is particularly true for the VG1A.

The life of a triode ionization gauge is difficult to predict but with the best of care and under conditions of constant low pressure it may last for 500 hours or more. As pressures increase to 10^{-3} the filament life will be somewhat shortened and the gauge should not be operated at all at higher pressures.

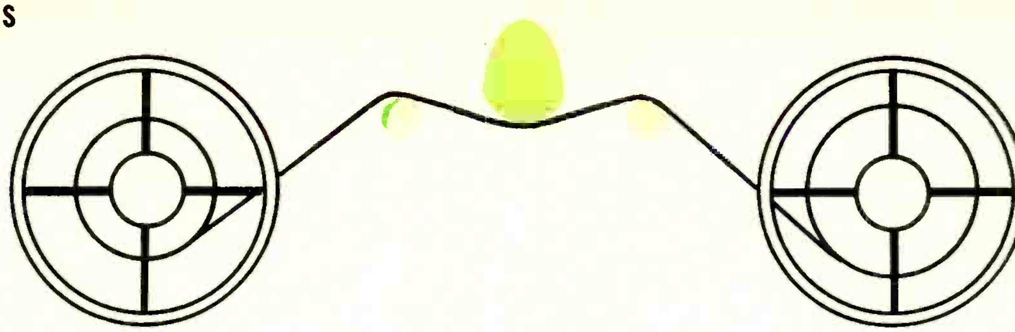
Oil or water vapor in the system will shorten its life to only a few hours and the admission of air to the tube at atmospheric pressure—or even at pressures very much lower than atmospheric—results in immediate destruction of the filament.

In conclusion, in addition to such considerations as pressure range, price and durability, the selection of a vacuum gauge will also depend on a variety of other factors. For example, the presence of oil vapor, which sometimes enters the vacuum system from the diffusion pumps, may cause hydrocarbon "poisoning" of the triode ionization gauge filament. The choice may, therefore, be made to use the VG1A tube in preference to the D79510, since the pure tungsten filament of the VG1A is more resistant to this effect than the thoriated tungsten filament of the Western Electric tube. However, the D79510 is more economical to operate because its thoriated tungsten filament requires less heating current.

The type and quantity of all contaminating vapors that may enter the vacuum system should also be carefully considered since these vapor will seriously affect the calibration of the gauge. This is a common difficulty in cyclotrons and other particle accelerators because gases such as hydrogen and helium are frequently admitted to the vacuum system for acceleration. When this occurs, it is necessary to choose between an absolute or relative measurement of the system pressure.

Other factors which may influence the selection of a vacuum gauge include the possibility of heated parts in the gauge causing decomposition of some of the gas in the system and (in the case of corrosive vapors), the likelihood of these gases attacking the gauge elements. The gauge itself may even influence the pressure in the system: the Phillips ionization gauge, for example, may act as a tiny vacuum pump and actually improve the vacuum because of the "getter" action of the glow discharge. This effect is very strikingly shown when the Phillips gauge is used on a small, closed, vacuum system at a pressure of about 10^{-4} mm Hg. As the gauge is operated, the pressures becomes lower and lower.

When all factors are considered, one "best" gauge will usually be found to satisfy specific requirements. With intelligent use and recognition of its limitations it can be relied upon to do a very dependable job. END



Magnetic Tape Recorder Aids Industry

By JAMES R. CORNELIUS*

IN many industrial manufacturing processes there is a time lag between the application of raw material to a machine and its arrival at an operating position. For instance, in the manufacture of self-tapping screws, the wire from which they are rolled arrives at the entrance to the machine at zero hour. But the screw cannot be made for some 10, 20 or 40 seconds due to the length of wire between the entrance to the machine and the production rollers. Or where cans of meat are being processed, each can passes an investigation point on the inspection table where rays such as the alpha or beta type examine the contents through the can walls for imperfections or loss of ingredients in processing. Any can not up to standard must be rejected. The rejection cannot take place at the position of inspection but must be performed physically some time later.

In these cases it is simple to mark the can or the wire and allow either an operator or a light cell to reject any can or length of wire so marked at the operating position of the machine.

A much more simple method, one that is practically foolproof, is to use a magnetic tape recorder as a memory system on a continuous basis.

Self-tapping screws are made from steel wire fed into a processing machine where it advances more or less rapidly, according to the size and length of the screws to be made. The wire, just prior to entering the machine, is passed through a materials flaw-detection apparatus (see diagram) which causes a relay to close every time a defective length of wire passes through the detector coil. This relay, in closing operates a circuit, permitting a 60-cycle 6-volt signal to operate a recording head fitted into a memory box attached to the detector unit.

The type of screw being made requires a time lag of, say, 12 seconds before the defective portion of wire reaches the processing rollers. The machines are usually arranged so that it is not possible to remove the faulty wire without losing more in time than the material is worth. Thus the wire is allowed to be processed and the screws fed to the scrap bin instead of being passed on to the next operation.

The signal to operate the deflector gate from pass to scrap is provided by the combination of: the defect signal given to the material detector by the wire; the signal passed by the instrument relay to the recording head of the memory box; the delay arranged between the recording head and a second pickup head fitted to a rotating disc around the periphery of which is a layer of magnetic film (the second head is adjustable around the disc to permit the correct time delay before the signal is used) and a second relay operated by the signal from the second pickup head that deflects the screws from good to scrap.

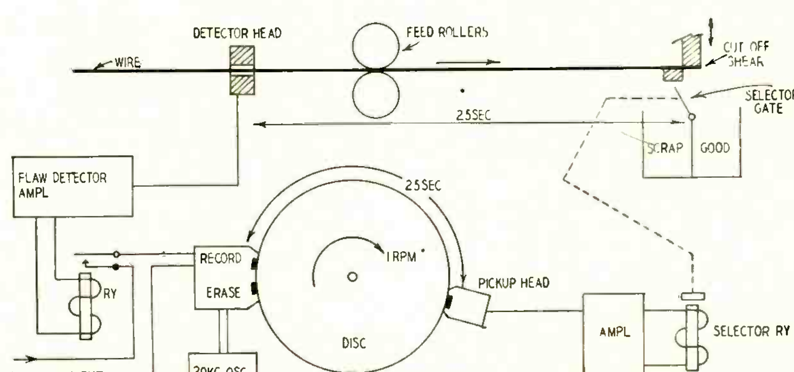
The time delay normally required in any manufacturing process rarely exceeds a minute and usually extends from a few seconds to about 35 seconds. The length of the signal may be many minutes, depending upon the quality of the material being processed. These conditions require a disc of about 10 inches in diameter with the edge containing a film of protected ferrous oxide or other paramagnetic coating.

The disc is mounted on a synchronous clock motor shaft to obtain continuous rotation with a speed of one revolution per minute. The combined recording and erasing head is fitted permanently so that the disc, in rotating, will always meet the erasing-head before the recording-head position. This will allow any signal impressed on the film to be removed before the recording head imprints another on the film.

Owing to the slow speed of the disc, a signal frequency of 60 cycles will be very different from the same signal impressed on a tape moving at 8 feet per second. This must be borne in mind when deciding the frequency of the erasing oscillator. Since the purity of any signal is of minor importance, the main conditions to be considered are signal power and freedom from unwanted signal noises.

The pickup head must be mounted on an arm that permits the head to be swiveled around the disc from the vicinity of the recorder head to the eraser head, thus obtaining some 50-second variation in delay between impression and relaying of the signal.

The action is simple. The disc in rotating causes the film to pass first the erasing head which impresses the constant high-frequency unmodulated signal base. The film then passes the recording head which modulates the high frequency with the 60-cycle signal that will be impressed for as long as it exists. The distance between recorder and repeater determines the time delay and the repeater will repeat the signal for as long as it has been recorded. This signal can be used for any necessary service. END



Applying the tape recorder to an industrial process for flaw detection

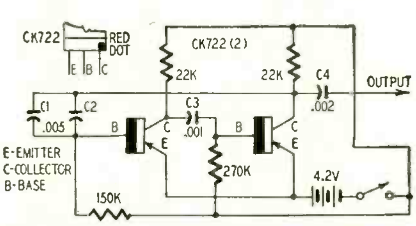
*Cornelius Electronic Instruments Ltd. Coventry, England

MIDGET TRANSISTORIZED SIGNAL INJECTOR

By ELLIOTT A. McCREADY

Tiny instrument produces a.f. and r.f. signals

The completed signal injector.



Schematic diagram of the midget transistorized signal generator.

TROUBLESHOOTING by signal injection is a speedy method of spotting a defective stage in a radio receiver or audio amplifier. Sometimes an r.f. or audio generator is used to provide the test signal. However, a slightly modified square-wave generator will, not only emit an audio tone, but also provide numerous harmonics usable as an r.f. source. Such an instrument was manufactured and widely advertised some years ago, and a home-constructed version appeared in RADIO-ELECTRONICS ("The Signal Launcher," Robert E. Altomare, October, 1951).

The wide availability and constantly decreasing price of the transistor now make it practical to construct a generator of this type as a very small, compact and self-powered unit.

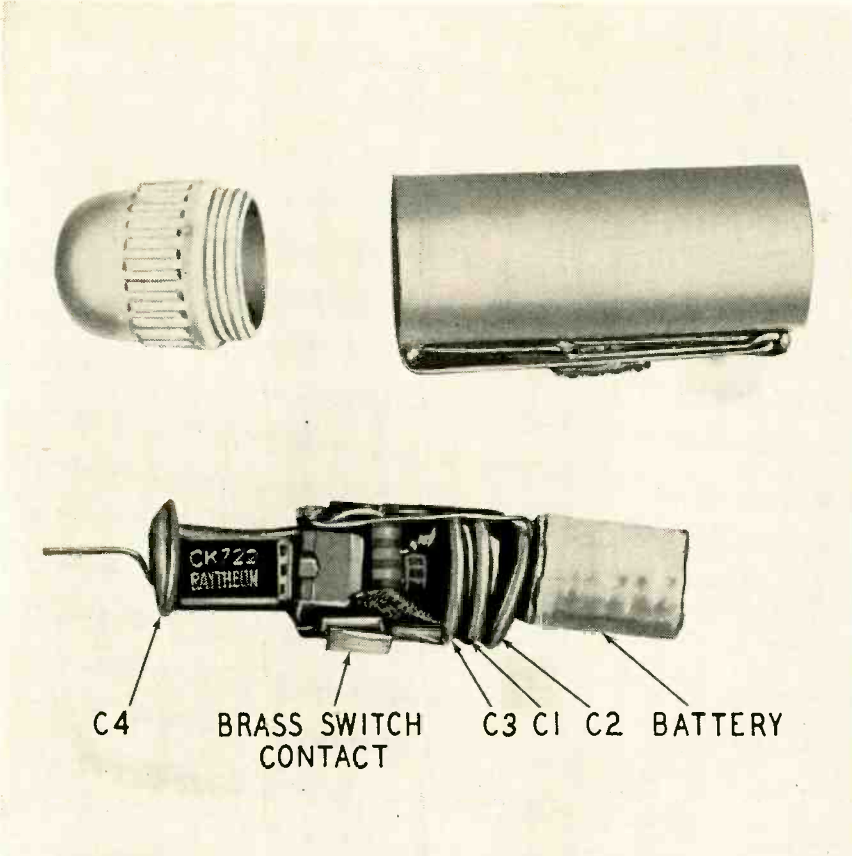
The instrument was built around two Raytheon CK722 junction transistors and is contained in a plastic inhaler case (see photos). The completed unit measures only ¾ x 3 inches and draws so little current—approximately 300 microamperes—that the self-contained power supply will last indefinitely.

The two transistors are connected in a conventional multivibrator circuit and component sizes are chosen to produce a pulselike wave of approximately 2,000 cycles. The output wave has an extremely high harmonic content, and a usable signal extends from the fundamental frequency through the entire broadcast band. Three cells of an RCA type VS087 transistor battery provide a 4.2-volt power supply which measures only ½ x ⅝ inch. The output waveform (see photo) is approximately 3 volts peak to peak. A square wave of twice this amplitude can be obtained at the collector of V1, but the harmonic content is much lower and the usable range of the instrument is considerably decreased.

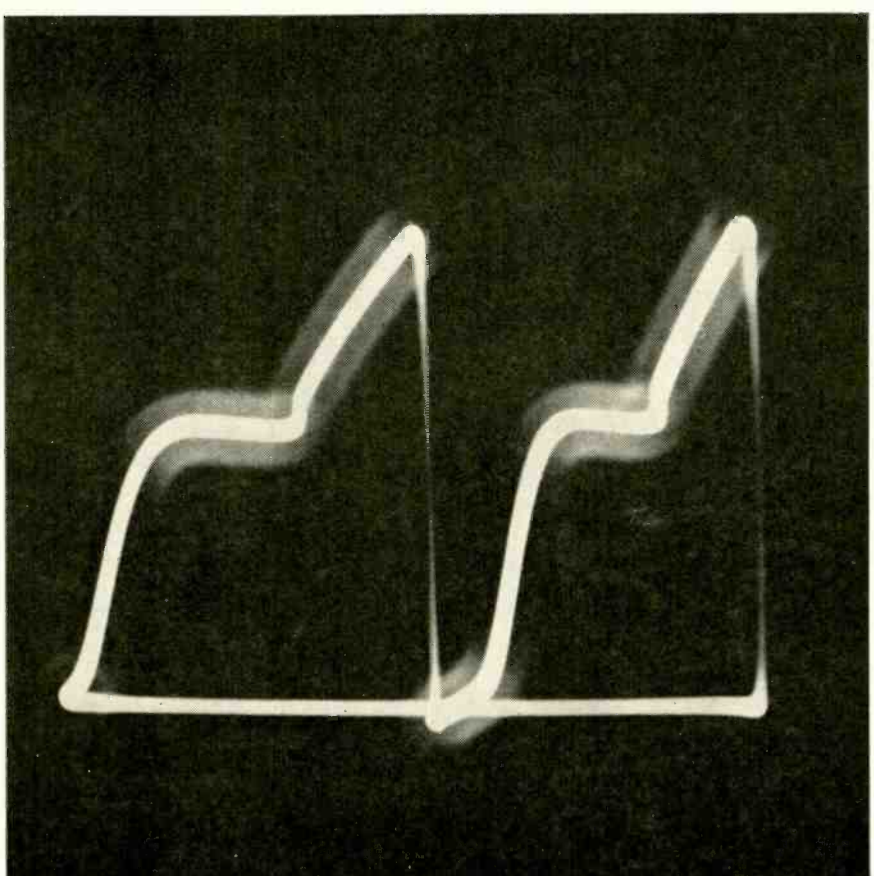
Construction

The two transistor sockets, with all unnecessary contacts removed, are clamped side by side and the emitter terminals joined. Base connections for the CK722 are shown in the diagram. Solder a length of tinned hookup wire to the emitter terminals for future connection to the battery. Then wire in all resistors and stack the disc type ceramic capacitors C1, C2 and C3 as shown.

Two .005-μf capacitors, C1 and C2, are used instead of a single .01-μf unit, due to the larger diameter of the .01-μf capacitor. An Ungar soldering iron with a No. 535 tip is very handy for applying solder to the more inaccessible places. Insert the two transistors in their sockets and mount C4 on top of them as shown in the photo. Arrangement of parts will, of course, vary with the case used. An even smaller case could be used if the transistors are soldered directly into the circuit. The sockets, however, provide a convenient terminal strip and prevent the heat of



Disc type capacitors (right of center) permit compact assembly of the unit.



Highly distorted output waveform of the instrument has high harmonic content.

the soldering iron from damaging the transistors.

The big problem that I ran into was that of finding a suitable switch for the instrument. Switches seem to be one thing that manufacturers have neglected to miniaturize. There was no room left in the case for a switch so it had to be mounted externally. The problem was solved by removing the pocket clip and slide switch from a Burgess two-cell penlight, drilling a hole in the plastic case of the signal generator to accommodate the switch contact and gluing the entire assembly to the side of the case. A strip of thin spring brass, soldered to the negative terminal of the generator and folded several times to fit flush against the inside of the plastic case directly under the hole in the case, provides the other switch contact.

Another small piece of spring brass is placed in the bottom of the case to make contact with the negative terminal of the battery and is connected through a hole in the case to the end of the pocket clip. The positive terminal of the battery is then soldered to the lead from the emitters, a hole drilled in the screw cap of the plastic case to accommodate the output lead and the unit is ready to assemble.

Parts for transistorized signal injector

Resistors: 2—22,000, 1—150,000, 1—270,000 ohms, ½ watt.

Capacitors: 1—.001 µf, 1—.002 µf, 2—.005 µf, ceramic disc.

Miscellaneous: 2—CK722 transistors; 2—Cinch-Jones subminiature hearing-aid sockets, type 2H5; 1—transistor battery (RCA type VS087 or equivalent); 1—switch assembly from Burgess two-cell penlight; 1—plastic case; 1—length of thin brass foil.

After carefully checking for shorts, insert the unit in its case and clip the excess lead from C4 to within about ¼ inch of the cap. This protruding wire forms the generator probe.

Checking the unit

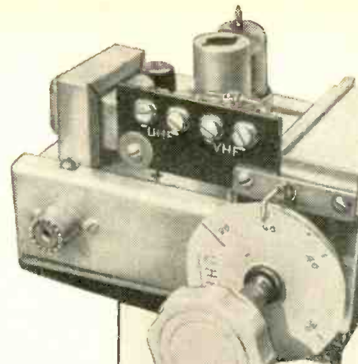
With the generator switched on, connect an oscilloscope between the metal switch assembly and the probe. A signal like that shown in the photo should appear. Interchanging V1 and V2 may change the waveshape somewhat, as each transistor will operate in a slightly different manner. Choose the most pulselike or differentiated waveshape since its harmonic content, and hence the r.f. output of the unit, will be higher.

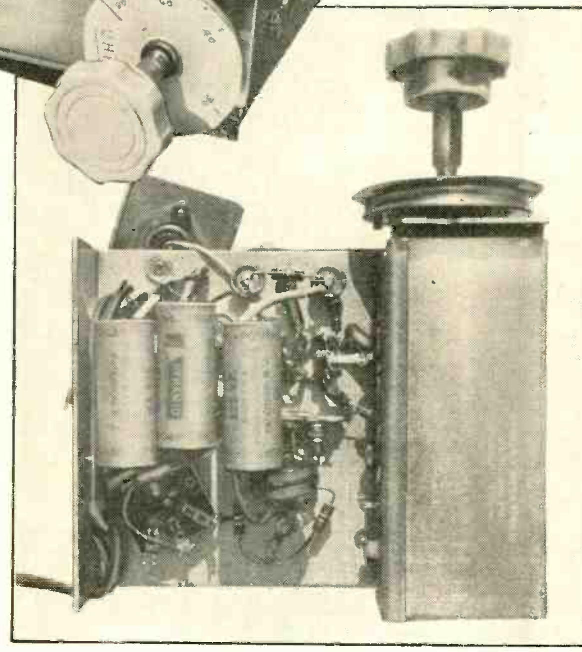
Output frequency will vary from unit to unit as the ceramic capacitors have only a 20% tolerance, but anything around 1,000 to 2,000 cycles will be satisfactory.

With the signal injector switched on, touch the probe to the plate and grid of each stage of the unit to be tested, starting with the output stage and working back. With some receivers, the output of the signal injector can be increased by touching the metal switch with the finger while the unit is in use. The point at which the signal is no longer heard indicates the stage where the trouble lies. END

U.H.F.

Right, u.h.f. bar generator and sweep adapter, showing mixer assembly board. Below, underchassis view shows arrangement of parts in oscillator and modulator.





BAR GENERATOR and SWEEP ADAPTER

Easily assembled, inexpensive unit built around a Mallory u.h.f. Inductuner

By BRUCE MORRISSETTE

SERVICE technicians and u.h.f. experimenters still widely lack such expensive instruments as u.h.f. sweep, bar and marker generators. This simple, easily constructed unit (see photos), intelligently handled, will provide a variety of u.h.f. test and service functions with excellent results and at a substantial saving.

Used without auxiliary equipment, the u.h.f. unit is a compact, portable bar generator providing a stable, clean-cut pattern of black-and-white horizontal bars on the screen of any TV receiver using either a u.h.f. converter or tuner. This checks the performance of a set at u.h.f. from antenna to picture tube in the absence of a test pattern or signal from a local u.h.f. station.

With the bar modulation turned off, the unit becomes a u.h.f. marker generator whose accuracy is a matter of calibration. Low-impedance coaxial output permits the marker-output r.f. to be coupled into a mixer or other device.

Since the signal passing through the u.h.f. unit does not encounter any unidirectional vacuum tubes, it may go in either direction, from v.h.f. to u.h.f. or from u.h.f. to v.h.f. The instrument may thus be used as a regular converter to view u.h.f. station programs on a v.h.f. receiver.

In connection with equipment already on the v.h.f. service bench, the u.h.f. adapter converts v.h.f. sweep generators to u.h.f. and may be used for aligning and testing u.h.f. converters and tuners. The v.h.f. sweep generator may be set at any convenient frequency from around 20 to 200 mc, with the adapter then tuned to provide a sum frequency at the u.h.f. output terminals ranging from television channel 14 to 83.

Harmonics of a v.h.f. signal generator may be used to supply calibrations along the alignment curve. This setup is shown in Fig. 1. Attenuation is controlled at the v.h.f. sweep generator output. The converter or tuner output is detected either by a crystal detector probe or by feeding the converted output to the regular v.h.f. input of a TV set and taking the scope output from the r.f. mixer grid test point. In the latter case the input to the v.h.f. tuner must match the frequency of the particular channel to which the v.h.f. tuner is set.

If two of the adapter units are constructed, one of them (which need not have the mixer assembly nor bar modulation feature) may be calibrated and used as a u.h.f. marker generator. The output of this oscillator may then be fed through a device such as the Sideband Modulator for Marker Generator, described by the author in the April, 1955, issue of RADIO-ELECTRONICS and, with a 4.5-mc crystal, provide both sound and video carrier markers for u.h.f. sweep curve adjustment to secure proper bandwidth, tilt and symmetry of response. This more complete alignment setup is shown in Fig. 2.

Circuitry and construction

The basic u.h.f. adapter design is a stable 6AF4 oscillator coupled in an ultraudion circuit to the front section of a Mallory u.h.f. Inductuner, providing u.h.f. output through a range of approximately 450 to 900 mc. These u.h.f. Inductuners have been used in u.h.f. converters of many different makes. If a discarded u.h.f. converter of the same or nearly any other design is available, its oscillator section may be used. It would be best not to build the unit around a converter that uses harmonic mixing, though it will work if the results are properly evaluated.

As is evident from the schematic Fig. 3, the pure r.f. from the 6AF4 u.h.f. oscillator may be plate-modulated to provide a horizontal bar pattern. When its heater is activated by modulation switch S1, a 12AT7 symmetrical multivibrator supplies square-wave modulation through a large (16-μf) electrolytic capacitor to the plate of the 6AF4. Switch S1 is placed in the heater circuit so that when it is open it will remove, not only the plate current drain of the 12AT7, but the 0.3-ampere heater load as well, permitting the midget power transformer to run cool when the unit is used for extended periods of time as a receiver converter.

The untuned u.h.f.–v.h.f. mixer assembly is mounted on a phenolic terminal board. The 1N82 mixer is mounted point-to-point between one u.h.f. and one v.h.f. terminal. The r.f. chokes are in back, connected from the terminals to an aluminum grounding strip which supports the phenolic board. The oscillator output from the 6AF4 is coupled to one side of the crystal through a gimmick capacitor consisting of two insulated wires twisted together for about 1 inch to give about 2 $\mu\mu$f of capacitance. Since the mixer is entirely untuned, it is a broad-band device that may be used at any frequency from about 20 mc up and may operate in either direction, from u.h.f. to v.h.f. or from v.h.f. to u.h.f.

The underchassis photo shows the

arrangement of most of the components. The selenium rectifier is located under the electrolytic capacitors. An aluminum chassis plate is cut and bent to fit against the u.h.f. Inductuner, with the 6AF4 socket located close to the terminals of the front section of the tuner. Orient the socket so that pins 1 and 7 (plate pins) are closest to and parallel to the tuner. Join these two pins with a ⅛ inch wide strip cut from a tin can, to provide a low-inductance connection. Join grid pins 2 and 6 with a similar strip. Ceramic tubulars of 12 $\mu\mu$f connect the grid and plate pins as directly as possible to the two u.h.f. tuner terminals.

The seven high-frequency r.f. chokes may be bought commercially (Burstein-Applebee No. 17B659) or wound on the bodies of high-ohmage resistors, using approximately 35 turns of No. 30 enameled wire closewound on a 3/16-inch form. The coupling capacitors are tubular ceramics for the oscillator and

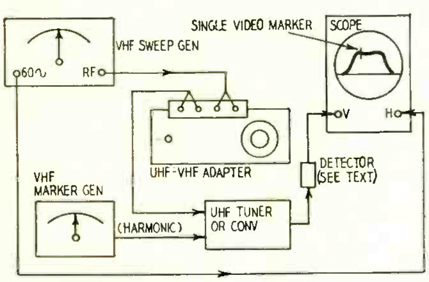


Fig. 1—Equipment layout for supplying calibrations along alignment curve.

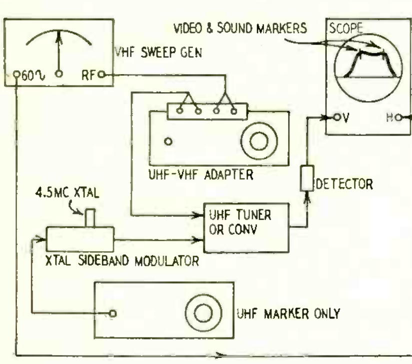


Fig. 2—Complete u.h.f. alignment setup, using author's sideband modulator.

disc type ceramics for the multivibrator. All resistors are ½ watt. Any type of small, half-wave power transformer may be used (Burstein-Applebee sells an excellent one, No. 19C714, for around $1). The wiring of the power supply and multivibrator circuits is not critical. Should the horizontal bar pattern prove slightly unstable, try changing one or both grid resistors in the 12AT7 circuit until good lock-in is obtained. An Amphenol r.f. connector (type 83-1R) connected directly to pin 3 of the oscillator tube supplies a high-output r.f. signal for marker or other uses. Bottom and end plates are added and a cardboard dial with calibrations as desired is placed over the tuner shaft.

Adjustment and use

When the unit is complete, test it for oscillation over its entire frequency range. A v.t.v.m. or 20,000-ohms-per-volt multimeter will show a negative grid voltage at the 6AF4 grid of 2 or 3 if it is oscillating properly (use an isolating resistor at the end of the probe touching the 6AF4 grid). Switch on the multivibrator and listen to its tone with a pair of headphones connected to ground and (through a 0.1-μf blocking capacitor) to the positive end of the 16-μf coupling capacitor from pin 1 of the 12AT7. If a scope is available, view the square wave. It should be of good symmetry and amplitude, having a frequency of between 600 and 700 cycles.

Air-check the entire unit by attaching a short length of wire to either J (a banana plug will fit the 83-1R receptacle) or to the u.h.f. terminal that is connected to the cathode end of the 1N82 crystal. Switch on bar modulation and tune in the u.h.f. horizontal bars at various u.h.f. channel frequencies on a TV set equipped with a u.h.f. tuner or converter. When it is apparent that the unit will supply a good bar signal over the u.h.f. range, the adapter may be calibrated and used for any of its functions.

In converting v.h.f. test gear to u.h.f. as in the block diagrams of Figs. 1 and 2, it is not necessary to compute exact sum frequencies to establish the u.h.f. alignment curve. For example, assume you want to use a v.h.f. sweep generator to align a u.h.f. tuner or converter for channel 54 (710–716 mc). We would set the v.h.f. sweep generator to some convenient frequency, sweeping, say, from 40 to 50 mc for a 10-mc bandwidth. (It is better *not* to set the v.h.f. generator at frequencies used in a receiver i.f. if the receiver portions of the set are to be used in alignment.)

With the v.h.f. sweep generator attached to the v.h.f. terminals of the adapter unit, either with or without matching resistors or balun, connect the u.h.f. adapter terminals to the u.h.f. antenna input of the tuner or converter. The scope is then connected to the u.h.f. tuner output in the manner described, either through a crystal detector probe or a test point in the receiver mixer grid. If sensitivity is inadequate, either through some fault in the tuner or lack of amplification in the scope, the curve may be taken from the receiver's diode detector.

With the scope properly connected, turn the u.h.f. adapter unit slowly from the low-frequency (maximum counterclockwise) end of the dial until the alignment curve appears. Use an independent marker generator to check exact frequencies along the curve. In the example we have used, the curve will appear with the u.h.f. adapter oscillator tuned to give an output of about 670 mc. Adjust the shape of the u.h.f. curve for symmetry and bandwidth in accordance with the manufacturer's instructions or by tuning such padders and trimmers as may be provided.

To use the adapter as a converter to view u.h.f. programs on a v.h.f. receiver, connect a good u.h.f. antenna to the u.h.f. terminals and the v.h.f. terminals through 300-ohm flat line to the TV antenna input of the set. Tune the TV set to *any* unoccupied channel, rotate the adapter tuning knob until a u.h.f. station signal appears. Try various conversion channels and select the one giving the best results. An ordinary v.h.f. booster connected between the adapter unit and a TV set will step up converter results to a point almost as good as that of the best two-tube converters. Tune the booster to whatever conversion channel you desire. Without a booster, results will as a rule be good only in primary signal areas. END

Parts for u.h.f. bar generator and adapter

Resistors: 1—1,500, 1—4,700, 2—10,000, 1—12,000, 1—47,000, 2—100,000 ohms, ½ watt.

Capacitors: 1—2-$\mu\mu$f gimmick; 2—12 $\mu\mu$f, ceramic tubular; 3—500 $\mu\mu$f, standoff ceramics; 2—.005 μf, disc type; 1—16 μf, 1—16-16 μf, 150 volts, electrolytics.

Miscellaneous: 7—r.f. chokes (see text); 1—6AF4 and socket; 1—12AT7 and socket; 1—Mallory u.h.f. Inductuner (see text); 1—1N82 crystal; 1—selenium rectifier, 35 ma; 2—s.p.s.t. switches; 1—output jack (Amphenol 83-1R or equivalent); 1—phenolic terminal board; 1—small half-wave power transformer (see text); 1—chassis; 1—knob for tuner.

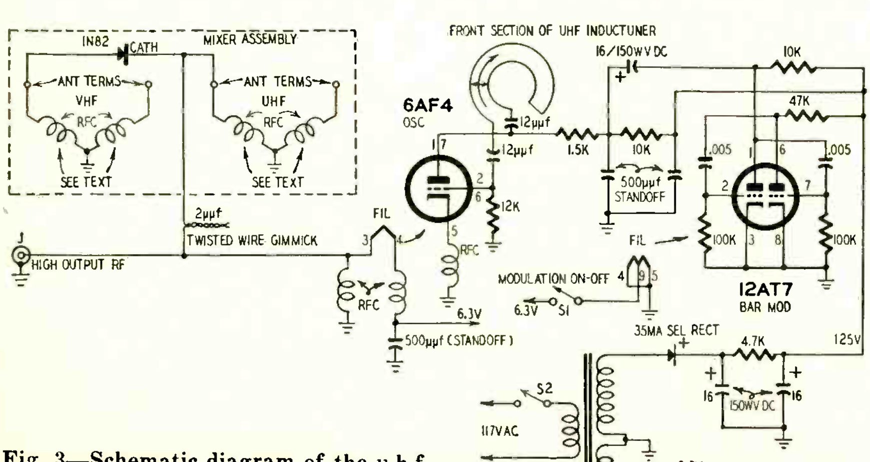


Fig. 3—Schematic diagram of the u.h.f. bar generator and sweep adapter.

Heathkit PRINTED CIRCUIT 5" COLOR TV *Oscilloscope Kit*

MODEL 0-10

$69.50

Shpg. Wt. 27 lbs.

The technical specifications for this fine instrument speak for themselves. Vertical channel sensitivity is 0.025 volts RMS/inch at 1 Kc. Vertical frequency response is essentially flat to 5 Mc, and down only 1.5 db at 3.58 Mc. Ideal for Color TV work!

Extended sweep generator range is from 20 cps to 500 Kc in five steps, far beyond the range normally encountered at this price level.

Other features are: plastic-molded capacitors for coupling and by-pass—preformed and cabled wiring harness—Z axis input for intensity modulation—peak-to-peak voltage calibrating source built-in—retrace blanking amplifier—regulated power supply—high insulation printed circuit boards—step attenuated and frequency compensated vertical input circuit—push-pull horizontal and vertical amplifiers—excellent sync. characteristics—sharp, hairline focusing—uses 5UP1 CRT—extremely attractive physical appearance.

An essential instrument for professional Laboratory, or for servicing monochrome or color TV.

Heathkit PRINTED CIRCUIT 3" OSCILLOSCOPE KIT

This light, portable 3" oscilloscope is just the ticket for the ham, for service calls, or as an "extra" scope in the shop, or lab. Measures only 9½" H x 6½" W x 11¾" D, and weighs only 11 lbs.

Employs printed circuit board for improved circuit performance. Vertical amplifiers flat within +3 db from 2 cps to 200 Kc. Vertical sensitivity 0.25 volts RMS/inch peak-to-peak, and sweep generator operates from 20 cps to 100,000 cps. R.F. connection to deflection plates.

MODEL OL-1

$29.50

Shpg. Wt. 14 lbs.

Heathkit PRINTED CIRCUIT 5" OSCILLOSCOPE KIT

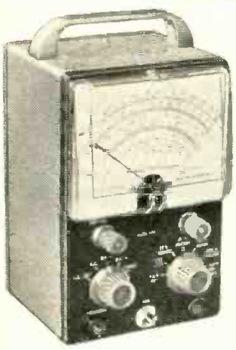
This full-size 5" Oscilloscope incorporates many outstanding features.

Vertical channel flat within +3 db. 2 cps to 200 Kc, with 0.09 volts RMS/inch peak-to-peak sensitivity at 1 Kc. Sweep operation from 20 cps to 100,000 cps. Built-in peak-to-peak voltage calibration—3 step frequency compensated input attenuator—phasing control—push-pull deflection amplifiers. Printed circuits for reliable performance and reduced construction time.

MODEL OM-1

$49.50

Shpg. Wt. 26 lbs.



Heathkit PRINTED CIRCUIT VACUUM TUBE VOLTMETER KIT

MODEL V-7

$24.50

Shpg. Wt. 7 lbs.

This VTVM has set a new standard for accuracy and reliability in kit-form electronic instruments. Features modern, time-saving printed circuits, and functional arrangement of controls and scales. Includes new peak-to-peak scale for FM and TV work.

Measures AC (RMS) and DC voltage at 0-1.5, 5, 15, 50, 150, 500, and 1500; peak-to-peak AC voltage at 0-4, 14, 40, 140, 400, 1400, and 4000; center-scale resistance readings of 10, 100, 1000, 10,000, 100 K, 1 meg., and 10 meg. DB scale provided also. Zero-center operation within range of front panel controls Polarity reversal switch—200 μa 4½ meter-transformer power supply—11 megohm input impedance — 1% precision resistors — high quality components used throughout.

Heathkit 20,000 ohms/volt MULTIMETER KIT

MODEL MM-1

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Shpg. Wt. 6 lbs.

Features comprehensive range coverage. 20,000 Ω/V D.C. and 5000 Ω/V A.C. Ranges: 0-1.5, 5, 50, 150, 500, 1500, and 5000 V. direct current from 0 to 150 μa., 15 a. in 5 steps. Center-scale resistance of 15, 1500 and 150,000 ohms, and db from —10 to +65.

Uses 1% precision resistors—50 μa. meter—molded bakelite case.

Heathkit DIRECT-READING CAPACITY METER KIT

Extremely valuable where speed and convenience are essential. Quality control work, production line checking, etc. Reads capacity directly on meter scale, from 0-100 mmfd, 1000 mmfd, .01 mfd, and .1 mfd. Residual capacity less than 1 mmfd. Not susceptible to hand capacity.

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Heathkit A. C. VACUUM TUBE VOLTMETER KIT

MODEL AV-2

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Shpg. Wt. 5 lbs.

Measures AC voltage only, from 10 cps to 50 Kc. Covers the range from 1 millivolt to 300 volts in 10 steps at high impedance input. Incorporates full 10 ranges of db scale from —52 db to +52 db. Essential in the audio laboratory or for audio enthusiasts and experimenters. Provides sensitivity essential for low level audio measurements.

Heathkit ELECTRONIC SWITCH KIT

This device will electronically switch between 2 input signals to produce both signals alternately at the output. Used in conjunction with an oscilloscope, it will permit the observation of 2 signals simultaneously. Provides switching rates from 10 cps to 200 cps.

MODEL S-2

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Once calibrated, this instrument provides a known peak-to-peak voltage standard for comparison with unknown voltage values on an oscilloscope. Panel calibrated directly—no involved calculations required. Operates within a voltage range of .01 to 100 volts peak-to-peak.

MODEL VC-2

$11.50

Shpg. Wt. 4 lbs

HEATH *Company*

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BENTON HARBOR 20, MICHIGAN

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Here is the complete R.F. signal source for FM and TV alignment, (both monochrome and color). Provides output on fundamentals from 3.6 Mc to 220 Mc in four bands, with harmonic output usable up through the UHF channels. Electronic sweep circuit eliminates mechanical gadgets and accompanying noise, hum, and vibration. Continuously variable sweep up to 0—42 Mc, depending on base frequency.

Variable marker (19—60 Mc on fundamentals) and crystal marker (4.5 Mc and multiples thereof) generators built-in. Crystal included with kit. Provision for external marker if desired.

Packed with outstanding features. 50 ohm output impedance — exceptionally good linearity — effective AGC action — plenty of R.F. output. An essential instrument for the up-to-date service shop.

$49.50

MODEL TS-4
Shpg. Wt. 16 lbs.

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This is one of our most popular kits, and is "serviceman engineered" to fulfill the signal source requirements of the radio serviceman and experimenter.

Covers 160 Kc to 110 Mc on fundamentals (5 bands), with output in excess of 100,000 microvolts. Calibrated harmonics extend usefulness up to 220 Mc. Choice of unmodulated R.F. output, 400 cps modulated R.F. output, or 400 cps audio output. Step-type and continuously variable output attenuation controls.

Coils are prewound, and construction manual is complete. Calibration unnecessary for service applications.

Heathkit RESISTANCE SUBSTITUTION BOX KIT

Model RS-1

Provides switch selection of 36 RTMA 1 watt standard 10% resistors, ranging from 15 ohms to 10 megohms. Numerous applications in radio and TV work.

$5.50
Shpg. Wt. 2 lbs.

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Model CS-1
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Shpg. Wt. 2 lbs.

Very popular companion to Heathkit RS-1. Individual selection of 18 RTMA standard condenser values from .0001 mfd to .22 mfd. Aluminum panel, bakelite case. and includes 18" flexible leads with alligator clips.

Heathkit DECADE RESISTANCE KIT

Model DR-1

Twenty 1% precision resistors provide resistance from 1–99,999 ohms in 1 ohm steps. Indispensable around service shop, laboratory, ham shack, or home workshop.

$19.50
Shpg. Wt. 4 lbs.

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Provides capacity values from 100 mmf to 0.111 mfd in steps of 100 mmfs. +1% precision silver-mica condensers used. High quality ceramic wafer switches for reduced leakage.

Shpg. Wt. 3 lbs.
$16.50

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Model C-3
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Measures capacity in four ranges from .00001 to 1000 mfds. Power factor control is provided for indication of electrolytic condenser efficiency. Tests capacitors under actual load conditions. Checks resistance from 100 ohms to 5 megohms. Direct reading scales for all tests. No calculation necessary.

Heathkit LABORATORY GENERATOR KIT

Model LG-1

$39.50
Shpg. Wt. 16 lbs.

Here is a signal generator for use where high accuracy and metered performance are essential. Covers 150 Kc to 30 Mc on fundamentals in 5 bands. 400 cps modulation variable from 0 to 50%. R.F. output at 50 Ω from 100,000 to 1 µv. Meter reads R.F. output in µv. or modulation percentage. Fixed-step and variable output.

Heathkit VISUAL-AURAL SIGNAL TRACER KIT

Model T-3

$23.50
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This signal tracer features a high-gain R.F. channel and probe to permit signal tracing from the receiver antenna input through the R.F. and I.F. stages. Separate low gain channel for audio circuits. Both visual and aural indication by means of speaker and electron beam "eye" tube.

Also noise locater circuit, wattmeter, and terminals for "patching" output transformer or speaker into external circuit.

Heathkit HANDITESTER KIT

Model M-1

$14.50
Shpg. Wt. 3 lbs.

The M-1 is literally pocket size to fit in your coat pocket, tool-box, glove compartment, or desk drawer. Measures A.C. or D.C. v. in 5 steps from a full scale minimum of 0—10 v. to a maximum of 0—5000 v. Measures direct current at 0—10 Ma and 0—100 Ma, and provides ohmmeter ranges of 0—3000 and 0—300,000 ohms. Sensitivity of 1,000 ohms/v. 1% precision divider resistors employed.

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New

Heathkit DX-100 PHONE AND CW TRANSMITTER KIT

This one compact package contains complete transmitter, with built-in VFO, modulator, and power supplies. Provides phone or CW operation—VFO or crystal excitation—and bandswitching from 160 meters through 10 meters. R.F. power output 100—125 watts phone, 120—140 CW. Parallel 6146's modulated by push-pull 1625's. Pi network interstage and output coupling for reduced harmonic output. Will match non-reactive antennas between 50 ohms and 600 ohms. TVI suppressed with extensive shielding and filtering. Rugged metal cabinet has inter-locking seams.

The high-quality transmitter is packed with desirable features not expected at this price level. Copper plated chassis—potted transformers—wide spaced tuning capacitors—ceramic insulation—illuminated VFO dial and meter face—remote control socket—preformed wiring harness—concentric control shafts—high quality, well rated components used throughout. Overall dimensions 20⅞" wide x 13¾" high x 16" deep.

Supplied complete with all components, tubes, cabinet and detailed construction Manual. (Less crystals.) Don't be deceived by the low price! This is a top-quality transmitter designed to give you years of reliable service and dependable performance.

MODEL DX-100

$189.50

Shpg. Wt. 120 lbs.

Shipped motor freight unless otherwise requested. $50.00 deposit required for C.O.D. orders.

Heathkit AMATEUR TRANSMITTER KIT

MODEL AT-1

$29.50

Shpg. Wt. 15 lbs.

Enjoy the trouble-free operation of commercially designed equipment while still benefiting from the economies and personal satisfaction of "building it yourself."

This CW Transmitter is complete with its own power supply, and covers 80, 40, 20, 15, 11 and 10 meters. Single knob bandswitching eliminates coil changing. Panel meter indicates grid or plate current for the final. Crystal operation, or can be excited by external VFO. Crystal not included in kit. Incorporates features one would not expect in this price range, such as key-click filter, line-filter, copper plated chassis, prewound coils, 52 ohm coaxial output, and high quality components throughout. Instruction Book simplifies assembly. Uses 6AG7 oscillator, 6L6 final and 5U4G rectifier. Up to 35 watts plate power input.

Heathkit GRID DIP METER KIT

Model GD-1B

$19.50

Shpg. Wt. 4 lbs.

This is an extremely valuable tool for Hams, Engineers or Servicemen. Covering from 2 Mc to 250 Mc, it uses 500 μa meter for indication. Kit includes prewound coils and rack. Will accomplish literally hundreds of jobs on all types of equipment.

Heathkit ANTENNA IMPEDANCE METER KIT

Use in conjunction with a signal source for measuring antenna impedance, line matching purposes, etc. Will double, also, as a phone monitor or relative field strength indicator.

100 μa meter employed. Covers the range from 0 to 600 ohms. An instrument of many uses for the amateur.

Model AM-1

$14.50

Shpg. Wt. 2 lbs.

Heathkit VFO KIT

MODEL VF-1

$19.50

Shpg. Wt. 7 lbs.

Weigh the cost of this kit against the cost of crystals—and consider the convenience and flexibility of VFO operation. This is one of the most outstanding kits we have ever offered for the radio amateur.

Covers 160—80—40—20—15—11 and 10 meters with three basic oscillator frequencies. Illuminated and precalibrated dial scale clearly indicates frequency on all bands and provides more than two feet of dial calibration. Reflects quality design in the use of ceramic coil forms and tuning capacitor insulation, and copper plated chassis. Simply plugs into crystal socket of any modern transmitter to provide coverage of the bands from 160 meters through 10 meters. Uses 6AU6 Clapp oscillator, and OA2 voltage regulator for stability. May be powered from plug on Heathkit Model AT-1 Transmitter, or supplied with power from most transmitters.

Heathkit ANTENNA COUPLER KIT

Model AC-1

$14.50

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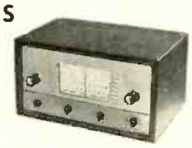

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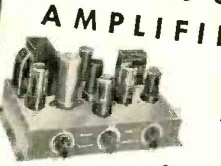

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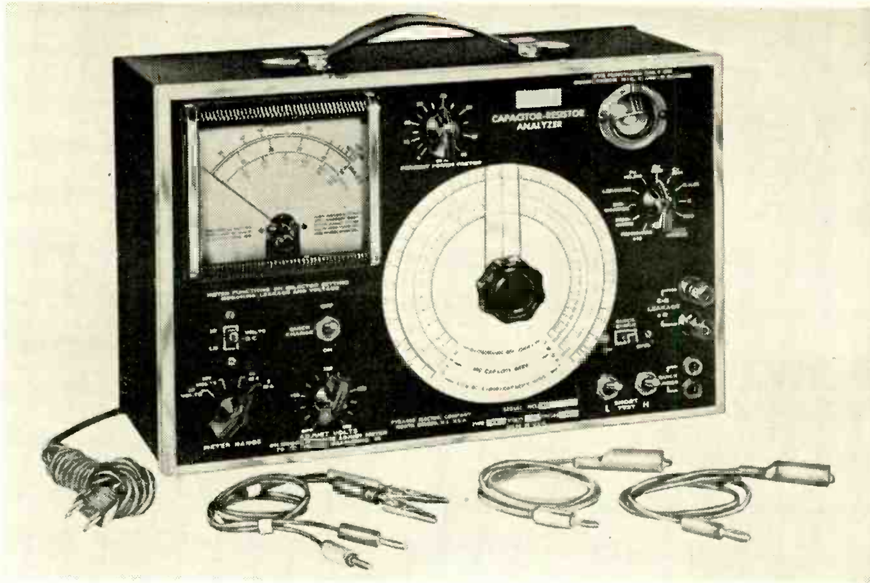
Capacitor–Resistor Analyzer

Circuit analysis of the Pyramid CRA-1 tester



The Pyramid model CRA-1 capacitor-resistor analyzer.

CAPACITORS—more than almost any other component—deteriorate slowly, a condition which can be detected some time before complete breakdown. Running a test on electrolytics is one way of avoiding further service calls in the too-near future. The capacitor analyzer can be one of the most important instruments in the service shop.

Capacitors are also responsible—by opening or shorting—for a fair percentage of breakdowns in electronic equipment. An instrument which can detect capacitor opens, intermittents and shorts quickly is a time- and money-saver to the technician.

The capacitor-resistor checker described in this article is a complete instrument for checking capacitors, quantitatively with a bridge and qualitatively with a quick-check circuit, and has a few additional features. It measures capacitance from about 10 μμf to 2,000 μf, and resistors from 100 ohms to 25 meghoms, on accurate bridge circuits. An insulation tester extends the resistance range to about 20,000 megohms, and a capacitor leakage meter shows leakage under all desired test voltages. The capacitance bridge provides a power-factor measurement for electrolytics (or other capacitors, if they show appreciable losses).

Though not an essential part of an analytical instrument, a device that tells, without disconnecting them from the circuit, if capacitors are open or shorted is very useful to the technician. The quick-check circuit of the CRA-1 checks capacitors between 100 μμf and 50 μf, virtually the entire range commonly encountered.

The circuit of this checker (Fig. 1) is a Hartley oscillator with its two sections so coupled by an additional coil L1 that—when properly adjusted—it will *not* oscillate. If a *capacitive* reactance is placed across L1 (by connecting it to the QUICK CHECK leads), the circuit is unbalanced and goes into oscillation. This signal voltage is applied to the grid of the 6E5 through a 100,000-ohm resistor and .02-μf capacitor, causing the shadow wedge ("eye") to close.

Resistance or inductance in the L1 circuit has no effect until the impedance drops to a few ohms. A capacitor can be checked with a 25-ohm resistor shunted across it.

Once a capacitor has been found to be not open, only half the job is done. It may be shorted (infinitely large to the checker). Two circuits (L and H) check for shorted capacitors. The L (low-capacitance) circuit of Fig. 2-a is used for capacitors under .002 μf. It

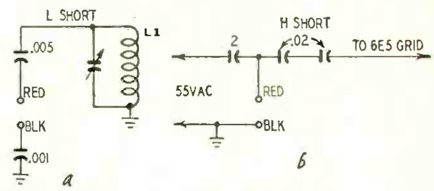


Fig 2—Circuits for checking shorted capacitors—*a*, low, *b*, high capacitance.

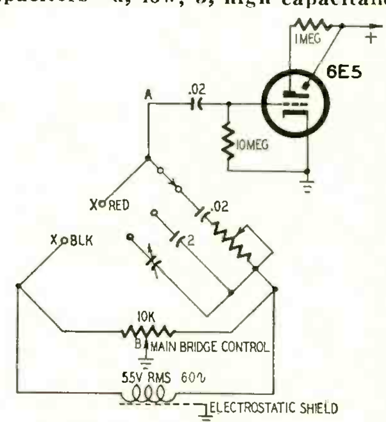


Fig. 3—Schematic diagram of bridge circuit for low-capacitance ranges.

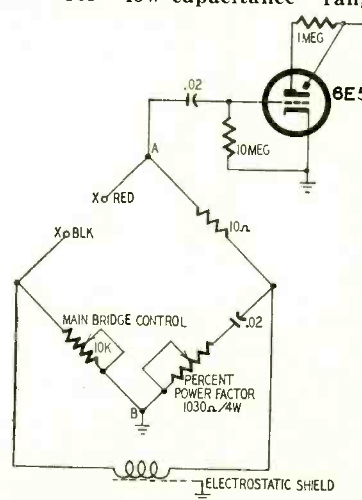


Fig. 4—Schematic diagram of bridge circuit for high-capacitance range.

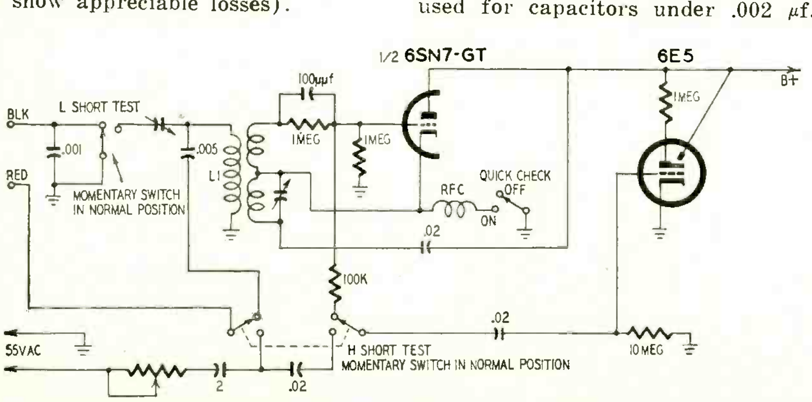


Fig. 1—Schematic diagram of the quick-check circuit in the analyzer.

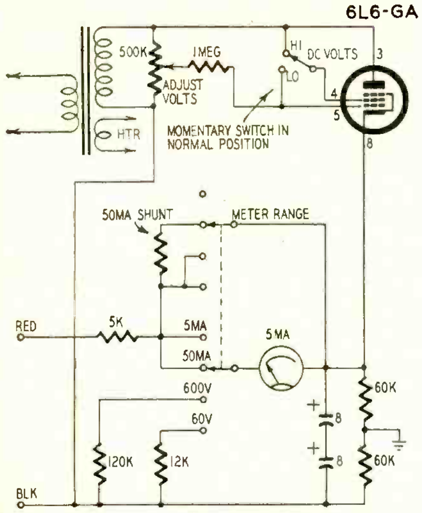


Fig. 5—Leakage-current test circuit.

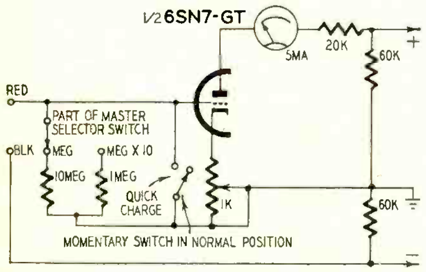
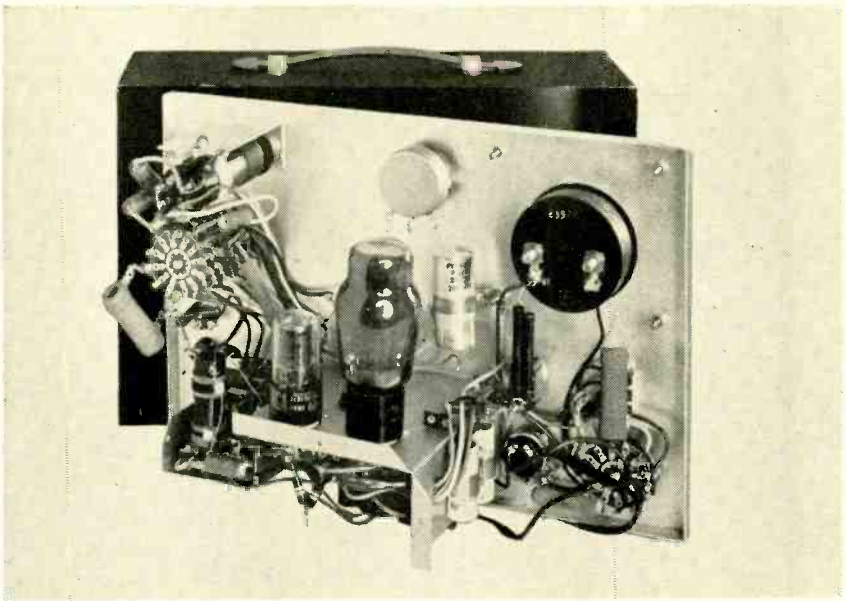


Fig. 6—Schematic diagram shows circuit for insulation resistance tests.



Rear, internal view of analyzer shows layout of all major components.

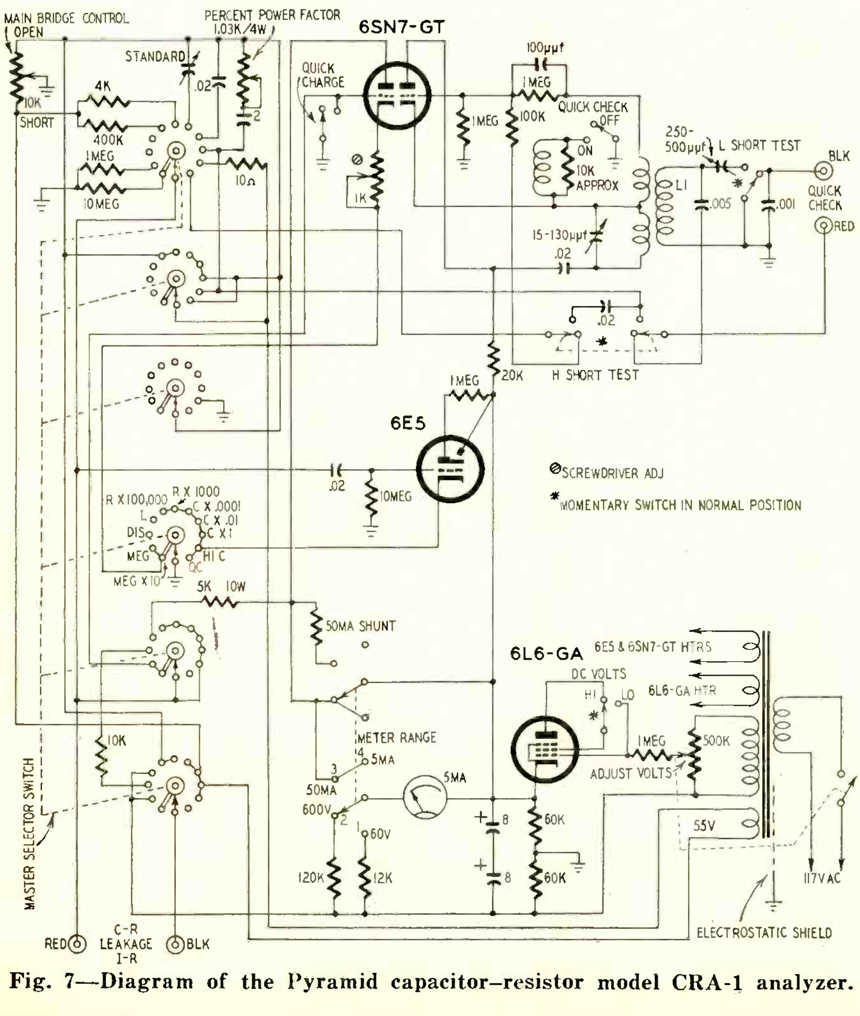


Fig. 7—Diagram of the Pyramid capacitor-resistor model CRA-1 analyzer.

connects an adjustable capacitor across L1 and makes the capacitor being checked the center unit of a series of three, also shunted across L1. The circuit is so adjusted that it is swamped out of oscillation if the tested capacitor has a reactance less than that of a good .002-μf unit.

If the capacitor shows "short" on the L check, it is either defective or larger than .002 μf. It is then tried on the H (high-capacitance) circuit (Fig. 2-b) which puts it across a 55-volt a.c. supply through a 2-μf capacitor. The hot side of the 55-volt generator is connected to the 6E5 grid through two .02-μf capacitors in series.

If the capacitor being checked is shorted, none of the generator output gets through to the 6E5, and the eye remains open. If the capacitor is good, some voltage reaches the 6E5 grid through the .02-μf capacitors, closing the shadow wedge. This test works to about 50 μf, after which point there is not enough voltage drop across the capacitor to "wink the eye."

Capacitance bridge

The bridge circuit for measuring capacitors is familiar to all technicians who remember the old Solar or similar analyzers. It consists of two resistive and two capacitive arms (Fig. 3). One of the capacitive arms is the capacitor being measured. The two resistive arms are formed by a single potentiometer, the ratio between the arms being changed by the potentiometer setting. When the resistance ratio of the two resistive arms is the same as the reactance ratio of the two capacitive arms, there is no voltage difference between points A and B, and therefore none between grid and cathode of the 6E5. The wedge opens and the capacitance of the unit being measured is indicated by the pointer attached to the potentiometer arm.

There are four capacitance ranges. Three (C × .001, C × .01, C) are obtained by switching the fixed capacitance arm. The three "standard" capacitors are .0002 (adjustable for calibration), .02 and 2 μf. A variable resistor in series with the 2-μf capacitor measures the power factor of electrolytics and makes it possible to balance the bridge when capacitors with a high power factor are measured.

For the fourth (HIC) range, the bridge circuit is set up as in Fig. 4. The reason is that in a bridge of the type of Fig. 3 the ratio between arms changes very rapidly near the ends of the scale, crowding the readings for high capacitances. In the HIC range, therefore, the potentiometer becomes one resistive arm of the bridge and a 10-ohm resistor the other one.

Capacitor leakage

Leakage in electrolytic capacitors is measured with d.c. from a 6L6 rectifier, the output voltage of which can be varied continuously by adjusting its control grid voltage. The METER RANGE switch (see Fig. 5) is used first to measure the voltage applied to the capacitor, then to put a low-resistance shunt around the meter for the 50-ma range or to remove the shunt for the 5-ma range. There are two voltage ranges. The LO VOLTS range—set by a separate switch which disconnects the screen of the 6L6 from the plate and connects it to the control grid—is used for capacitors with a 60-volt or lower rating.

Other circuits

The circuit of Fig. 3 becomes a resistance bridge simply by substituting fixed resistors for fixed capacitors in one arm of the bridge and connecting the resistor to be measured across the X terminals. Thus all four arms of the bridge become resistors.

Much higher resistances—such as the leakage of coupling capacitors—can be measured by the insulation resistance test circuit of Fig. 6. The triode is so hooked up that its cathode is at the center point of a bleeder across the B supply. The unknown "resistor" is connected between the negative end of the B supply and the grid. Any leakage puts a negative voltage on the grid, driving it toward cutoff. In operation, the meter is set on the 5-ma range and tube plate voltage adjusted to give a full-scale reading (infinite resistance). Two resistors between grid and ground permit some of the negative charge to leak off the grid, and therefore permit calibration in two ranges which run roughly from 5 to 20,000 megohms. The QUICK CHARGE switch speeds up insulation tests on capacitors.

The DISCHARGE position of the selector switch connects a 10,000-ohm resistor across the test leads and discharges any capacitor connected across them.

The LEAKAGE circuit can be used as a continuity tester. The meter is set to the 50-ma range, the test leads shorted and the voltage adjusted to give a reading of about 15 ma. There is then about 120 volts at the probes. Continuity in any circuit between the probes will be indicated by some motion of the meter indicator.

A complete schematic diagram of the CRA-1 appears in Fig. 7. END

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A DEPENDABLE GAS TEST

An important addition to tube testing

By H. B. CONANT

THE presence of gas in a tube is usually unsuspected until it shows itself as a visible blue glow. However, long before that, gas ions are at work on the control grid, reducing its effectiveness as a control element. This is especially true when the grid is fed from a high-resistance circuit as in a resistance-coupled stage. And when the grid follows a tuned circuit, grid current due to gas ions loads the circuit.

Modern tube testers are a miracle of engineering but none of the commercial models provide for a gas test. The tube manuals make no mention of such tests in the sections on tube testing and the matter of gas seems to have received little attention.

In designing this gas test, I have borrowed from the technique of measuring high vacuum with a hot-cathode ionization gauge (Fig. 1). The circuit uses a triode but it is not connected in the customary manner. There is a relatively high positive potential on the grid and a relatively low negative potential on the plate.

The *modus operandi* of the vacuum gauge is simple: electrons are accelerated from cathode to grid because of the positive grid potential. Because of their velocity, some of them pass through the grid wires. If enough gas molecules are present, there will be collisions with the high-velocity electrons, resulting in ionization of the gas molecules. Such positively charged gas ions will be repelled by the grid and attracted to the plate or "ion collector" where they can pick up the needed electrons to become normal gas molecules again. This causes a current to flow in the plate circuit, which is read on the plate microammeter in terms of gas pressure.

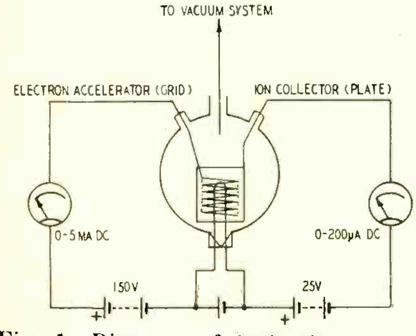


Fig. 1—Diagram of ionization gauge.

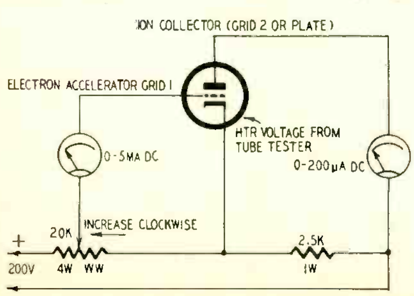


Fig. 2—Diagram of gas test circuit.

A well designed vacuum gauge will read to a pressure of 1×10^{-8} millimeter of mercury or enough gas pressure to support a column of mercury .00000001 mm or .0000000003937 inch high. This would be considered high vacuum though it is far from perfect. However, at pressures greater than 1×10^{-8} mm, ionizable gas molecules are present; the vacuum gauge will not operate unless they are, and in sufficient numbers to insure a substantial number of collisions and thereby generate a readable value of plate or ion-collector current.

The blue glow in a tube is very unlikely if the pressure is less than 1×10^{-2} millimeter or 1,000,000 times the pressure at which the ionization gauge will no longer operate. In between these two pressures, no blue glow will show to warn of gas. Yet the ionization gauge proves beyond doubt that ionizable and therefore harmful gas molecules are present.

So why can we not make a modified ionization-gauge circuit into which we can connect the tube to be tested? It is true that triodes made for ionization gauges have a rather special geometry of the elements to achieve the greatest sensitivity and to provide a reproducible calibration or response curve. But this is no reason why a triode of different configuration will not behave in the same manner. Although we may find no indication of gas when the pressure may be 1×10^{-6} mm, for example, such a tube would contain so little gas that it could not be considered gassy.

Although the variations in element geometry among the many tube types prevent accurate measurement of the gas pressure within a given tube, if we can obtain no ionization in this test harmful ionization is very unlikely to occur in normal service.

The circuit of the gas test is shown in Fig. 2. The tube to be tested is connected as a triode, using the control grid or grid 1 as the electron accelerator. The ion collector will necessarily be the plate if the tube is a triode, but grid 2 will serve as the ion collector in tetrodes, pentodes, etc. It is not necessary or even helpful to tie the remaining elements together as a plate.

The potentiometer provides a variable source of voltage for the electron-accelerator grid and should always be started from zero voltage. This procedure is recommended to avoid damage to the ion-collector microammeter. A really gassy tube will slam the meter pointer hard if the whole accelerator potential is applied suddenly.

After the tube has heated thoroughly, advance the potentiometer, starting at zero, while watching both meters. With an ionization-gauge tube, the plate microammeter would read full scale by the time the grid potential has been increased to produce a grid current of 5 ma if the gas pressure is 1 micron (1×10^{-3} mm). These values may be used for approximating the gas or absence of gas in the tube under test. In other words, if the plate meter reaches full scale before the grid meter has done so, the tube is probably gassy enough to glow in service. When both meters reach full scale together, the tube probably won't glow in service but still contains a harmful gas pressure. Whenever the grid meter can be run to full scale without producing a readable indication on the plate meter, the tube may be considered strictly non-gassy.

Whenever enough gas has accumulated inside a tube to be detectable on this gas test, it must be assumed that the envelope or seal is leaking because the getter, normally used in the manufacture of the tube, is sufficient to take care of any outgassing of the elements for many years. A leak therefore is likely to get worse instead of better so any indication on the ionization-collector meter should be taken as a sure sign that the tube should be discarded.

When testing dual triodes such as, for example, the 6SN7, it is necessary to connect only one of the triodes. Unfortunately diodes cannot be tested for gas by this method.

In constructing this gas tester, it may be possible to build it into an existing tube tester, or an obsolete tube tester could be worked over as a gas tester. In any event, the heater voltages for the gas tester can be taken off the existing tube-tester heater switch. All the constructional details I will leave to the ingenuity of the individual technician. END

By WAYNE E. LEMONS

Perk up the LITTLE SET

Improving the performance of the popular a.c.-d.c. sets

ONE of the greatest service headaches for the radio technician is the little set that sells for less than $15 and usually contains three tubes and a rectifier. This may not be as much of a problem in a large city where there are several powerful local stations but it can be a genuine nuisance in fringe areas. Many manufacturers do not recommend these small sets except for strong local reception, but that doesn't prevent the public in outlying areas from buying. To make matters worse, these sets often receive even distant stations well when they are new.

When the set is brought to the service technician for repairs, he generally has the problem of bringing it back to normal and still keeping the bill low.

Although the following techniques may be used on more expensive radios, where applicable, they are primarily intended to help the service technician make a profit on the repair of the little set.

To start, check the tubes—but not with a tube checker. There is no better way to check tubes than by substitution. Do not attempt to use your ear to check the difference. Because of peculiar qualities of the ear it is sometimes impossible to distinguish between two tubes although one may have 25% to 100% more gain. This situation is aggravated by the warmup time between changing tubes. By far the best method is to use a v.t.v.m. on the a.v.c. line to check the converter tube and i.f. amplifier if there is one. A good tube will show a definite increase in voltage over a weak one.

The first a.f. tube should be checked with a signal tracer which has an a.f. indicator, while feeding in a steady tone from a signal generator. The output tube may be checked the same way, but usually a weak output tube will be accompanied by some distortion. The bias voltage may be measured across the cathode resistor and should be about 4.5 to 5 for a typical output tube (50L6). Unfortunately, this test cannot always be made because, for economy's sake, the output tube is often biased by the negative voltage at the oscillator grid. Check the rectifier by measuring the B plus voltage. After checking the tubes and replacing any that are defective, the set should be aligned.

Other than tubes, the greatest reason for low sensitivity is one or more tuned circuits not properly peaked or not tracking. The gain of a small set depends almost entirely on the proper functioning of every tuned circuit. A typical small radio has only three tuned circuits contributing to gain and selectivity.

A station signal can be used to better advantage than a signal generator when adjusting these radios, except for aligning i.f. transformers.

This type of radio almost invaribly uses a cut-stator capacitor and an i.f. of 455 kc. Peak the i.f. at the correct frequency, using the v.t.v.m. on the a.v.c. line as a peak indicator.

These radios usually have an antenna coil and a hank of antenna wire. It is very important that the original length of wire be used with the set and that it be extended to full length. Close coupling is used in the antenna coil and any large change in antenna capacitance will be reflected in the grid circuit tuning.

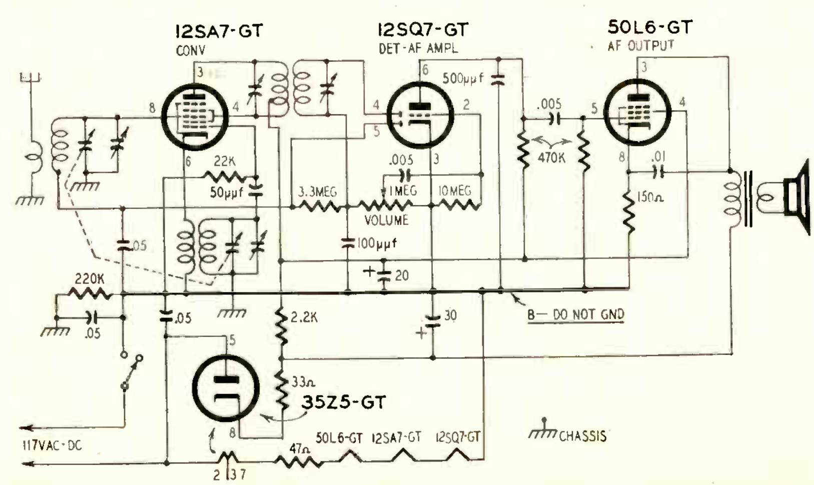
Peaking an oscillator trimmer at the low end is unheard of in manufacturers' instructions; but if the radio has not been tampered with (bent capacitor plates, etc.), this is the quickest and surest adjustment. Improper tuning causes a marked reduction in sensitivity at the low end.

Keep the v.t.v.m. on the a.v.c. line and peak the oscillator trimmer while rocking the tuning capacitor for maximum response of a weak station near 600 kc. After the peak is found, turn to a weak station in the vicinity of 1400 kc and peak the r.f. trimmer. If a definite peak is found and the dial calibration is not too far off, the job is finished. However, if the r.f. trimmer cannot be peaked, turn the oscillator trimmer in the direction required to find a peak with the r.f. trimmer.

When it is necessary to move the oscillator trimmer at the high end more than a small amount, you can expect either an incorrect length of antenna hank or a change in inductance of the antenna coil.

If you are reasonably sure that the antenna wire is all right, use a tuning wand in the antenna coil to determine whether it needs an increase or decrease in inductance. If an increase is needed and the antenna coil has a hollow core, a tuning slug of the type used in auto radios may be slipped inside the coil and wedged into position.

Retune according to the preceding



Typical of present-day small sets—diagram shows the a.c.–d.c. Trav-Ler 5054.

instructions. After finding the correct placement of the slug, cement it into place and you have saved 75% of the cost of a new antenna coil. Occasionally the coil may have too much inductance —the tuning capacitor must be opened too much to arrive at a peak when adjusting the oscillator trimmer for low-frequency stations. This time use a slug of brass in the same manner as described for the tuning slug. An old brass volume-control shaft is ideal. The brass slug will lower the inductance and make the tuneup procedure possible.

If neither of these methods gives the desired results, it usually indicates that the antenna coil is not faulty and that the oscillator coil should be examined.

The same methods of increasing and decreasing inductance may be used with an oscillator coil. However, an oscillator coil may not have an open core. A metal washer with a hole slightly larger than the oscillator coil core can be slipped on to lower the inductance. If the inductance must be increased and a slug cannot be used, a few turns of wire between the coil and tuning capacitor may do the trick.

Occasionally a loop is found on a little set. If an increase in inductance is needed, you may be able to get just the right amount by using an old auto radio A choke in series with the loop and tuning capacitor. By cutting or spreading the turns of the choke the proper inductance can be found. To lower inductance use the capacitor-in-series method for a check. Don't remove turns until you find out whether the loop or oscillator coil is the offender. All this may sound as if it takes more time than the replacement of parts would cost, but after a little experience the whole procedure should take not more than 15 or 20 minutes.

Often the correct replacement part is not available and you may not always be sure which part is defective unless the above tests are made.

Many other things may cause a loss of volume. Some of them are difficult to troubleshoot.

The resistance of the volume control is normally higher than in more expensive sets, frequently being around 2 megohms. The volume control may change to a low value on rare occasions and still control the volume without introducing noise. Check with a good ohmmeter. Frequent offenders are mica capacitors used across the volume control and from the plate of the first audio amplifier to ground. They may become slightly leaky, permitting the set to play but reducing volume. A practical way to check these is by removing one lead from the circuit and noting any increase in volume. Do not confuse an apparent increase in volume due to the introduction of "highs." If in doubt, use a v.t.v.m. and see if the voltage increases when a lead is removed.

The first a.f. amplifier plate load resistor is often made purposely high to increase the stage gain. Check this for any change in value. The coupling capacitor between the a.f. and output stage should always be checked in these sets. Many service technicians believe that a leaky coupling capacitor will show up as distortion in the output. This is not always the case, especially in "not-too-high-fidelity" sets. A slightly leaky capacitor will not show a positive voltage at the grid of the output stage even with a v.t.v.m. because of grid rectification. It can be easily checked by placing a v.t.v.m. on the grid pin and removing the output tube. If the capacitor is leaky, the voltmeter will go more positive. Sometimes a positive voltage on the output grid with the tube in place is caused by a defective output tube.

One trouble that can throw the novice for a loop is a leaky bypass capacitor across the primary of the output transformer. Unfortunately, there is practically no way of checking this component without removing it from the circuit. This trouble usually causes distortion, but it is of the type that can easily be attributed to poor design. Those who have had experience with universal replacement output transformers should have no trouble recognizing this improper-impedance distortion.

A fairly uncommon, although very possible trouble is loss of sensitivity of a PM speaker. As a matter of fact, any part used in these sets should be open to suspicion because of the inexpensive materials used.

Service technicians have increased the power output of these sets by bypassing the output tube's cathode bias resistor with an electrolytic filter capacitor. This is not recommended unless adequate B plus filtering is used. Bypassing the resistor increases the low-frequency response of the stage, introducing hum from a poorly filtered power supply.

Some technicians do not believe these small sets can be serviced profitably and therefore make no attempt at repair. In the long run I believe that a job well done for a reasonable amount of money will be profitable even if not on the individual set. These small sets are often the "extra" around the house. If you make that little radio perform, it means you are in line to repair the "other" radio or TV set when it becomes defective. All this points up the fact that doing a small job well today probably means a better job tomorrow, charge the time spent to advertising!

Check the tuning of these sets each time they are repaired. It might be a good idea to do what a customer of mine, who owned a t.r.f. Atwater Kent, asked me to do. He brought the set into the shop "for tuning up" every month or so. I finally asked him why he brought it in so often. "Well," he said, "it says on the back of the set to TUNE RADIO FREQUENTLY." As I seldom charged him anyway I didn't have the heart to tell him that it actually said TUNED RADIO FREQUENCY. END

POT AIDS PRINTED CIRCUIT SERVICE

To aid in the servicing of printed-circuit chassis, Motorola has developed a controlled-temperature heating pot. This soldering pot is used in a five-step plan for removing and replacing defective components in printed circuits:

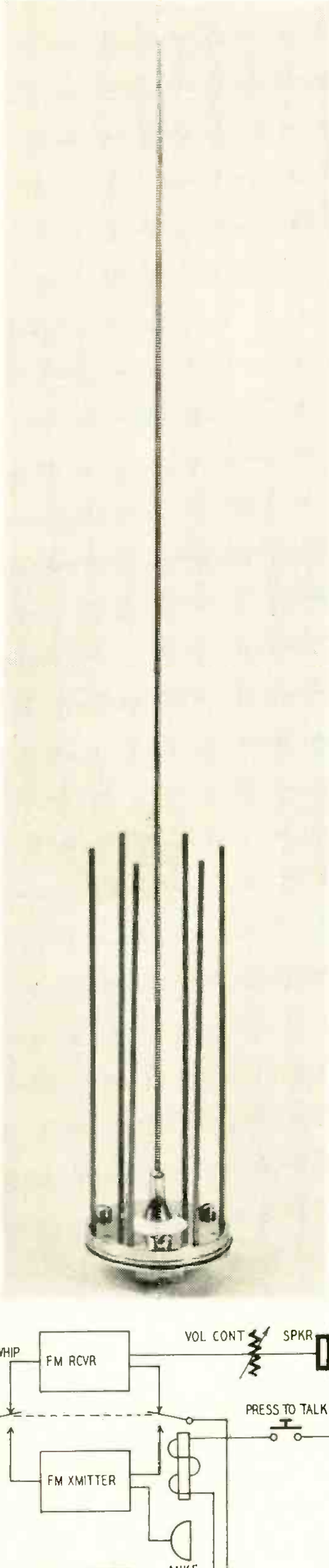
1. Simultaneously heat all terminals of the component. Check the bottom of the chassis to see that all terminals are straight and the soldered points free to make contact with the heat.

2. Dip the terminals into the soldering pot (see photo). With a gentle lift, the component will become unsoldered.

3. After removing the defective part, heat each chassis terminal for the new component and then remove the excess solder from the chassis base and terminal holes with a low-wattage soldering iron.

4. Clean the chassis base around the repair area with a suitable cleaner such as carbon tetrachloride before installing the replacement part.

5. Install the new component and resolder. If in removing the component a conductor is damaged, bridge the break with a short piece of tinned wire.



460-mc RADIO

The spectrum between 450 and 470 mc—its characteristics, regulations, equipment

By LEO G. SANDS

THE rapidly expanding use of two-way mobile radio systems has caused concern to equipment manufacturers and potential users because it seemed that soon there would be no more room for new systems. All available channels in the 25–50 and 152–162-mc bands have been allocated to specific services and in several areas all channels for a specific service are being fully used. However, a 20-mc-wide band of premium radio spectrum space has been available for almost 5 years and it has been only in the past 2 years that any serious attention has been given to it—the u.h.f. band between 450 and 470 mc.

This portion of the radio spectrum was long shunned because many felt that the communications range in mobile applications would be too short to be practical. However, the propagation characteristics of u.h.f. radio from 450 to 470 mc are fairly comparable

Left—460-mc antenna, made by Connecticut Telephone & Electric, has high gain, strong ground wave. Below—Ambulance in RCA's Camden plant uses 460-mc unit.

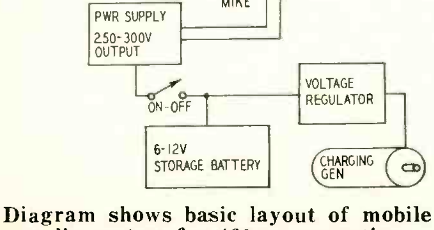


Diagram shows basic layout of mobile radio system for 460-mc operation.

to v.h.f. radio in the 152–162-mc band. The communications range is approximately the same but noise levels are much lower in the u.h.f. band. And because of the superior multiple-reflection characteristics of u.h.f. radio, better coverage is often obtained in electrically shaded areas such as narrow city streets lined with tall buildings. Tests have demonstrated that 460-mc radio talks well even inside tunnels.

The communications range at 460 mc depends upon effective antenna height to a greater degree than at 160 mc. Effective antenna height does not necessarily mean the distance of the antenna above ground, but does mean the distance of the antenna above the highest areas within the desired communicating range. For example, an antenna atop a 200-foot building will have an effective elevation of only 100 feet if the community is within a bowl with ridges 100 feet high.

As at 160 mc, the range is somewhat greater than line of sight. The calculated range for point-to-mobile communications is 7 miles when the base station antenna effective height is 50 feet and almost 19 miles with a 350-foot effective antenna height. In both cases it is assumed that the mobile unit antenna is on a car top. In heavily wooded areas or in hilly country covered with foliage, the range may be less. U.h.f. signals are easily reflected by hard surfaces whereas foliage tends to absorb the signals.

Since suitable equipment is now available for use in the 450- to 470-mc bands and many have discovered the desirable characteristics of u.h.f. radio for mobile communications, there is considerable activity. FCC figures show the number of stations authorized to operate in these two bands (see table) but the figures do not mean that that many stations are actually operating since applicants apply for authority for the maximum number of stations they desire to operate and not the number of stations they plan to install immediately.

Some manufacturers are unwilling to give information on the number of mobile radio units and base stations they have sold, so it is not practical to guess closely how many stations are currently on the air. However, it is safe to assume that a goodly number are in service. The Yellow and Checker cab companies of Chicago, for example, have been authorized to install upward of 1,000 u.h.f. mobile units. The Burlington Trucking Co., a subsidiary of the Burlington Railroad, is equipping a fleet of 40 trucks with 460-mc radio. Griffith Consumers, a fuel-oil distributor in Washington, D. C., has been using 460-mc radio for over a year. Coca-Cola distributors in some cities have equipped their beverage-cooler service trucks with 460-mc radio. It is a big business but is uncalibrated in dollars or volume.

Frequency availability

Radio communications channels are available for occupancy in the still uncrowded 450–470-mc bands. Under present operating standards with 100-kc separation, these two adjacent 10-mc-wide u.h.f. bands can be divided into 200 channels. And if standards are tightened to allow only 50-kc frequency separation, 400 radiotelephone channels can be made available.

The spectrum between 450 and 460 mc has been divided by the FCC into 100 radio communications channels allocated to various types of organizations and industry groups. The adjoining 460- to 470-mc band has been allocated to the Citizens Radio Service, a much misunderstood and as yet little used but extremely valuable band of radio frequencies.

In the 460–470-mc Citizens band, no specific frequency assignments are being made except for class-B stations which can be operated on only one specific frequency, 465 mc. Class-A stations may be operated on any frequency within the band if power input to the final r.f. stage of the transmitter is less than 10 watts. Power input up to 50 watts is permissible on any frequency between 460–462 and 468–470 mc.

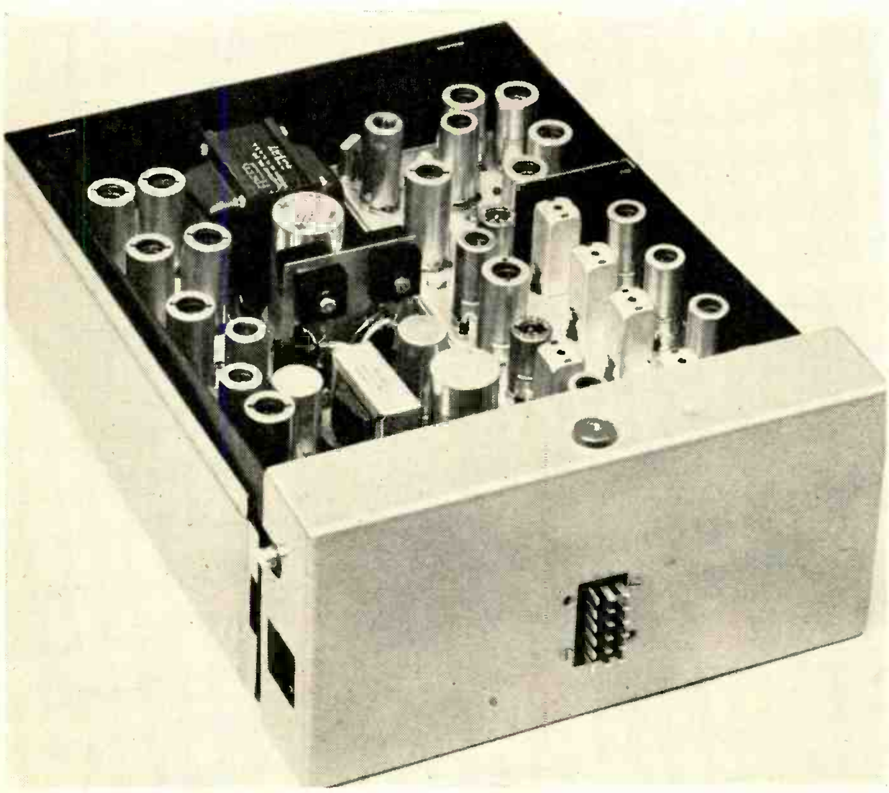
The 450- to 470-mc section of the radio spectrum has been allocated as listed below:

Application	Band limits	No. channels
Remote pickup broadcast	450.05–450.95 mc 455.05–455.95 mc	10 10
Industrial	451.05–451.95 mc 456.05–456.95 mc	10 10
Land Transportation	452.05–452.95 mc 457.05–457.95 mc	10 10
Public Safety	453.05–453.95 mc 458.05–458.95 mc	10 10
Domestic Public	454.05–454.95 mc 459.05–459.95 mc	10 10
Citizens Radio Service Class-A	460–470 mc	
Citizens Radio Service Class-B	465 mc	

Licensing regulations

All radio station authorizations in the 450–460-mc band are presently being granted on a developmental basis. This does not imply that licensees are apt to lose their authorizations without cause nor that the art is still in the experimental stage. It does mean, however, that sufficient experience has not been had as yet in this band upon which to formulate hard and fixed rules governing equipment and operating requirements. When the "developmental" tag is removed from authorizations for operation in the 450–460-mc band, licensees will be required to conform with possibly more rigid standards than now. Most equipment now available for use in the 450- to 470-mc bands far exceeds the current requirements of the FCC.

Any company or individual operating a business or commercial enterprise for which a radio service has been established by the FCC in the Land Transportation or Industrial Radio Services (for which frequencies have been allocated in the 450- to 460-mc band) may



Two way 460-mc mobile radio—contains transmitter, receiver and power supply. *Connecticut Telephone and Electric Corp.*

apply for radio station licenses for operation in this u.h.f. band. Likewise, safety services such as police and fire departments are eligible. All applicants must qualify as outlined in Parts 10, 11 and 16 of the FCC rules and regulations and must be citizens of the U.S.A.

At the present time there is no charge for station licenses. Operator's licenses are not required by persons using mobile radio units but a third-class or restricted radiotelephone operator's license is required by the operator of the base station. No technical knowledge is required for this grade of operator's license. Application forms may be obtained from the FCC, Washington 25, D. C., and copies of Parts 10, 11 and 16 of the FCC rules may be obtained for 10 cents per part from the Government Printing Office.

Citizens radio

It is popu'arly believed that the Citizens Radio Service is primarily for the housewife, hobbyist and sportsman. This is not true. The Citizens band is being used and is intended for use by business for commercial purposes. Many types of industries and business organizations ineligible for radio station licenses in other radio services may be eligible in the Citizens Radio Service. Fuel-oil distributors, soft-drink bottlers, radio and TV service technicians, delivery organizations and farmers are typical of commercial enterprises making use of two-way radio in the Citizens band.

Two classes of Citizens radio stations may be operated in the 460–470-mc band. Class-B stations are limited to 10-watt input, must operate only on 465 mc and are intended for short-range personal communications or for radio control of objects like model airplanes.

A transmitter-receiver for class-B Citizens Radio Service generally consists of a superregenerative receiver that converts into an AM self-excited transmitter. It is an engineering feat to design and build such a unit to meet the frequency-stability requirements of the FCC. Equipment for class-B service is now on the market which will meet FCC requirements.

Two-way radio equipment designed for use in the 450- to 460-mc band is generally tunable to frequencies in the 460- to 470-mc Citizens band. This equipment exceeds FCC requirements for class-A Citizens radio service by a wide margin. For example, the rules specify transmitter frequency stability of ±.02% whereas most available equipment is rated at ±.0005%. The allowable transmission band is 200 kc whereas 460-mc commercial mobile radiotelephone transmitters have a transmission band of only ±15 kc of center frequency.

Commercial equipment

Commercial 460-mc mobile and base station radio units for other than class-B Citizens service use FM exclusively. The transmitters and receivers are fixed-tuned to a specific frequency and are crystal-controlled. Double superheterodyne receivers are standard. Mobile units are available for direct operation from a 6- or 12-volt storage battery and some can be operated from either voltage by simple modification of the equipment. Base station units are normally designed for operation from 117-volt a.c. lines. Base stations may be operated locally or by remote control over wire lines or a radio link.

Transmitter power input is generally from 4 to 20 watts. Greater power is seldom necessary. A cheaper way to obtain greater range is to raise the antenna or use a high-gain antenna. Several types of medium- and high-gain antennas for 460-mc operation are available commercially.

Tubes used in 460-mc mobile radio equipment are generally standard, well known types. The power amplifier and driver tubes (5894-A) used in some RCA equipment are of a fairly new type manufactured to JAN specifications in the United States around a Dutch design. Some Motorola sets use the type 2C39 lighthouse tube which has found wide popularity in microwave systems.

FCC AUTHORIZATIONS

Band (mc)	Service	Stations*
450–460	Special and Safety	700
460–470 and 27.255	Citizens Radio Service**	7,054

* A station is defined as a separate license or construction permit authorization. For example, 65 mobile units operating on one license are counted as one station.

** No record is maintained by the FCC of the number of stations authorized in a specific band, so the 7,054 stations in the Citizens Radio Service include both those operating on 27.255 mc and the 460–470-mc band.

Information on mobile radio equipment for operation in the 450–460 and 460–470-mc bands should be readily obtainable from the manufacturers listed below:

Radio Corporation of America, Communications Marketing Dept., Camden, N. J.

Motorola, Inc., 4545 Augusta Blvd., Chicago 51, Ill.

General Electric Co., Communications Equipment, Syracuse, N. Y.

Connecticut Telephone & Electric Co., Meriden, Conn.

Allen B. Du Mont Laboratories, Inc., Clifton, N. J.

Platt Manufacturing Co., 125 W. 17th St., New York, N. Y.

Stewart-Warner Electric Div., 1826 Diversey Parkway, Chicago 14, Ill.

Servicing 460-mc equipment

Servicing u.h.f. mobile radio systems is very similar to that of v.h.f. mobile radio. The same basic tools and test equipment are required. In addition, a suitable high-grade u.h.f. signal generator, a frequency and deviation meter for the 450- to 470-mc range and an electronic r.f. power output meter and dummy load are recommended shop equipment.

Information on alignment is generally available from u.h.f. mobile equipment manufacturers. Circuitry is usually standard so no unusual problems should be encountered. Be sure however, not to alter r.f. circuitry because at these frequencies physical misalignment could ruin performance.

In addition to tools, test equipment and familiarity with transmitters and superheterodyne receivers, the technician who is to service 460-mc mobile radio equipment (see diagram and photos) must possess a first- or second-class radiotelephone or radiotelegraph operator's license. Such a license is issued by the FCC without cost upon passing a test on radio and electrical principles and FCC rules and regulations.

Where a large volume of mobile radio service is anticipated, the shop should be provided with jigs to permit rapid setup of equipment for testing and alignment. A heavy-duty rectifier power supply may be used as a power source for operating 6- or 12-volt mobile sets on the bench. Since the current drain with the transmitter on is often two to three times the standby drain, it is wise to select a rectifier power supply with adequate voltage regulation. Of course, a storage battery and charger may be used as a bench power source. (Such a supply is unusually useful and flexible. The battery floating across the charger output acts like a very large filter capacitor and voltage regulator. Since current is supplied by the charger, an older battery can be used. — *Editor)*

Installation of 460-mc u.h.f. mobile equipment is much the same as installation of v.h.f. mobile equipment. The equipment is mounted in the same manner and looks the same. The antenna, however, is generally a vertical car-top whip only 6 inches long and easy to install.

Base station installations, too, are similar to v.h.f. base station installations. The length of the antenna transmission line, however, should be kept as short as possible because transmission-line losses at 460 mc are far greater than at 30 or 160 mc. Low-loss transmission line like *Styroflex*, RG-17/U or a good hollow line should be used.

Now that good equipment is available from a number of sources it is expected that the u.h.f. mobile radio will continue to expand at an even more phenomenal rate. The quality of communications, especially the freedom from noise, and solid coverage in either the 450–460 or 460–470-mc Citizens band makes u.h.f. mobile radio particularly attractive. END

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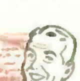

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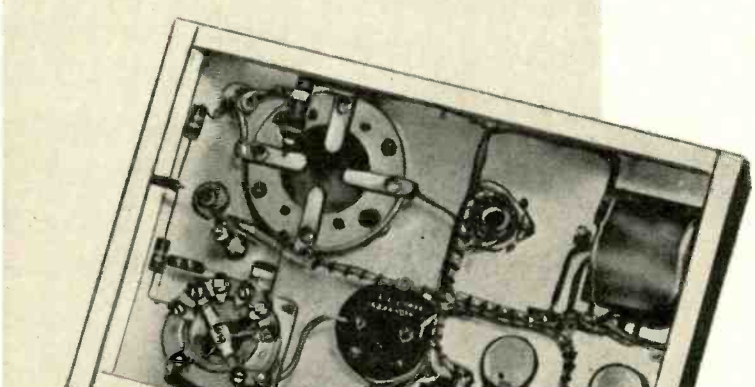
ELECTRONIC LOAD

Forms a variable resistor for checking power supplies

By DON M. WHERRY



Above—the electronic load. Decals add attractiveness to the neatly arranged unit. Below—under-chassis view of electronic load.

WHILE the idea of an electronic load is not new you seldom see one rugged enough to test all sizes of power supplies used in audio amplifiers, small- to medium-sized "ham" transmitters and electronic equipment in general. When designing equipment of this type you have no idea what your power supply will put out under load, and as a result a blind guess is the best you can do. Feeling that that situation should be remedied at once, and with the least possible strain on the budget, the electronic load described in this article was conceived.

Since the tube used in the load must dissipate considerable power in the form of heat, the use of a receiving type tube was out of the question for higher values of current and voltage. Not wishing to purchase, or use, an expensive transmitting tube I cast about for the nearest acceptable substitute. The final choice was a surplus 211 or VT4C. This tube is very cheap on the surplus market (29 cents at one time) and a type many of us have on hand but never intend using. They will take 2,000 volts with little strain, and up to 300 or so milliamperes will not shorten their life appreciably. In any event a greatly shortened tube life means little when a tube is used only a few hours a year. Of course the maximum current at the maximum voltage will exceed the plate dissipation badly but even that can be handled if the meter readings are taken in a few seconds.

The unit (see diagram) uses a 6SN7-GT as a rectifier for the grid bias of the load tube. This is somewhat unusual but necessary because the 211 is a relatively high-gain tube. Thus, the grid must be at a positive potential to get a heavy load current at low voltages. As the grid draws considerable current when operated at a positive potential, some method other than a potentiometer for bias voltage control was desireable.

One half of the 6SN7 was connected so as to furnish that positive voltage, the value of which is controlled by its own grid bias adjusted by R1. This performs very well, the bias of the 211 being adjustable betwen zero and approximately 50 volts positive smoothly and easily. The remaining section of the 6SN7 is diode-connected to furnish a negative voltage for the 211 and also for the control of the positive section. The negative voltage to the 211 is controlled by potentiometer R2 as the grid takes no power while negative. A switch is used to go from positive to negative bias.

The transformer used is a standard broadcast type furnishing approximately 350 volts each side of center. The two filament windings are connected in series to furnish 10 volts for the 211. This voltage, being slightly high, is dropped by adjustable 1-ohm 10-watt resistor R3.

The current and voltage of the power supply under test are measured by a 1-ma meter with its various shunt and series resistors. To design meter shunts it is necessary to know the resistance of the meter. This is done with a small flashlight cell, two potentiometers and an ohmmeter.

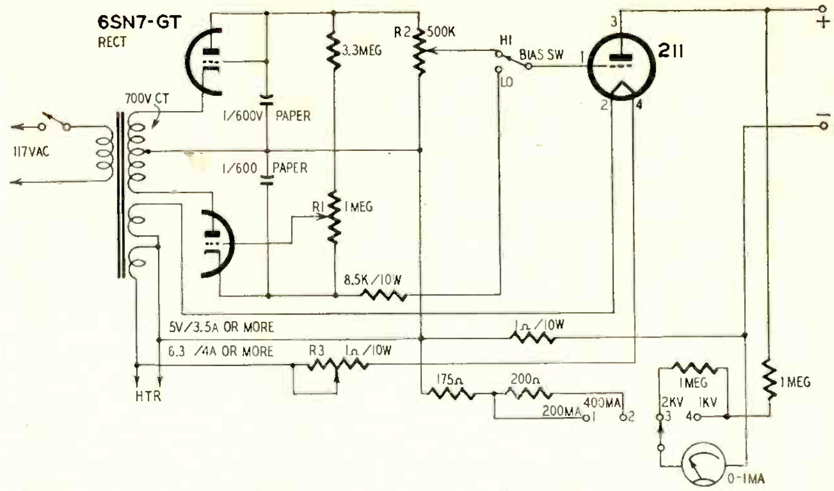
Connect one potentiometer, the cell and the meter to be used in series and adjust the potentiometer for full-scale deflection. Without touching that adjustment connect the second potentiometer across the meter and adjust for half-scale deflection. Remove the second potentiometer and measure its resistance—this will be the resistance of the meter. With most 1-ma meters it will be low—my unit is 25 ohms. Knowing the resistance of the meter, the shunts and multipliers can be computed by the following formulas: milliammeter shunt $R = \frac{R_m}{n-1}$ where R_m is the resistance of the meter and n is the scale multiplication factor; voltmeter multiplier $R = R_m (n-1)$.

However, a slightly different approach was used. A 1-ohm resistor was permanently connected in series with the negative load line. Then, as the two current readings desired are 200 and 400 ma, respectively, it was calculated that the drop across the 1-ohm resistor would be 0.2 volt for the 200-ma range and 0.4 volt for the 400-ma. Since 0.2 volt will draw 1 ma through 200 ohms, it was necessary only to add a resistor of 175 ohms in series with the meter and place the two across the 1-ohm dropping resistor for the 200 scale. For the 400-ma scale it was necessary to add an additional 200-ohm resistor in series with the meter. You will find this method much easier than trying to wind two shunts to put directly across the meter. It's no cinch to wind a shunt for a multiplication of 400 and get it right.

The voltmeter was easy. As 1,000- and 2,000-volt ranges were desired, it was calculated that 1 megohm would pass 1 ma at 1,000 volts, so two 1-megohm resistors were used in series for the 2,000 range and the meter tapped off the center point for the 1,000 range. The meter resistance was neglected, being insignificant in this case.

Be careful how you wire the meter switch. Have the lowest voltage at the opposite side of the four positions from the lowest current. In this way you can go from any current range to the desired voltage range without harming the meter.

The meter switch used was a surplus affair, removed from a BC-375 tuning unit. Many of us have these laying around unused because of their rather violent indexing system. The remedy is, not to weaken the spring, but to file new indexing marks. It is easy. Remove the contact ring and the smaller wiper ring. Then revolve the shaft 180° and file small indexing notches on the smooth edge of the indexing disc. A small rat-tail file will do the job nicely with no further disassmbly. Reassemble and use with the shaft 180° rotated from normal.



Schematic diagram of the electronic load. Extremely rugged 211 is used.

When wiring the unit, wire the two load tube bias potentiometers so that, when both are in the "off" position, the tube has either high negative or zero bias on the grid, depending on the position of the bias switch. This switch is decaled LO – HI, which refers to the voltage being tested. When operating the unit, always start with the meter on the 2,000-volt scale, the bias potentiometers in the "off" position and the LO–HI switch in the HI position—this is important. Next, switch to the current range desired and advance R2 until the desired load current is drawn. If the voltage being measured is too low to obtain the desired current with R2 entirely advanced, turn it back to the "off" position and switch to LO and repeat with R1. The important thing is always to start with both potentiometers in the "off" position and the LO–HI switch in the HI position.

This unit can also be used as a variable resistance, when placed in the positive high-voltage lead, for first tuning up a new transmitter. The voltage on your pet transmitting tube can be kept to a safe value in case something goes wrong. Take care, however, when it is being used in this manner because a very high voltage to ground may appear across the filament to the primary winding of the bias transformer in the load box. The chassis is left floating to lessen the danger to the technician when testing high voltage. High voltage is not dangerous—it's deadly.

Parts for electronic load

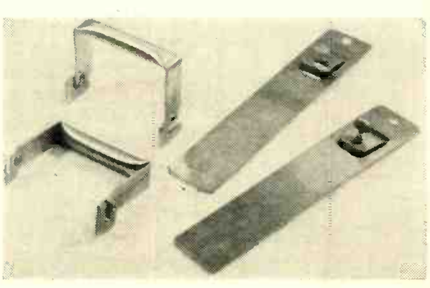
Resistors: 1—175, 1—200, 2—1 megohm, 1—3.3 megohms, ½ watt; 1—1, 1—8,500 ohms, 10 watts; 1—1 ohm, adjustable; 1—500,000, 1—1 megohm, potentiometers.

Miscellaneous: 2—1-µf 600-volt paper capacitors, 1—6SN7-GT and socket; 1—211 (VT4C) and socket; 1—s.p.s.t. switch; 1—s.p.d.t. switch; 1—single-pole 4-position rotary switch (see text); 1—transformer, 700 volts c.t. @ 50 ma, 6.3 volts @ 4 amperes, 6.3 volts @ 3.5 amperes; 1—meter, 0-1 ma; 1—chassis; 1—line cord; 2—output terminals.

As can be seen from the photo the electronic load is decaled. Decals are highly recommended. They are easy to apply and make the difference between a fine commercial-appearing unit and a "thing."

The unit shown was made completely from junkbox parts but its usefulness to most experimenters would well justify the purchase of new components. It is a valuable addition to the shop or ham shack equipment. END

CHASSIS HANDLING MADE EASY

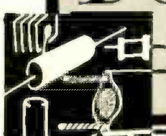


Two simple and useful items to the TV service technician are these pieces of chassis-handling equipment, made by Barb City Industries (De Kalb, Ill.). They make it easier to get the set into the shop and to keep it on the bench once it gets there.

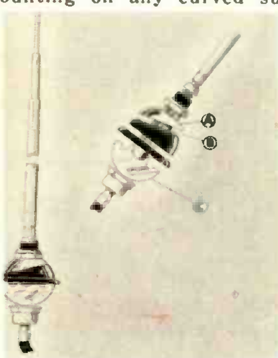
The pair of handles at the left form a chassis carrier. The slotted hooks seen on the one lying down are hinged to the handle with a rivet. The slot is wide enough to accommodate the edge of a chassis. When the handle is picked up, the weight of the chassis forces it against the outside of the chassis skirt, while the inner side of the hook is held firmly against the inside.

The two strips make up what is possibly the simplest chassis support ever manufactured. They are fastened to the bench—a suitable distance apart—with a screw through the hole in each one. Then, with the chassis held in a vertical position, one edge is slipped under the tab on each strip.

new Devices

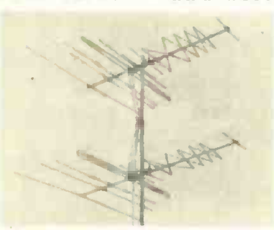


AUTO ANTENNA, *Antenna Specialists' Baseball,* has rocker support for positive grounding. New mounting support design eliminates wet-weather shorts. Universal swivel base permits mounting on any curved sur-



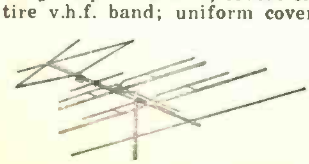
face with a slant of up to 35° from horizontal. Only one hole required for installation; entire job can be done from outside of car Completely assembled with a 56-inch replaceable telescopic whip and either a 36- or 54-inch lead.—**Antenna Specialists Co.,** 13435 Euclid Ave., Cleveland 6, Ohio.

TV ANTENNA, *JFD Super-Star-Helix (model SX13,* single bay; *model SX13S,* stacked) incorporates *Star-Helix* layout with special front-end modification for peaking channel-13 performance. Modifications are added director and delta-



matched helical section, a shortened stub at center of helix. Flat helical section composed of individual nonlinear additive collectors, each tuned for high gain and sharp sensitivity on one high-band channel. Matching booster transformer for close stacking with maximum high-band response and electrical wide stacking with optimum low-band response.—**JFD Manufacturing Co., Inc.,** 6101 16th Ave., Brooklyn 4, N. Y.

TARGET TV ANTENNA, *S & A Target Space Master,* covers entire v.h.f. band; uniform cover-

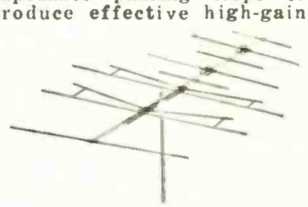


age over channels 2–6, higher gain on channels 7–13. Co-channel interference eliminated by high front-to-back ratio. Maximum transfer of signal by matching terminal impedance and 300-ohm transmission line. Good gain and directivity from Target V-X director system.—**S & A Electronics,** 1039 Nevada St., Toledo 5, Ohio.

U.H.F.-V.H.F. ANTENNA SWITCH, *Superex model UV-1,* features silver-plated switch contacts, positive indexing, no measurable signal loss and an

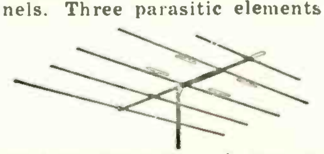
attractive case with easy out-of-sight mounting brackets, as well as a means of coupling two antennas to a TV set.—**Superex Electronics Corp.,** 4-6 Radford Pl., Yonkers, N. Y.

ANTENNAS, *Telrex Thunderbird,* loop-phased multielement arrays for fringe and subfringe area TV reception. Element function duplexed by variable impedance phasing loops to produce effective high-gain



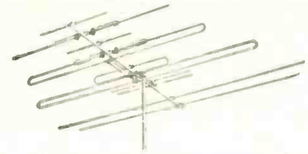
Yagis for high- and low-channel v.h.f. bands in all-in-line array. Compensated-T match for high- and low-band operation, for use with single transmission line through special decoupling system which isolates high- and low-channel signals to preserve symmetrical single-lobe response.—**Telrex, Inc.,** Asbury Park, N. J.

TV ANTENNA, *Trio 99,* for channels 2 to 13, uses two dual-purpose active elements, each consisting of three half-waves in phase on high channels and single half-wave on low channels. Three parasitic elements



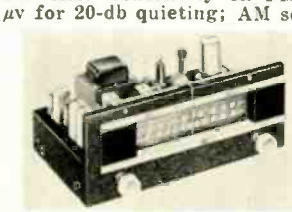
on low channels and five on highs.—**Trio Manufacturing Co.,** Griggsville, Ill.

ZEE-BEAM ANTENNAS, *Welco model 110, model 220* and *Super ZEE-Beam,* all featuring ex-



clusive *ZEE-X* elements.—**Welco Mfg. Co.,** Burlington, Iowa.

HI-FI EQUIPMENT, *Allied model 728* FM-AM tuner (illustrated) has a.f.c. circuit, two controls, tuning and function selector, r.f. amplifier stage for FM and AM. Sensitivity on FM 5 μv for 20-db quieting; AM sen-



sitivity 5 μv for 1-volt output; response from 15 to 15,000 cycles, ± 1db.

Knight Bantam 12-watt amplifier measures 3½ x 13 x 10¼ inches. Frequency response at 12 watts output ±0.5 db from 20 to 20,000 cycles. Harmonic distortion less than 1% at rated output; intermodulation distortion less than 2% at rated output. Speaker output impedance 8 and 16 ohms.

Self-powered *Knight* preamp-equalizer. Has bass and treble controls, five input jacks, 6 position input selector switch. Rated output 2.5 volts; frequency response at rated output 20 to 20,000 cycles, ±1 db; harmonic distortion at rated output 0.8%.—**Allied Radio Corp.,** 100 N. Western Ave., Chicago 80, Ill.

VOLTAGE AMPLIFIER, *Electro Products model 3400-A,* for use as preamp ahead of electronic instruments when actuating signals have insufficient amplitude. Also usable as all-purpose laboratory type voltage

amplifier. Boosts voltage of low-output transducers. Distortion less than 2½% up to 10 volts, 6% to 30 volts—saturation over 50 volts; gain of 200 or more between 1 and 30,000 cycles. Gain about 100 at 100,000 cycles; 50 at 200,000 cycles.—**Electro Products Laboratories,** 4503 N. Ravenswood Ave., Chicago 40, Ill.

THREE-WAY SPEAKER SYSTEM, *Electro-Voice Skylark,* 14 x 33 x 10¾ inches, contains two tapered-horn ports which load properly *SP8C* low-frequency and mid-range reproducer from 70 to 3,500 cycles. *Super T35B* high-frequency tweeter takes over at 3,500 cycles to beyond audibility. Reproduces

complete frequency range from about 70 to 15,000 cycles, ±6 db. — **Electro-Voice, Inc.,** Buchanan, Mich.

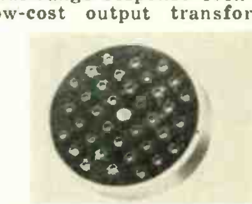
12-INCH WIDE-RANGE SPEAKER, *Lansing model 123,* is only 3⅝ inches in depth. This new *Signature* speaker mountable between studding, flush with surface of standard wall or partition; also enclosable in

reflex cabinet or can be loaded with a horn. Usable frequency response range, as direct radiator and enclosed with adequate baffle, from 20 to 15,000 cycles. Power input 20 watts; impedance, 16 ohms. — **James B. Lansing Sound, Inc.,** 2439 Fletcher Dr., Los Angeles 26, Calif.

SPEAKER SYSTEM, *Permoflux Largo 12 inch* (Big Brother to the famous Largo 8 inch), features *Super Royal* 12-inch speaker and 32KTR super tweeter. Utilizes enclosure similar to Largo 8, but larger. Peak-free reproduction over full range of 30 to 16,000 cycles. Power-handling capacity,

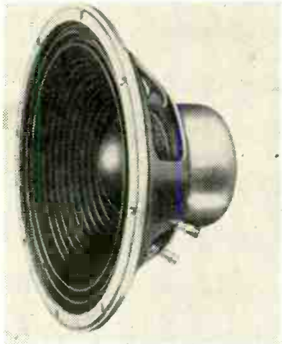
20 watts; impedance system, 8 ohms; overall size, 23⅛ x 27¼ x 15½ inches. This speaker was described in this column in the May, 1955, issue and incorrectly illustrated with a photo of the *Maestro* speaker-headset control box. Correct photo appears here.—**Permoflux Corp.,** 4900 West Grand Ave., Chicago 39, Ill.

CRYSTAL TWEETER, *Ronette,* requires no output transformer. Connects into plate circuit of output tube, permitting wide-range response even with low-cost output transformers



handling the lower frequencies. Blocking capacitor attenuates lower frequencies and eliminates expensive crossover networks. — **Ronette Acoustical Corp.,** 135 Front St., New York 5, N. Y.

NEW CONE, for the *Stephens 120LX Tru-Sonic* low-frequency driver, is straight-sided, ribbed cone of low resonance; cuts free-air resonance of 120LX to 45 cycles. This results in improved bass response, with lows



of 20 cycles with properly housed speaker. Voice coil in the 120LX woofer is 2 inches in diameter; power supplied by a 1½-pound Alnico-V magnet.—**Stephens Manufacturing Corp.,** 8538 Warner Dr., Culver City, Calif.

DESK MIKE, *Turner Chief,* usable as original or replacement equipment for tape recorders. Has ⅝-inch adapter for stand mounting. *Model 808* (crystal interior): response, 70 to 7,000

cycles; level, −46 db. *Model 807* (ceramic interior): response, 780 to 7,000 cycles; level, −55 db. *Models S-807, S-808* have on-off slide switch. *Model 809* (magnetic interior for ruggedness): response, 100 to 8,000 cycles; level, −52 db.—**Turner Co.,** 933 17th St., N. E. Cedar Rapids, Iowa.

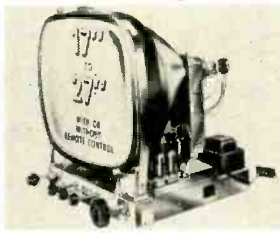
ELECTRONIC ORGAN KIT, *Schober,* a full concert instrument with 2 manuals, 32 pedals, 19 stops, 6 couplers. No moving

parts except keys and controls; 130 printed circuits. Kits for separate components, such as each of the 12 tone generators, or preamplifiers, stop filters, also available.—**Schober Organ Corp.,** 35 Dail St., New Hyde Park, N. Y.

PRINTED CIRCUIT KIT, *Tele-Diagnosis model 1955,* contains materials and equipment, such

as heating apparatus, thermometer, etching trays, etc., for fabricating experimental printed circuits. Also step-by-step instructions and suggestions concerning design. Instructions supplemented by description of each process as accomplished in automatic mass production.—**Tele-Diagnosis Co.,** 155 W. 72nd St., New York 23, N. Y.

TELEVISION KIT, *Transvision model E1,* designed so that color TV may be added. Each part individually packaged and marked with an identification number. Eight types of kits

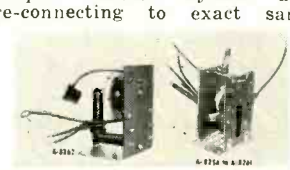


available in 17-, 21-, 24-, 27-inch sizes. Remote control optional. Photos and diagrams of each stage of assembly, a service section, and a book on TV and hi-fi.—**Transvision, Inc.,** New Rochelle, N. Y.

METALLIZED PAPER CAPACITOR, *Astron Comet,* small and lightweight with low r.f. impedance. New solid thermo-

setting impregnant provides high dielectric strength and improved insulation resistance. Operates dependably to 125° C. Bonded shell and protected seal immersion-proof and impervious to extremes of heat, cold and moisture.—**Astron Corp.,** 255 Grant Ave., East Newark, N. J.

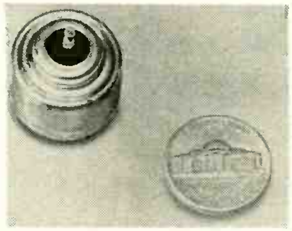
6 FLYBACK TRANSFORMERS, *Stancor,* exact replacements for 11 G-E flybacks. Can be installed without circuit or chassis alteration by disconnecting old unit and replacing with proper Stancor flyback and re-connecting to exact same



terminals.—**Chicago Standard Transformer Corp.,** Addison & Elston, Chicago 18, Ill.

ELECTROLYTIC CAPACITORS, *Cornell-Dubilier TH Tantalums,* rated from −55° to +125°C. (Units rated to +175°C. can be supplied). Standard case size ½ x ⅞ inch to

120 μf; only slightly larger to 240 μf. Series combinations supplied at higher capacitances and voltage ratings. Standard units from 25 to 120 μf with a



working range of 18 to 100 volts d.c. Higher capacitances and voltages to 630 volts d.c.

Series *NT* capacitors are ⅛ inch in diameter, ⅝ inch in length. Retain characteristics of larger prototypes; are well suited for transistor, printed-circuit and other applications where space is at a premium. Capacitance range from 1.0 μf at 16 volts d.c. to 8.0 μf at 4 volts d.c.—**Cornell-Dubilier Electric Corp.,** S. Plainfield, N. J.

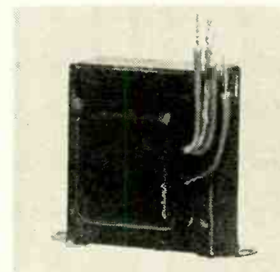
FM TUNER, *Granco model T-160,* has built-in antenna, 5 tubes plus selenium rectifier, sensitivity of 5 μv for 20-db quieting. Selectivity of 200 kc at 6-db points, with ratio detector peak-to-peak separation of 300 kc and linear detector

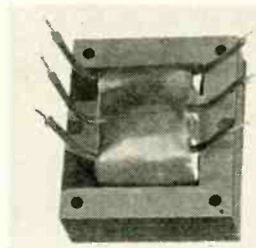
response for 180 kc, minimizes interference. Hum level, 70 db below 1 volt; maximum audio output ±0.5 db, 20 to 20,000 cycles; audio distortion, 0.2% at 1-volt output; input, 300 ohms or built-in line-cord antenna; a.c. operation, 105–125 volts, 30 watts.—**Granco Products Inc.,** 36-17 20th Ave., Long Island City 5, N. Y.

GERMANIUM POWER RECTIFIER, *International Rectifier type 53-0075-0* (35 kw liquid-cooled). A 3-phase bridge unit, rated for maximum of 450 amp, d.c. continuous output. For input voltages of 26, 36, 52, 66 r.m.s. maximum. Volume ap-

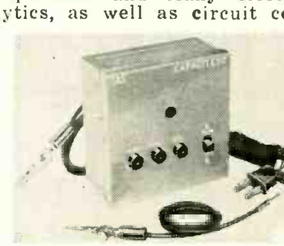
proximately 220 cubic inches as compared to 1,650 cubic inches for comparable selenium unit (fan-cooled) and 14,000 cubic inches for copper oxide unit (fan-cooled). Liquid coolant (water, oil, etc.) at maximum inlet temperature of 25° C, ½ gallon per minute minimum. Efficiency up to 97% attainable; power factor essentially 100%. Applicable for all types of d.c. load requirements except those requiring heavy surge currents or subject to heavy intermittent overloads or occasional short circuits.—**International Rectifier Corp.,** El Segundo, Calif.

12-V TRANSFORMERS, *Merit models P-2860* and *P-2861,* are replacement vibrator units for auto radios.—**Merit Coil & Transformer Corp.,** 4427 N. Clark St., Chicago 40.





CAPACITEST, *Barjay,* shows open, shorted or intermittent capacitors and leaky electrolytics, as well as circuit con-



tinuity and a.c. and d.c. voltages. Indicates leakage of over 300 meghoms. Checks capacitors at 150 volts. Measures 4 x 4 x 2 inches; compact and light.—**Barjay Co.,** 145 W. 40th St., New York 18, N. Y.

TUNING SLUG RETRIEVERS, *General Cement,* 12- and 15-inch sizes work on all Standard Coil tuners to retrieve tuning slugs on oscillator coils of channel strips. Easily fit new wide-slotted slugs and deep-seated tuning units. Also useful for reclaiming screws and starting set screws in previously inaccessible spots.—**General Cement Mfg. Co.,** 919 Taylor Ave., Rockford, Ill.

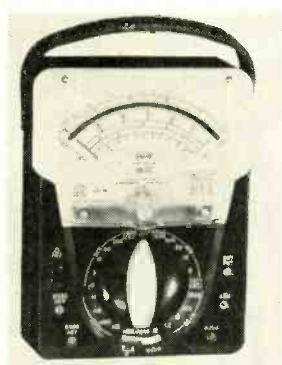
A. C. OSCILLOSCOPE, *Brown-*

ing models 701 and *701-D* (with delay line), cover 5 cycles to 10 mc; useful to 20 mc. Sensitivity of 16 mv peak to peak per centimeter; rise time, .035 μsec. Sweep circuits provide triggered or recurrent sweeps from 0.1 to 10,000-sec per centimeter. Input impedance of 2 megohms paralleled by 25 μμf permits more accurate measurements through low loading of tested circuit. Power supply permits operation at any frequency between 50 and 500 cycles and at voltages of either 115 or 230.—**Browning Laboratories, Inc.,** 750 Main St., Winchester, Mass.

PICTURE TUBE TESTER, *Century model 102,* self-contained, tests for quality by emission method. Also tests for inter-element leakage, shorts and open elements. Supplies own C-R tube power through cir-

cuit which allows efficient testing with tube in or out of set. Single master control eliminates complicated switching and shows condition of C-R tube under test.—**Century Electronics Co.,** Mineola, N. Y.

THREE NEW PRODUCTS, *Triplett:* new color bar generator *model 3439;* AM generator, *model 3442-A,* with frequency range from 160 kc to 110 mc; volt-ohm-milliammeter (illustrated here), *model 630-NA.*—**Triplett Electrical Instrument Co.,** Bluffton, Ohio.



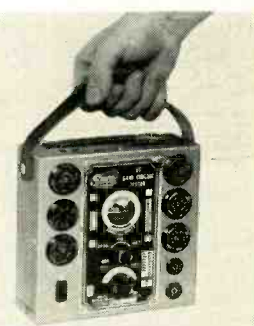
TUBE TESTER, *Precise Model 111,* available in wired and kit form. Checks emission and mutual conductance; all tubes, including hearing aid, miniatures and C-R. Has new type switches,

voltage sapper check, gas check, simplified short check and latest roll chart. Measures 14 x 16 x 6 inches; weighs 30 pounds.—**Precise Development Corp.,** Oceanside, L. I., N. Y.

D.C. MIDGETSCOPE, *RCP model 534,* combines linear sweep with d.c. amplifier for color TV

restorer circuits and for complex waveforms. Has provisions for a.c. coupling, full vertical and horizontal expansion of trace, automatic astigmatism control circuit, linear time base and sweep, automatic blanking of return trace, vertical or horizontal operation. Frequency range, d.c. to 500 kc; sensitivity better than 50 mv; push-pull deflection throughout.—**Radio City Products Co., Inc.,** Easton, Pa.

TUBE TESTER, *Seco model GCT-5,* tests over 40 tubes in a.g.c., r.f., i.f., sync circuits. Filament voltage selector for 3-, 4-, 5-, 6-, 7-, 12-volt tubes.



Determines grid-to-cathode and cathode-to-heater shorts, gas, and control-grid emission.—**Seco Manufacturing Co.,** 5015 Penn Ave. South, Minneapolis, Minn.

RADIO-FREQUENCY BRIDGE, *Sylvania,* measures resistance in junction type transistors, making it possible to determine whether a transistor meets certain necessary performance standards which could not otherwise be measured and could not be determined until the transistor had

been applied directly to a circuit.—**Sylvania Electric Products Inc.,** Ipswich Electronics Laboratory, Estes St., Ipswich, Mass. END

All specifications given on these pages are from manufacturers' data.

RCA-WO-78A—5" Oscilloscope $425.00 (suggested user price) complete with WG-294 direct probe and cable, WG-293 low-capacitance probe, alligator clip, ground cable, insulator, green graph screen, instruction book.

RCA WO-78A 'Scope for BLACK and WHITE, COLOR TV

An investment in quality that can pay its own way

Expert technicians have learned that the fastest way to isolate trouble in "tough" sets is by using a good 'scope. A quality 'scope like the WO-78A is a sound investment which can pay its own way if it saves you only a few hours of trouble-shooting a week.

Advanced design and expert engineering make the WO-78A a superior instrument which helps you deliver *top-grade TV service work in less time.* And, with the wideband WO-78A, you have an instrument especially suited for the complex circuitry of color TV—to observe color burst signals and to aid in the analysis of complicated circuit waveforms. Your safest investment for both color and black-and-white TV is to choose the finest TV service 'scope available. Here are some of the outstanding features of the WO-78A:

• *Maximum utility* . . . dual-band response; wide-band position (3 cps to 4.5 Mc, –1 db with gradual roll-off to 6 Mc) for color TV; high-sensitivity position (3 cps to .5 Mc,—3 db) for general service, black-and-white TV.

• *High sensitivity* . . . direct sensitivity of 0.01 volt peak-to-peak per in. (0.0035 rms volt per in.) in high-sensitivity position; 0.1 volt peak-to-peak per in. (0.035 rms volt per in.) in wide-band position.

• *Excellent phase and frequency response* . . . minimum ringing, negligible tilt, and overshoot.

• *Full-screen vertical deflection*... without distortion up to 4.5 Mc (many lab 'scopes provide only half-screen deflection).

• *Voltage calibrated "V" input attenuator* . . . frequency compensated 14-position (steps of 3 to 1) vertical-input attenuator.

• *Low circuit loading*... WG-293 Low-Capacitance probe supplied with RCA WO-78A has impedance of 10 megohms shunted by 14 μμfd.

• *Bright sharply focused trace* . . . provided by the use of the RCA 5ABP1 flat-face cathode-ray tube which utilizes post-deflection acceleration and an ultor potential of 3000 volts.

• *Extremely simplified operation* . . . No need to disconnect the input or to apply external calibrating voltages. Push-button applies fixed input voltage to vertical amplifier for calibration. Limiter in sync circuit eliminates horizontal sync adjustments; gives positive lock. Removable graph screen calibrated in inches and tenths of an inch permits easy measurement and comparison of signal amplitudes. As speedy to read as a VTVM.

See the RCA WO-78A with the "features plus" . . . at your RCA Distributor. For technical data write RCA, Commercial Engineering, Sec. F-39-W, Harrison, N.J.

RADIO CORPORATION of AMERICA

TEST EQUIPMENT **HARRISON, N.J.**

new Tubes & Transistors

5AM8, 6AM8, 6AW8, 6BZ6, 12CA5

RCA has announced five new miniature tubes for use in television receivers.

The 5AM8 and 6AM8 are general-purpose multiunit tubes of the nine-pin miniature type, each containing a high-perveance diode and a sharp-cutoff pentode in one envelope.

The high-transconductance pentode may be used as an i.f., video and a.g.c. amplifier. It has separate base pins for the suppressor grid and the cathode. This permits the use of an unbypassed cathode resistor to minimize changes in input loading and input capacitances with bias, without causing oscillation that might otherwise occur if the suppressor grid were internally connected to the cathode. The tube also contains an internal shield to minimize coupling between the diode plate and the pentode unit.

The high-perveance diode, which has its own cathode terminal, may be used as a video detector, d.c. restorer or a.g.c. delay diode.

The 5AM8 is like the 6AM8 except for its heater characteristics — the 5AM8 draws 600 ma at 4.7 volts, the 6AM8 450 ma at 6.3 volts.

The 6AW8 is a general-purpose, multiunit tube of the nine-pin miniature type containing a high-mu triode and a sharp-cutoff pentode in one envelope. The tube has a 600-ma heater for series-string operation.

Featuring high transconductance (9,000 micromhos), the pentode section of the 6AW8 may be used as a video amplifier, a.g.c. amplifier and reactance tube. The triode section may be used in sync-separator, sync-clipper and phase-splitter circuits.

The 6BZ6 is a semiremote-cutoff pentode of the seven-pin miniature type, intended for use in gain-controlled video i.f. stages.

The semiremote-cutoff characteristic minimizes cross-modulation effects in the video i.f. stages and distortion resulting from high signal levels and a.g.c. time delay. In addition, the tube has a high transconductance permitting high gain per stage. The 6BZ6 has separate base pins for the suppressor grid and the cathode.

The 12CA5 is seven-pin miniature beam power tube intended for use in the audio output stage of TV receivers. The tube has a 600-ma heater for series-string operation.

The 12CA5 has a high power sensitivity, high efficiency and is capable of providing high power output at relatively low supply voltages.

6BA8

Still another tube designed for series-string operation is the 6BA8. The miniature nine-pin, medium-mu triode and sharp-cutoff pentode has a 600-ma heater. Designed to operate as a video amplifier, the pentode section of the 6BA8 has a plate dissipation rating of 3.25 watts. The triode section has a mu of 18 and is suitable where low-mu triode operation is desirable, such as in sync amplifiers. The 6BA8 was announced by Sylvania.

24YP4

An aluminized picture tube, the 24YP4 is identical in all respects to the 24DP4-A except that it has a higher value of capacitance between external conductive bulb coating and the second anode.

The tube uses low-voltage electrostatic focus, 90° magnetic deflection. Maximum overall length is 21½ inches. The external conductive bulb coating, together with the internal conductive coating, forms a supplementary filter capacitor having a value within the range of 1,200 to 1,500 $\mu\mu$f. The ion-trap gun requires an external single-field magnet. The 24YP4 was announced by RCA.

5AYP4 view-finder

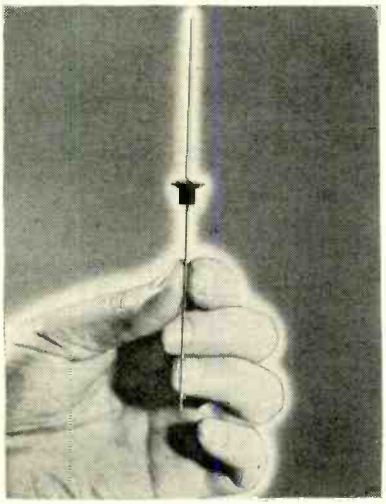
A new directly viewed 5-inch cathode-ray tube, the 5AYP4, has been announced by RCA. Designed for view-finder service in connection with portable TV cameras, it provides a 3⅜ x 2½-inch view of the televised scene.

Electrostatically focused and magnetically deflected, the 5AYP4 uses an electron gun designed to provide high resolution and good uniformity of focus over the entire picture area.

The 5AYP4 has a practically flat face; a high-efficiency, aluminized, white fluorescent screen which not only improves picture contrast and brightness, but also eliminates the need for an ion-trap magnet, and an external conductive coating which with the internal conductive coating forms a supplementary filter capacitor. The maximum design-center rating for the second anode is 10,000 volts; for the focusing electrode, 1,500 volts.

Silicon power rectifiers

Bogue Electric has announced quantity production of high-current high-voltage silicon power rectifiers. Outstanding among the characteristics of this type rectifier are its efficiency of approximately 99% and its ability to operate in extremely high ambient temperatures. The rectifiers (see photo) are small, occupying about ⅛ cubic inch and weighing about 0.1 ounce. They are hermetically sealed.



The high efficiency is due to the low voltage drop and extremely small reverse leakage current (100 μμa). The silicon power rectifier's efficiency is approached only by germanium rectifiers but, unlike the germanium, the silicon type may be used in ambient temperatures of 100° C and higher.

6655

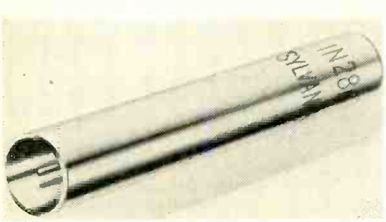
RCA has announced a new flat-face head-on multiplier phototube for use in scintillation counters and other applications involving the measurement of low-level large-area light sources.

The 6655, having the 5819 as its prototype, retains the high sensitivity and other electrical characteristics of the older type but contains new design features. These include a flat face with a minimum diameter of 1 11/16 inches to simplify the mounting of flat phosphor crystals in direct contact with the surface.

The spectral response of the 6655 covers the range from about 3,000 to 6,500 angstroms, with maximum response at approximately 4,400 angstroms.

1N286

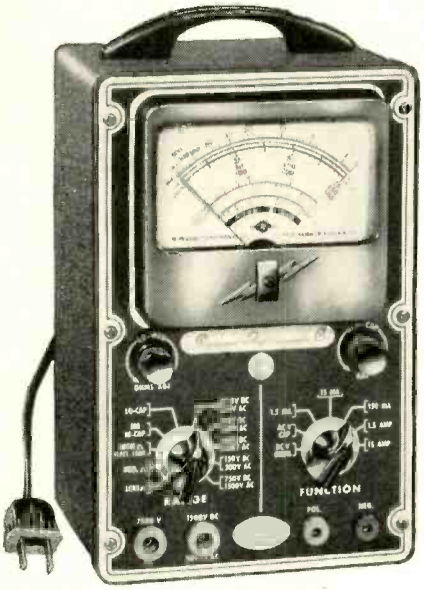
A new silicon crystal diode, the 1N286, a broadband, coaxial point-contact type (see photo), has been announced by Sylvania. It is designed



for use as a crystal mixer and covers a range from 10,000 to 20,000 mc. Its broadband characteristics make it particularly useful in tunable-frequency radar systems and counter-measuring devices. END

Superior's new Model 670-A

SUPER METER



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

SPECIFICATIONS:

D.C. VOLTS: 0 to 7.5/15/75/150/750/1,500/7,500 Volts

A.C. VOLTS: 0 to 15/30/150/300/1,500/3,000 Volts

OUTPUT VOLTS: 0 to 15/30/150/300/1,500/3,000 Volts

D.C. CURRENT: 0 to 1.5/15/150 Ma. 0 to 1.5/15 Amperes

RESISTANCE: 0 to 1,000/100,000 Ohms 0 to 10 Megohms

CAPACITY: .001 to 1 Mfd. 1 to 50 Mfd. (Good-Bad scale for checking quality of electrolytic condensers)

REACTANCE: 50 to 2,500 Ohms, 2,500 Ohms to 2.5 Megohms

INDUCTANCE: .15 to 7 Henries 7 to 7,000 Henries

DECIBELS: −6 to +18, +14 to +38, +34 to +58

ADDED FEATURE:

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

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

$28.40 NET

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

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.

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.

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.

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.)

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

$47.50 NET

SHIPPED ON APPROVAL

NO MONEY WITH ORDER—NO C.O.D.

Try any of the above instruments for 10 days before you buy. If completely satisfied *then* send down payment and pay balance as indicated on coupon. **No Interest or Finance Charges Added!** If not completely satisfied return unit to us, no explanation necessary.

MOSS ELECTRONIC DISTRIBUTING CO., INC.
Dept. D-136, 3849 Tenth Ave., New York 34, N.Y.

Please send me the units checked. I agree to pay down payment within 10 days and to pay the monthly balance as shown. It is understood there will be no finance, interest or any other charges, provided I send my monthly payments when due. It is further understood that should I fail to make payment when due, the full unpaid balance shall become immediately due and payable.

☐ Model 670-A.................................Total Price $28.40
$7.40 within 10 days. Balance $3.50 monthly for 6 months.

Name ....

Address ....

City..............................Zone........State..................

☐ Model TV-50.................................Total Price $47.50
$11.50 within 10 days. Balance $6.00 monthly for 6 months.

Superior's New Model TV-11

TUBE TESTER

SPECIFICATIONS

★ Tests all tubes, including 4, 5, 6, 7, Octal, Lockin, Peanut, Bantam, 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 TV-11 as any of the pins may be placed in the neutral position when necessary.

★ The Model TV-11 does not use any combination type sockets. Instead individual sockets are used for each type of tube. Thus *it is impossible to damage a tube by inserting it in the wrong socket.*

★ Free-moving built-in roll chart provides complete data for all tubes.

★ Newly designed Line Voltage Control compensates for variation of any Line Voltage between 105 Volts and 130 Volts.

★ 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.

The model TV-11 operates on 105-130 Volt 60 Cycles A.C. Comes housed in a beautiful handrubbed oak cabinet complete with portable cover

$47.50 NET

EXTRA SERVICE—The Model TV-11 may be used as an extremely sensitive Condenser Leakage Checker. A relaxation type oscillator incorporated in this model will detect leakages even when the frequency is one per minute.

Superior's new Model TV-40

C. R. T. TUBE TESTER

★ **A complete picture tube tester for little more than the price of a "make-shift" adapter!!**

★ **Tests all magnetically deflected tubes . . . in the set . . . out of the set . . . in the carton!!**

The Model TV-40 is absolutely complete! Self-contained, including built-in power supply, it tests picture tubes in the only practical way to efficiently test such tubes; that is, by the use of a separate instrument which is designed exclusively to test the ever increasing number of picture tubes!

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.

SPECIFICATIONS

- 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.
- Tests for open elements.

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

$15.85 NET

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☐ Model TV-11..........Total Price $47.50
$11.50 within 10 days. Balance $6.00 monthly for 6 months.

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

Name ....

Address ....

City.......... Zone..... State..........

MISCELLANY

THE FUND REACHES $11,573.86

HELP-FREDDIE-WALK FUND

WHEN the Help-Freddie-Walk Fund was inaugurated in April, 1950, no one at RADIO-ELECTRONICS was willing even to guess how far it would go, for we knew only too well that its success or failure depended upon the interest and generosity of our readers. However, our contacts with Herschel Thomason, radio technician of Magnolia, Ark., had convinced us that the plight of his son Freddie—born without arms or legs—was a cause worthy of our time and effort, and we were certain that readers all over the world would respond with characteristic sincerity.

The Fund is now in its fifth year. During that time Freddie's friends have contributed a total of $11,605.11, far more than our most optimistic hopes. Thanks to their generosity, Freddie's family has been able to provide for him many of the necessary mechanical appliances that help make his life as nearly normal as is possible under the circumstances.

At 7 years of age, Freddie is able to walk about very competently on his artificial legs, and he is eagerly awaiting the day when he will be fitted with mechanical arms. In the meanwhile, he exercises in his specially built playroom, plays with his younger brother and his friends and attends school regularly, a happy and healthy youngster.

Lack of space precludes running the story of Freddie every month, but we sincerely hope that our readers will not construe this as a lack of interest. We are still receiving contributions, which are forwarded to the Thomasons promptly, and we know that their appreciation of any donation, no matter how small, is heartfelt. We ask each of our readers to make a special effort to send Freddie a word of encouragement, for, as Freddie grows, so must the Fund grow if he is to develop into the responsible member of society we all know he can be.

Please send your contributions as often as you can. No amount is too small to receive our sincerest thanks and appreciation, and every donation is acknowledged by letter. *Make all money orders, checks, etc., payable to Herschel Thomason.* Address all letters to:

Help-Freddie-Walk Fund
c/o RADIO-ELECTRONICS Magazine
25 West Broadway
New York 7, N. Y.

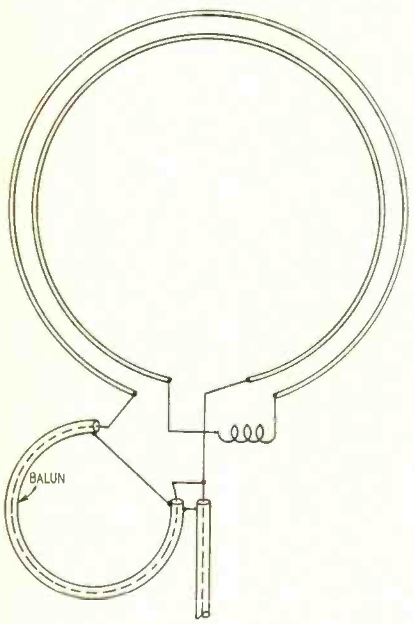
FAMILY CIRCLE Contributions	$ 602.50
RADIO-ELECTRONICS Contributions as of Jan. 17, 1955	10,971.36
Louis J. Buttel, Jamaica, N. Y.	2.00
Capt. Romeo L. Buttolo, Cape Town, South Africa	2.00
A. H. Danter, St. Louis, Mo.	5.00

MISCELLANY

Lillian Everts, N. Y., N. Y.	5.00
Mr. and Mrs. Clayton Loyd, Chicago, Ill.	1.00
J. L. McClurg, Baltimore, Md.	1.00
Alexander Rys, Minneapolis, Minn.	.25
R. Six, Inglewood, Calif.	5.00
Gray C. Trembly, Arlington, Mass.	10.00
TOTAL CONTRIBUTIONS as of April 15, 1955	$11,605.11

L'ANTENNE GERNSBACK

A highly improved indoor antenna, a form of the Gernsback *Variotenna* (see photo) is now being manufactured in France. The unit was introduced in 1949 by Hugo Gernsback, appearing



in the August and September issues of RADIO-ELECTRONICS that year. The improved model (see schematic) contains

a small coil in series with the antenna for operation in the 185-mc range. The balun, mounted in the base, permits connecting the antenna to an unbalanced transmission line.

The appearance of the Europeanized Gernsback antenna is highly attractive. Approximately 18 inches in height, the two loops are made of ½-inch tubing finished in gold. The entire unit rests on a heavy ceramic base. The antenna comes with several feet of 72-ohm lead-in. END

radio-electronic Circuits

STARVED-CURRENT INTERCOM

Needing an intercom between my basement and kitchen I decided to try the small amplifier that I had constructed when experimenting with starved-current circuits. (See "Ultra-High-Gain Starved-Current Amplifier" in the March, 1954, issue.)

This amplifier has a number of advantages for this application. It has very high gain, uses few components and is small. Its limited frequency response is an asset in reducing hum and noise. It draws about 20 ma at 205 volts. The circuit is wired as in Fig. 1. Spring-return s.p.d.t. TALK–LISTEN switches in the master and remote stations switch the 4-inch PM speakers to the amplifier input for use as microphones.

The circuit is wired so both speakers are across the amplifier output circuit when the intercom is not in use. When S1 is in the NORMAL position, each station has to operate its TALK–LISTEN switch in turn. Throwing S1 to TWO-WAY enables the master station to hold two-way conversations without the need for operating the switch on the remote station. The master station must now operate two switches simultaneously but this is of no consequence. *—Paul S. Lederer*

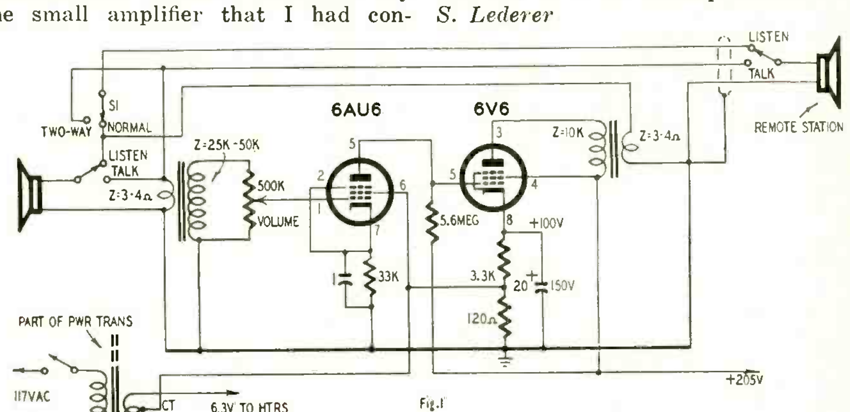


Fig.1

(By using a double-pole three-position switch as the master as in Fig. 2, all switching is handled at the master station except when the remote station initiates the call. The master switch

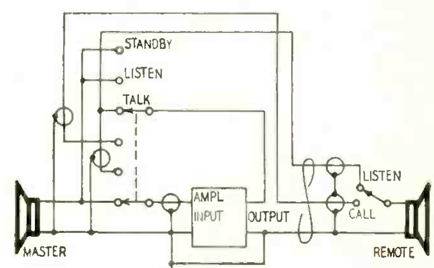


Fig.2

may be a rotary or lever type with spring return to center from one side and positive action on the opposite side. Use the positive position for STANDBY, the center for LISTEN and the other side for TALK. Wire the switch on the remote so it automatically returns to LISTEN.—*Editor*)

LIQUID-LEVEL CONTROL

This simple liquid-level control is automatic, inexpensive and remarkably troublefree.

There are no floats or moving parts inside the tank to jam or fail. It is designed around the TT-1 cold-cathode control tube (manufactured by Haledy Electronics Co., New York) which differs from the 0A4-G and similar types in several respects. It has a sprayed-on external electrode that connects to a high-resistance voltage divider between plate and cathode. Its starter anode must be at least 20 volts *negative* with respect to the cathode to initiate the glow discharge that fires the tube. It has an amplification factor of 2.5 million. In this circuit, the trigger current is less than 2 μa.

The starter anode is the control electrode when connected as shown in the diagram. Capacitor C is charged with its upper plate negative with respect to ground and the cathode of the TT-1. This charge appears across a voltage divider consisting of R1, R2 and the resistivity of the liquid between the probes and ground. When the resistance of the liquid is less than 10 megohms, the voltage on the starter anode is not sufficiently negative to fire the tube.

When the liquid level drops below the long probe, its effective resistivity

THE MALLORY *25th Anniversary* VIBRATOR

Now hear this! (if you can)

The Mallory 25th Anniversary Vibrator is the quietest ever...

You've never heard a vibrator as silent as the new Mallory 25th Anniversary model. Mechanical hum and shake are reduced practically to zero . . . by a unique "floating" design* that isolates the vibration of the reed element from the case. Hum is squelched to a level never before possible.

The experience of 25 years of pioneering development . . . and the manufacturing know-how gained by making more than 60 million vibrators . . . went into this latest Mallory model. Always the leader in performance, and in usage by service men and manufacturers alike, Mallory vibrators are now better than ever!

NO EXTRA COST. The new, ultra-quiet vibrators cost no more than previous models. They're a real bargain in performance.

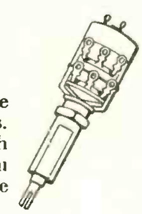
NO CHANGE IN PART NUMBERS. Order by the same catalog numbers — and you'll automatically get the improved model.

Get ready to give your customers the best, by ordering your supply today from your nearby Mallory distributor.

**Patent applied for*

ON AUTO RADIO JOBS
BE SURE TO USE . . . *MALLORY MIDGETROLS*

The fast, sure way to get tailor-made replacements for carbon volume controls. High stability resistance elements, with accurate tapers. A small stock equips you to replace practically any control. In single and dual concentric types.



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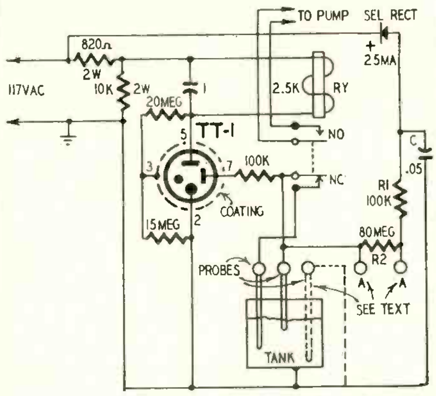
approaches infinity and the starter anode voltage goes sufficiently negative to fire the tube and operate the relay.



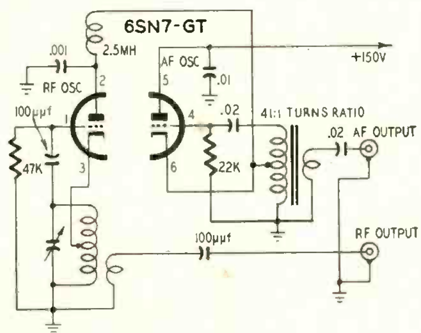
The normally open relay contacts start the pump or open a valve to admit more liquid to the tank. The normally closed contacts disconnect the long probe from the circuit.

Liquid flows into the tank until it reaches the short probe. The voltage divider circuit is again completed by the liquid so the starter anode voltage drops and the tube stops conducting. This releases the relay so its contacts assume the positions shown in the diagram. Current through the liquid is less than 2 μa and the voltage is low. When the tank is of glass or lined with an insulating material, use a third probe as shown in dashed lines and connect it to an external ground.

Vapor from highly volatile liquids may cause the control to operate prematurely or erratically. In this case, use a jumper or resistor across contacts A-A to short out or reduce the value of the 80-megohm resistor.—*Harry Peach*

SIGNAL GENERATOR

This simple and inexpensive a.f.–r.f. signal generator is ideal for the home experimenter who does not need a laboratory type of instrument. It supplies modulated r.f. and a.f. output signals and can be powered by any convenient supply delivering 150 volts at 10 ma



or so and 6.3 volts at 0.6 ampere.

The circuit uses separate Hartley type a.f. and r.f. oscillators. Its most unusual feature is the cascode type arrangement used for modulating the r.f. oscillator. The r.f. oscillator is powered by the audio voltage available at the cathode of the audio oscillator so it is modulated by the audio tone.

LAFAYETTE'S SPECTACULAR MONEY SAVERS

A BUY OF A LIFETIME
PORTABLE ELECTRONIC MEGAPHONE and AMPLIFIER SYSTEM

ALL THREE UNITS ONLY 89.50

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● Powerful 20 watt amplifier! ● Pistol grip dynamic megophone!

All Units BRAND NEW and GUARANTEED

A complete portable 20 watt amplifier system at a fraction of its original cost! Quality is unquestionable—designed and built for the U. S. Navy! Use on fishing boats—pleasure craft—traffic control—parking lots—day camps—carnivals—sports events—life saving stations—any place where handling large crowds; or reaching large audiences is necessary. Unit operates from self contained rechargeable batteries—no power line connections necessary. May be set up permanently when used with charging rack. System consists of a 20 watt 6 tube amplifier—in a waterproof portable metal case, an electronic megaphone, a battery charger power unit that operates on 110 volts AC/DC and on 12, 24, 48, or 96 Volts DC, 3 cell 6 volts storage battery, tubes, cables, plugs and 30 page instruction and diagram book. Overall size complete 15½"x13"x12". Shpg. wt. 88 lbs.

ELECTRONIC MEGAPHONE SYSTEM.......................................Net 89.50

Lafayette Greatest Tape Buy Ever!

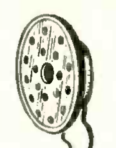
1200 FT. REEL Genuine Plastic Base RECORDING TAPE Shpg. Wt. 14 oz.

$1.89 per roll plus postage (C.O.D.'s accepted)

LAFAYETTE made a terrific deal with one of the leading manufacturers of recording tape to supply us with their regular tape which sells for almost twice our price. WE GUARANTEE ABSOLUTE SATISFACTION OR YOUR MONEY BACK. The finest, professional-quality recording tape obtainable. Highest performance for thousands of playings. Red Oxide Base in a smooth, uniform coating; greater signal strength; with maximum fidelity; uniform frequency response from 40-15,000 cps.

In lots of 10 rolls - 1.75 ea

MINIATURE CRYSTAL MICROPHONE



Here's a typical Lafayette special for the experimenter, student or dealer. An extremely sensitive and small crystal microphone used in hearing aids and other small apparatus. Can be used as lapel mike—miniature transmitter mike for concealed locations, etc. Its size and performance gives it joint versatility. Brand new. Size only 1⅜" Diam. x 5/16" deep. Imported to save you money.

MS-108....................Net 1.95

Masco CASCADIAN TV BOOSTER

Reg. Price ~~$42.50~~

SALE 9.95

Biggest Booster Buy Ever!

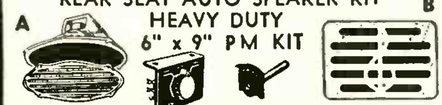
Famous Masco Cascode Booster!!

- Three tuned circuits—cascode!
- Golden Grid 6BZ7 Plus 6J6 Plus rectifier!
- 35 db gain (56 times!) average on all channels!

A sensational new tunable VHF booster utilizing a special low-noise circuit. Employs the new Golden Grid 6BZ7 tube so well known for its use in cascode circuits. Field pioneer and specifically designed for new low noise-high gain front ends. Brings superior reception to older type receivers. Single knob control for utmost simplicity of operation. Signal strength is increased at least 56 times—35 db!—average on all channels. Rack and pinion permeability for precision stability. Automatically switched on and off by TV set. Uses cross-neutralized 6J6 and 6BZ7 tubes for maximum gain and bandwidth. U/L approved. For 110 volts AC. Wt. 5 lbs.

Masco TVB-53. In lots of 3, Net 9.45 Singly, ea. 9.95

REAR SEAT AUTO SPEAKER KIT HEAVY DUTY 6" x 9" PM KIT



A complete kit for adding another speaker in the rear of your car. You get a 6"x9" PM speaker with a 2.15 oz. Alnico V magnet; a CRL PK300 three position switch so you can select either speaker alone or both together, dial plate with mounting bracket, knob and hardware; a plastic grille (illustration A) (your choice of brown, grey or silver), wire and wiring instructions. Simple to install. Shpg. Wt. 4 lbs.

SK-36.......................................Net 4.50

DELUXE 6" x 9" KIT

SK-37, with chrome plated metal grill (Fig. B).

Shpg. Wt. 5 lbs..........................Net 5.75

LAFAYETTE EXCLUSIVE! DYNAMIC EAR PHONE

A new lightweight plastic ear phone especially imported by Lafayette to bring you the high quality of a dynamic ear phone with the ease and comfort of an almost weightless unit—at a price less than half that of any comparable unit. Fits right into ear. Excellent sensitivity of 65 db. Ideal for use with miniature sets, hearing aids, transcribing, etc. DC resistance 2000 ohms, impedance 5000 ohms at 1000 cycles. Complete with 3 ft. plastic covered cord.

MS-72.................................Net 1.95

LOW IMPEDANCE MODEL FOR SILENT LISTENING OR VIEWING

Will replace speaker on any radio set or T.V for silent listening, by direct connection to secondary of output transformer. Impedance 8 ohms.

MS-100....................................Net 1.95

5" Tweeter AND Crossover Network

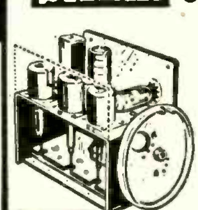
7.95

A specially designed 5" Tweeter and Crossover Network that will assure high frequency response when used with any speaker you now possess. You can now make your present speaker into a 2-way speaker system increasing the high frequency range up to 15,000 cycles. Diagram included. Shpg. Wt. 5 lbs.

STOCK NO. SY-14.........................Net 7.95

SALE! RADIO RECEPTOR UHF CAVITUNER

Complete with 6 AF4, 6BZ7 and IN82



Tunes all UHF channels 14-82. Most advanced engineering, three cavities, two used as bandpass pre-selector, one controlling local oscillator. Features frequency stability, uniformly broad bandwidth, high selectivity, low noise, high gain. Completely shielded. Ideal for building convertors, etc. Size 3½" H x 4¾" W x 1⅜" D. Shpg. Wt. 4½ lbs.

4.95

TL-26...Lots of 3, ea. 4.45

Singly, ea. 4.95

SALE ASTATIC UHF CONVERTER

channels 14 thru 83

In Lots of 3.... 13.95

Singly, each...... 14.45

Below manufacturer's cost! Continuous vernier tuning—14 thru 83. Operates into TV receiver channels 2-3-4-5 and 6! Two stage preselector. Fully shielded spiral inductance tuner reduces oscillator radiation. Uses 6AF4 or 6T4 and IN82 crystal diode. High sensitivity—low noise performance!

ASTATIC UHF— Singly, each.................. 14.45

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11.95

DIAMOND and SAPPHIRE (LP) (78)

LIST ~~$31.00~~

Replacement for All G.E. RPX-050 Triple-Play Cartridges!

Stock No. PK-29 Net 11.95

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Prism-Coated Lenses

- All-Metal Construction
- Individual Focus
- Leather Case & Straps

F-86 —8X,25 I.F.	Net 17.45	with order, Add 10% Fed. Tax
F-105—8X,30 I.F.	Net 18.25	
F-15 —7X,35 I.F.	Net 19.95	
F-103—7X,50 I.F.	Net 21.95	
F-117—10X,35 C.F.	Net 23.95	
F-104—12X,50 I.F.	Net 32.50	
F-118—16X,50 C.F.	Net 34.95	

QUALITY HEARING AID at an UNBELIEVABLE PRICE

QUALITY BUILT FOR YEARS OF OUTSTANDING PERFORMANCE

39.50

- Completely self contained unit—including batteries slips into breast pocket.
- Extra sensitive microphone.
- Tiny sensitive dynamic ear piece.
- Continuously variable volume control.
- 3 position tone Control.

Modern! Powerful! Tiny! As small as a pack of cigarettes! Only 3½"x2⅜"x⅞". And only ⅓ the usual price for an instrument of this quality. Weighs only 5 ozs.—including the batteries! No extra bag or pouch to carry—batteries are inside the unit. Guaranteed to suit your particular hearing problem. Only Lafayette's purchasing power makes this price possible—backed by their amazing Warranty. No charge replacement on any defective part (except cords and batteries) due to normal usage for 1 year from date of purchase. Complete with batteries and carrying case.

HA-100.......................................Net 39.50

INDUCTION MODEL

Identical to HA-100, but has built in induction coil for use with telephone.

HA-101.......................................Net 49.50

FREE send for it RADIO CATALOG

GET LAFAYETTE'S NEW CATALOG PACKED WITH THE LARGEST SELECTION OF QUALITY ELECTRONICS EQUIPMENT AT BARGAIN PRICES.

Lafayette Radio

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BRONX, N.Y.	542 E. Fordham Rd
NEWARK, N.J.	24 Central Ave.
PLAINFIELD, N.J.	139 West 2nd St.
BOSTON, MASS.	110 Federal St.

DEPT. JF

Include postage with order.

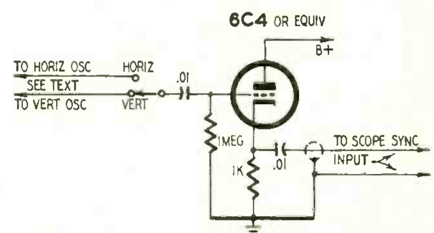
The audio transformer is a surplus unit to match push-pull plates to headphones. Its turns ratio is 41 to 1. You can use almost any conventional push-pull output transformer with a 250- or 500-ohm secondary.

The r.f. coil and capacitor may be any combination that tunes to the desired frequency range. You can use superhet oscillator coils with an r.f. takeoff coil of about 10 turns of No. 28 wire wound around the ground end. —*Arthur L. Manning*

SYNC FOR TV SCOPE

A scope is a useful tool for TV sync and deflection circuits. However, if a defective sync circuit does not produce enough sync to operate the set properly, it may also not produce enough to sync the scope. In such cases the scope can be synchronized from a reliable external source such as an old TV set.

The diagram shows the modification of the auxiliary receiver. The cathode follower couples the outside set's sync sweep circuits to a length of shielded cable or coax going to the scope's external sync terminals. Either an extra triode can be added to the chassis or its present a.f. amplifier tube can be replaced by a dual triode with one section used as the cathode follower.



You can take the sync signals from the set's sync separator, but I prefer using scanning-generator voltages, since the larger signals make for more reliable synchronization. The actual connections to be made depend both on the type of scanning generators used in the TV set and the type of sweep generator in the scope. A scope with a multivibrator sweep requires negative sync pulses. In that case, if the scanning generator (vertical or horizontal) in the TV set is a blocking oscillator (or a Synchroguide) connect to the blocking oscillator plate. If it is a multivibrator or a Synchrolock, connect to the plate of the discharge tube or second triode in the multivibrator.

If your scope has a gas-tube sweep, it requires positive pulses for sync. Then connect to the grid of a blocking oscillator or Synchroguide blocking-oscillator section, the grid of the discharge tube in a Synchrolock or the plate of the first triode in a multivibrator.

Connect the shielded output cable to the scope's sync input terminals and set the scope for external sync operation. Tune the auxiliary set for a clear steady picture on the same channel tuned in on the set under test —*Charles Erwin Cohn*

END

Technotes

MITCHELL 1250, 1251

Low volume on these models can be corrected by taking out the 220-ohm cathode resistor of the 50L6-GT output tube and replacing it with a 120-ohm resistor.—*John Flint*

RCA MODEL 6T72A

A 16-inch picture pulled in to the size of a 14-inch rectangular and remained that way, with slight distortion in sound. By substituting a low-voltage 5U4-G rectifier known to be good from a radio and replacing a 6SN7 the picture returned to normal size and the sound returned to full brilliance.—*James H. Bell*

SQUEAKING RECORD PLAYER

When a Philco 47-1201 comes in with the record player making a squeaking noise, open the cabinet and inspect the two locating rollers. Make sure they do not touch when the record is playing. If they are touching, an adjustment can be made with the ¼-inch nut under the pickup arm that locks an eccentric bushing.—*G. Anglado*

RCA 56-X

When replacing the 50-μf filter capacitor in these sets, oscillations usually take place. These can be corrected by connecting a 0.1-μf capacitor in parallel with the new filter capacitor.—*George Taylor*

17-INCH PHILCO

Trouble: no high voltage on a brand-new 17-inch Philco television receiver. Sound was O.K. and all tubes tested good; even the voltages appeared normal. Examining the rear of the set in the darkened room, I noticed arcing in the multiprong connecting plug. The horizontal sweep leads feeding the deflection yoke were shorting to the vertical sweep wires by way of a small hole burned through the plug. The horizontal wires were removed from the plug and a new wide-gap connecting plug was used to join the two horizontal leads, restoring the high voltage.

This is a common defect in these sets and should be checked for in every case where the picture tube is mounted to the cabinet and the deflection yoke and focus coil leads are disconnected from the chassis by a coupling plug. In this set, the socket is fastened to a bracket on the high-voltage cage.—*J. Dubinsky*

STROMBERG-CARLSON TV-12

Complaint: hum; found especially in the 1220-T AM chassis used in the TV-12 combinations.

Connect a 25-μf 25-volt capacitor between the cathode terminal of the 6SC7 and ground. This reduces the hum to a point where in most cases it will no longer be objectionable.—*George R. Anglado*

OSCILLATOR REPLACEMENTS

Instruction sheets accompanying commercial oscillator coils specify the correct points for connection to grid, ground, B plus and plate. I have received sets in which the terminals for both windings were transposed, either by accident or heedlessness. Since both were transposed, the circuit still produced oscillations but tuning was wrong because of the additional coil capacitance due to the incorrect connections. In some cases the full tuning range could not be covered. The remedy is obvious. This presumably applies—to a lesser extent—with r.f. and antenna coils.—*Charles Erwin Cohn*

RCA 1953 21-INCH SETS

Four of these have come in with a complaint of loud hiss. The trouble is arcing inside the high-voltage capacitor. The noise is loud but nothing can be seen. Disconnect the high-voltage leads from the capacitor. If the trouble stops, the capacitor was defective. Replace with a 20,000-volt .0005-μf unit.

The capacitor is threaded on both ends and is mounted on the outside wall of the high-voltage compartment, facing front, and fastened to the wall with a nut. It can be installed with a pair of pliers in about 15 minutes. When I service one of these sets, I always replace the capacitor as callback insurance.—*Jacob Dubinsky*

G-E MODEL 20C105

A very elusive intermittent condition occurred on this receiver. It would work O.K. for a few days, then sound and picture would vanish while the raster remained. Advancing the contrast control all the way restored sound and picture.

Finally tracked down, the trouble proved to be that the 6SL7-GT sync separator was oscillating. This caused the a.g.c. voltage on the grid (pin 1) to be from 30 to 50 volts negative. The 10-μf 450-volt capacitor in the plate circuit was opening intermittently. —*Henry Josephs*

GENERAL ELECTRIC

Early production models came in with a complaint of buzz in the audio when tuned for the best picture on weak signals. This was due to a 41.25-mc trap coupled to the second video i.f. coil (removed in later models). The trouble can be cleared up by shunting the trap with a 5,000-ohm resistor. Connect it across the trap trimmer. —*Wayne Miller*

SENTINEL 309-W

This set was very noisy at times—especially when moved around for directional reception. The copper loop—pressed on a Masonite section on the back of the receiver—was found loose in a few places. Putting a little speaker cement on the loose loops, pressing them down and letting the cement dry stopped the noise.—*Manuel E. Silva*

DAMPING BARS

When a vertical damping bar appears on the left side of the screen on an Olympic 950, and the 6BG6 and 6W4 tubes are not at fault, replace the balancing capacitor across the high side of the horizontal deflection coil. Its original value is 47 $\mu\mu$f—change it to 110 $\mu\mu$f.—*John Flint*

ELIMINATING B.O.

No single remedy will correct Barkhausen oscillation on all sets. Things that correct it on one set or model group may have very little effect on others. Likewise, one particular remedy may eliminate it, or it may require a combination of several.

The following suggested remedies have been found very effective:

1. Keep the antenna lead-in dressed as far as possible from the horizontal output circuits.
2. Check the setting of the horizontal drive control.
3. Connect a capacitor (.005 to 0.1 μf) between the damper tube filament (pin 7 on Super V's) and chassis. (Keep leads short as possible.) This is usually very effective. However, in some cases it may shift the oscillation to another channel. In such cases use the particular value which shifts it to an unused channel.
4. Check the horizontal output tube's screen resistor.
5. Check the B boost filter capacitor (C138 on the Super V's) and try bypassing it with a .05-μf capacitor.
6. Try several horizontal output and damper tubes.

NOTE: It has been found that tubes which cause Barkhausen oscillation in some sets will work satisfactorily and not show any trace of it in another.

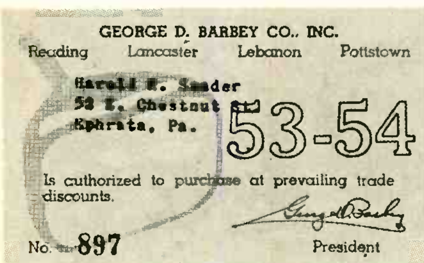
7. Install a magnet (ion trap) on the horizontal output tube. Adjust it to the position which eliminates or shifts the oscillations to an unused channel.
8. Check bypass capacitors in the r.f. tuner and i.f. section of the receiver.

—*Crosley Service Department* END

Technicians' News

TECHNICIANS IDENTIFIED

The Lancaster County (Pa.) Electronics Servicemen's Association has issued cards (see illustration) to bona-fide service companies and technicians


GEORGE D. BARBEY CO., INC.
Reading Lancaster Lebanon Pottstown
Harold R. Snader
52 E. Chestnut St.
Ephrata, Pa.
53-54
Is authorized to purchase at prevailing trade discounts.
No. 897 President

in the Reading, Lancaster, Lebanon and Pottstown areas, to indicate to distributors that they are not retail customers and are entitled to purchase goods at regular trade discounts.

The secretary of the association, Harold R. Snader, reports encouraging cooperation from distributors. "Not all the distributors in the area have as yet set up a card system," he says, "but they have all promised to do so shortly."

MICHIGAN REVIEWS ACTS

New officers of the Television Association of Michigan (Detroit) were elected at the annual meeting in March. Alexander Weiss was re-elected president. Charles Judd was elected first vice president; Karl Heinzman, second vice president; Ray Cobbledick, secretary, and Malcolm Wright, treasurer.

Six directors—Edward Brown, Wm. Mattingly, Clayton Hibbert, Vernon Ederhardt, Harold Chase and Jack Barton—were elected.

Among the activities of the past year reviewed at the meeting were the writing of the proposed licensing law for service shops in Detroit, pretesting on the new educational u.h.f. TV channel and fulfilling the organization's consumer education program on television servicing. This program was carried to more than 500,000 consumers and school children during the year, the educational committee reported.

FRSAP DEMANDS PROOF

The following resolution was passed at the March meeting of the Pennsylvania Federation of Radio Servicemen's Associations:

"Resolved: That Glenn McDaniels, president of the Radio-Electronics-Television Manufacturers Association, and Wm. H. Parkinson, chairman of the RETMA committee on technical education, furnish satisfactory proof to the federation that licensing of technicians would increase cost of service to the consumer, as stated before various legislative bodies."

The federation also formulated plans for the annual award to the individual or company who had contributed most to the welfare of the television servicing industry. This year's recipient will be Lewis E. Winner, editor of *Service* magazine.

TUBE FIRM CONVICTED

Barrack Electronics, Inc., of Brooklyn, N. Y., and two of its officials were found guilty of fraudulent practice in the sale of radio and television tubes. They had been charged with reconditioning used tubes and selling them as new, affixing to them counterfeit or imitation trade marks of legitimate manufacturers.

The president of the firm, Isidore Barrack, and its secretary were found guilty and continued in $5,000 bail each for later sentencing. Maximum penalty is a year in jail, a fine or both.

A Q & A REPORT

Licensing was the subject of discussion at a meeting of independent television service technicians and service shop organizations held under the auspices of the Western New York Electronics Guild (Buffalo). The conclusion, as given below, was that licensing would not be beneficial to the industry or the public:

Question: Do you believe a licensing law would stop malfeasance practices by some within the industry?

Answer: No, present laws already govern this as to petty larceny and fraud. Some believe or would like you to believe that this is practiced only by new and part-time members of the trade, but unfortunately this is not altogether so. Cooperation with local law enforcement agencies could do as much under existing laws.

Remedy we propose to take: Set up a local investigating committee to study charges of malfeasance practices and misleading "bait" advertising and induce cooperation with the District Attorney's office to bring those guilty into the courts.

Question: Do you believe a licensing

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law would retard the growth of the service industry?

Answer: Yes, as these laws would possibly put an undue burden on part-time technicians and one-man shops with possible loss of their experienced services to the public, thereby increasing service cost through a non-competitive field. . . .

Other opinions:

Many proponents of these laws attempt to compare the radio and television service industry with that of plumbers, electricians and liquor stores, falsely. It is incredible as to how the pure foods and hygiene laws could apply to television service with the only possible encroachment in the electricians' field being antenna installations. . . .

Open service field to unionization, forcing in many cases an increase of service cost beyond the reach of most of the public. Increase "do-it-yourself" era and the neighbor "tinkerer" and "tube-change artist"—with no fanfare, no bill, no overhead or tax.

WILL POLICE TRADE

TV repairmen of Toronto, Canada, at a meeting attended by more than 400 technicians and service dealers pledged themselves to a public relations plan aimed at driving racketeers out of TV repair. The meeting was sponsored by the Radio Electronic Technicians Association (RETA).

The plan is to open a complaint bureau under the auspices of the association to handle customer complaints and to recommend reliable repairmen to set owners, on request.

According to Richard Cartwright, president of RETA, "Complaints (on TV service) have gone up 300% since firms have been offering cut-rate service calls." Thomas Rimmer, of the Better Business Bureau, corroborated, stating that one complainant had repairs to his set appraised at $80, including a new picture tube. An honest repairman then appraised the repair at $3.50 for one tube and $5.50 for the service call.

GUILD SHOPS AROUND

The Radio Television Guild of Long Island has initiated a "shopping service" to check on the amount of retail selling going on among the distributors in the area. In recent issues of the *Guild News* (which circulates among 2,000 Long Island technicians) full-page reports list distributors who either sold or did not sell to a customer who had "nothing about his appearance or manner to lead the distributor to believe he was in any way connected with the service industry." It is interesting to note that in the guild area—where an intensive educational campaign has been carried on both for the distributor and customer—a majority of the distributors do not sell retail. Of 30 concerns listed in a recent issue of the *Guild News*, 17 would not sell to the "shopper." END

Question Box

RECORDER AMPLIFIER USES DRY BATTERIES

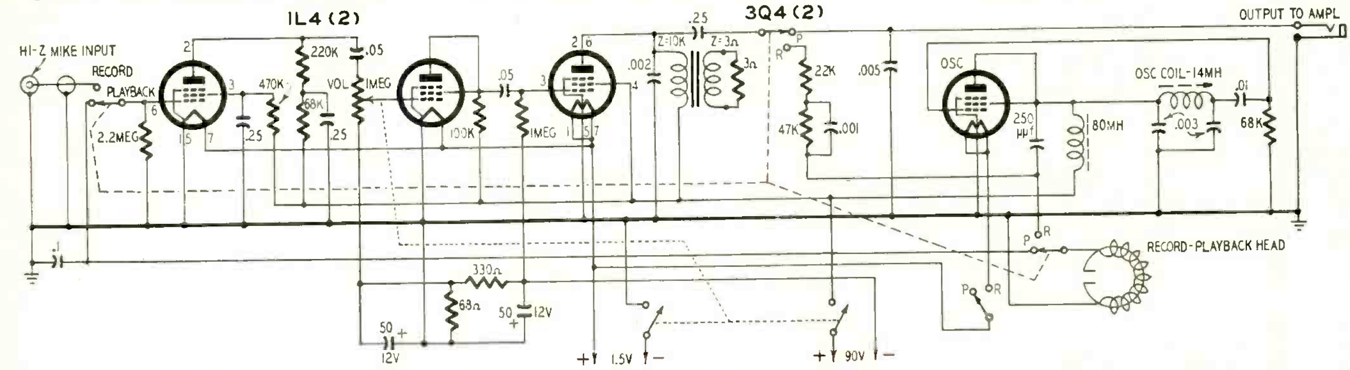
I want to construct a battery-powered portable tape recorder but have not been able to find a suitable circuit. Please print a diagram or tell me where I can find one.—H. C. C., Long Island City, N. Y.

This battery-powered tape recorder amplifier was described originally in *Revue du Son* (Paris, France). Its audio circuit for record and playback consists of a 1L4 input stage, a 1L4 driver and a 3Q4 power amplifier.

The plate circuit of the power amplifier is capacitance-coupled to a jack for external amplifier on playback and to the head when recording. The plate load is an output transformer with a 10,000-ohm primary and 3-ohm secondary. The latter is loaded with a 3-ohm resistor but a small speaker may be substituted and used for playback and as a recording monitor. An auxiliary volume control may be inserted in the voice-coil circuit so the speaker output can be held below the feedback level when recording from a microphone. The input and output circuits are designed for high-impedance heads.

The 35-kc bias oscillator—a triode-connected Colpitts—operates only on recording. The oscillator coil has an inductance of approximately 14 mh. It may be a high-Q r.f. choke or a TV linearity or width coil that can be adjusted to the required inductance.

The record–play switch is a four-circuit double-throw type with low-capacitance contacts designed for audio switching. Shield all leads to the input



grid and from the output circuit to prevent feedback and oscillation.

The recorder uses a 1.5-volt A battery and a 90-volt B supply.

STROBOSCOPE

Several years ago you printed a construction article on a stroboscope. I would like to build one to stop motion and indicate speeds of rotation between 100 and 5,000 r.p.m. I want to keep the flashing light separate from the control box to make it easier to handle in cramped quarters.—J. P., Waterbury, Conn.

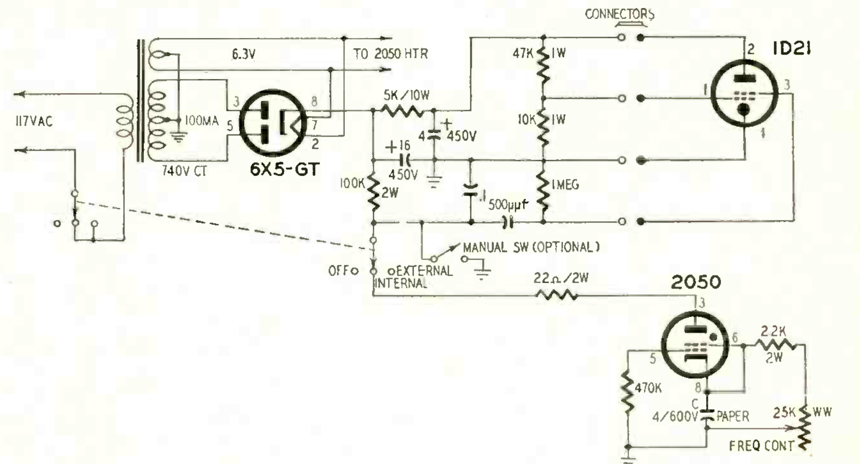
The article appeared in the October, 1950, issue. This issue is out of print so the diagram is reprinted here. When the switch is set to INTERNAL, the 2050 oscillates over a frequency range of approximately 8.33 to 60 cycles per second. This corresponds to a speed range of approximately 500 to 3,600 r.p.m. when the lamp flashes once for each revolution. Other speed ranges can be obtained by substituting other values for capacitor C and the resistors connected to pins 6 and 8 of the 2050.

A speed of 5,100 r.p.m. requires an oscillator operating at 85 cycles

$$\left(\frac{5100}{60} = 85\right)$$

The oscillator can be calibrated with an oscilloscope.

Throwing the switch to EXTERNAL disconnects the oscillator so the lamp can be triggered manually by a snap-action switch. Do not operate the 1D21 stroboscope tube above 240 flashes per second. This corresponds to 14,400 r.p.m.



The control circuit can be mounted in a metal utility box about 7 x 8 x 9 inches with the frequency or speed control on the panel. The 1D21 fits a standard four-prong socket that may be mounted in a convenient reflector on the end of a cable.

ULTRASONIC GENERATOR

My high-school science teacher has asked me to build an ultrasonic transmitter. Can you tell me where I can obtain suitable diagrams for a small unit?—R. S., Rush, N. Y.

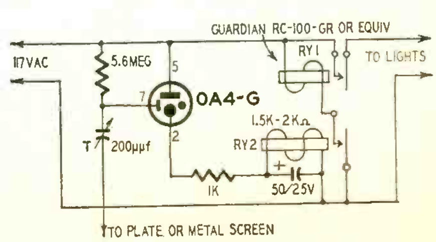
The term ultrasonics is generally taken to include all frequencies from around 20 kc to about 500 mc. Frequencies between 20 and 100 kc are widely used in sonar and in underwater signaling and communications. From 100 kc to about 15 mc the signals are used for testing materials, ultrasonic therapy, absorption measurements and in radar trainers. Frequencies above 500 mc have been generated experimentally. We would like to know more about how you plan to use the signal so that we can try to supply a suitable circuit.

The transducer is likely to be your greatest problem. Crystal and magnetostrictive transducers for ultrasonic applications are usually custom-built for a particular job and not generally available. Your best bet from a standpoint of economy and availability is to consult suppliers handling scientific and laboratory equipment for schools. They may have transducers designed for a given frequency, application and power output. Once you have decided on the transducer, it will be comparatively easy to design the generator.

AUTOMATIC LIGHT CONTROL

I would like to control the lights in one room with a capacitance-operated relay. Placing my hand near a particular spot on the wall should turn on the lights and they should remain on until the hand is again placed over the same spot.—J. K., Chicago, Ill.

This circuit was a prize-winner in the Radio-Electronics in the Home contest in November, 1950. The starter

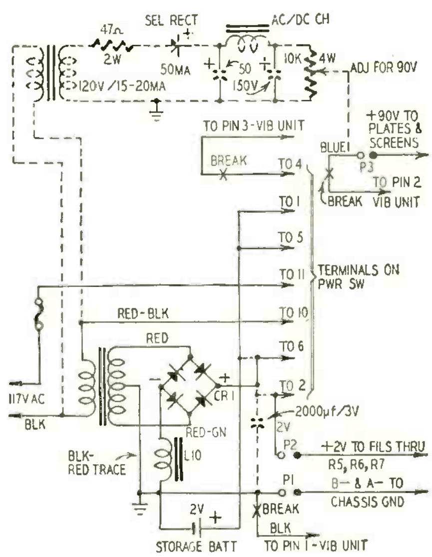


anode (pin 7) of the 0A4-C connects to a metal screen or "feeler" plate on the wall through a 200-$\mu\mu$f trimmer capacitor. When the capacitor is set properly, the tube fires and operates RY2 when the hand is brought close to the "feeler" plate. When RY2 (a plate-circuit relay) operates, it closes the circuit to the coil of RY1, a 117-volt a.c. locking type ratchet or impulse relay. A momentary application of voltage to its coil locks the contacts closed. The next application of voltage locks the contacts open. The contacts of RY1 control the light circuit.

If the control is mounted in the wall, be sure that it is enclosed in an approved type box with cover. Mount it so the cover will be flush with the outer surface of the wall. The cover may then be painted or papered to match the surrounding surface.

RCA 65BR9 PORTABLE

I have an RCA 65BR9 a.c.–battery 2-volt storage battery with a vibrator to supply B voltage. On a.c. it uses a stepdown transformer and rectifier to supply the vibrator and filaments. Please show how I can convert this set to eliminate the vibrator supply and operate it from a.c. lines.—H. J. V., Kittanning, Pa.



Here is a partial schematic of the power supply with modifications shown by dashed lines. The charger unit (line transformer, rectifier and power switch) is retained intact. The vibrator unit is removed to make room for the new a.c.-operated plate supply. The line (stepdown) transformer and rectifier are used to supply 2 volts d.c. to the filaments. If the storage battery is not shorted, leave it in place as a low-voltage filter. If it is damaged, replace it with a 2,000-μf electrolytic capacitor as shown. Codes on the diagram are those used in the original RCA schematic.

The added power supply is a simple half-wave unit using a 50-ma selenium rectifier. The transformer can be small, a 20-ma unit being sufficient. END

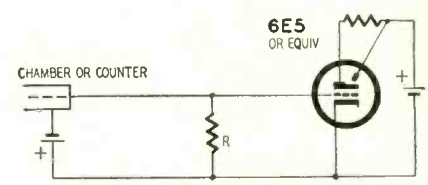
Patents

RADIATION METER

Patent No. 2,696,563

John H. Coleman, Palm Beach, Fla.
(Assigned to Radiation Research Corp., W. Palm Beach, Fla.)

An electron-ray indicator (see diagram) is used here to measure radiation. It can be used with ionization chambers, Geiger counters, or



any device in which a variation in ionization or radiation may be caused to produce a voltage change across a load.

The chamber or counter shown in the figure is exposed to radiation and the indicator tube measures the voltage across R, which acts as the load resistor for the counter tube and grid leak for the electron-ray indicator, which measures the voltage across R. The shadow angle of the "eye" may be calibrated in terms of radiation *rate* (Roentgens per hour). If a capacitor is substituted for R, the eye measures the total *dosage*, since the charge on a capacitor is the integral (sum) of all current over a period of time.

SINGLE-GUN COLOR TUBE

Patent No. 2,692,532

Ernest O. Lawrence, Berkeley, Calif.
(Assigned to Chromatic TV Laboratories, Inc.)

Designed especially for any sequential method of color transmission, including dot, line or frame, this single-gun tube differs from a conventional tube—either black-and-white or color—in that it includes a secondary deflection assembly composed of grids G1, G2. See Fig. 1. Anodes A1, A2 accelerate and focus the electron beam. T is the target.

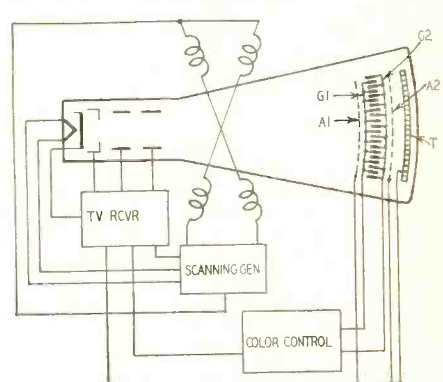


Fig. 1

G1 and G2 form a structure in which a large number of alternate grids are connected together and fed from a color control circuit. Fig. 2 shows the grids in greater detail. Electrons passing between the grids are deflected by them. When G1, G2 are at the same potential, the particles move straight on and fall on areas G which are coated with green phosphor. If G1 is more positive than G2, the electrons are deflected toward B, which is coated with blue phosphor. In the same way, a higher potential on G2 than on G1 deflects the beam toward R, containing red phosphor. Thus the signal at G1, G2 determines the color at the moment.

If a frame-sequential system were used, a square-wave signal would be fed to the grids. The voltage would be positive during one frame, zero during the next and negative for the third. Thus successive frames would be seen as blue, green and red images, in synchronization with color pickup at the transmitting end.

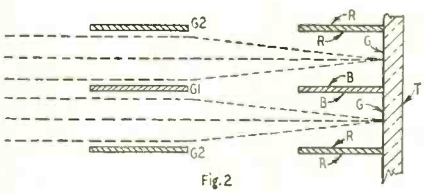


Fig.2

The tube may be used with present-day simultaneous color TV, but a special control signal is needed to energize G1 and G2 in proper sequence. One method is to spin the electron beam during deflection so that the three colors alternate rapidly and continuously.

ORGAN SWELL CONTROL

Patent No. 2,695,386

Francis M. Schmidt, N. Tonawanda, N. Y.
(Assigned to Rudolph Wurlitzer Co.)

Musicians know (and Fletcher-Munson curves show) that hearing sensitivity depends upon sound level. For example, when good music is reproduced at low levels, it seems lacking in bass. Therefore, when a radio, organ, or other instrument is played with volume down, its bass must be boosted. This patent deals with an organ swell control which compensates for deficiency of bass when the volume is turned down. It does not introduce noise typical of other volume controls.

Some convenient point in the organ's audio system (between two successive stages, for example) is shunted by a tube network through C in Fig. 1. At low frequencies this capacitor has considerable reactance, so the tube resistance has less effect on the signal. For treble tones, the tube may be considered directly across the signal.

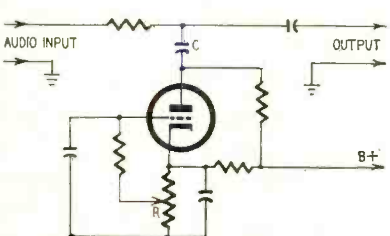


Fig.1

R is a volume control operated by the pedal clavier of the organ. It varies the bias of the tube and, therefore, its resistance. For loud volume, R's arm is moved to the grounded end and the tube is blocked or nearly so. There is no shunting of the audio. See curve B (Fig. 2).

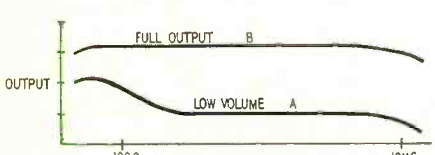


Fig.2

When volume is cut down, the arm approaches the cathode and bias decreases toward zero. Now the tube resistance is relatively low. Higher frequencies pass easily through C and are shunted to ground through the tube network to a great extent. Of course the bass is affected, but to a considerably lesser degree. See curve A.

A grid capacitor and resistor form a network to filter out noise originating in volume control R.

PATENTS (Continued)

IMPROVED 3-GUN KINESCOPE

Patent No. 2,690,518

Norman F. Fyler and William E. Rowe, Newburyport, Mass.
(Assigned to Columbia Broadcasting System, Inc.)

The planar mask 3-gun kinescope is very difficult and expensive to manufacture. The shadow mask and phosphor-dot plate present many problems. These cannot be aligned after they are inside the tube, so they must be assembled as one unit beforehand. To assure correct alignment in any tube in which it might be placed, the assembly requires *flat and parallel* elements. Special construction is necessary, since the slightest warping or bending can produce serious color distortion. Also, as most color TV technicians know, the flat mask and plate present difficult problems of focusing and convergence.

This is the basic patent for the now familiar curved-mask type of color tube. The new kinescope described in it has many advantages over previous models. In constructing it, the glass tube is cut apart, leaving a screen portion and a conical section. Each of these is sealed to a protruding flange. The phosphor-dot trios are coated photographically directly on the faceplate, providing maximum light for viewing. Then the shadow mask (curved like the faceplate) is placed against the upper flange along its rim. There is provision for proper alignment of mask and dot plate. Finally, the two flanges are welded together to finish the tube.

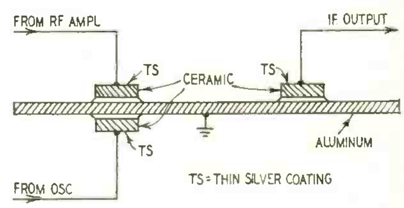
With a curved mask and dot plate, there is no need for special or "dynamic" focusing and convergence. Adjustment made at any point of the screen holds over the entire face of the kinescope. There is no longer the problem of convergence as the electron beam sweeps over a varying radius.

MECHANICAL CONVERTER

Patent No. 2,695,357

Hugh L. Donley, Princeton, N. J.
(Assigned to Radio Corp. of America)

This superhet converter operates on the piezoelectric principle. A piezoelectric element is driven to vibration by a signal voltage. A similar element is energized by a local electronic oscillator. The resulting beat gives a mechanical vibration at an i.f. rate. Another piezoelectric element converts the vibration back to an electric voltage at the intermediate frequency. In this mechanical system, the Q is very high so excellent selectivity can be obtained. Another advantage, of course, is that no tubes are required.



An elementary converter is shown in the diagram. Signal and oscillator voltages are fed into separate piezoelectric capacitors at the left. The ceramic dielectric may be barium titanate or similar material which has a high dielectric constant and a nonlinear response. A beat vibration is set up in an aluminum bar, 1 wavelength long. For an i.f. of 50 kc, this is only 4 inches, and for higher frequencies would be less.

Vibrations transmitted along the bar are picked up by the ceramic capacitor on the right. Here the vibrations are converted back to an i.f. voltage which feeds the intermediate frequency amplifier.

The inventor states that higher efficiency is obtained when a *harmonic* of the oscillator is used rather than its fundamental. Output can also be increased by connecting a bias battery across each ceramic capacitor.

In a typical converter, the oscillator frequency was 101.5 kc. Its second harmonic (203 kc) was heterodyned against a 153-kc signal to produce the desired 50-kc intermediate frequency. Making use of a mechanical beat frequency, this converter is an extremely rugged device.

HIGH-FREQUENCY TRANSISTOR

Patent No. 2,695,930

Robert L. Wallace, Jr., Plainfield, N.J.
(Assigned to Bell Telephone Labs., Inc.)

The frequency response of present-day junction transistors is limited generally to the broadcast band or slightly above. This patent indicates methods for increasing the range as much as 15 to 1. For example, junction oscillators have been designed for reliable operation above 50 mc, and experimental ones have operated at far higher frequencies.

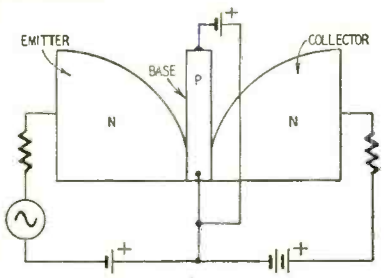


Fig.1

The frequency-limiting factors of a junction are capacitance between elements, transit-time effects and base resistance. All can be greatly reduced by a chemical process which etches or dissolves active material at the junctions. Fig. 1 shows a treated n-p-n crystal. Note how little junction area remains. In many cases each area is decreased to 0.1 sq mm or less.

Effective junction area can also be lowered by adding a second base connection as shown. A current is passed from base to base, biasing the upper end negative. Electrons from the emitter (at left) tend to drift into more positive regions. This limits the flow to the very lowest portion of each junction. In effect, this means a still further reduction of each of the junction areas. This is the famous "tetrode transistor" also an invention of Dr. Wallace, the holder of this patent.

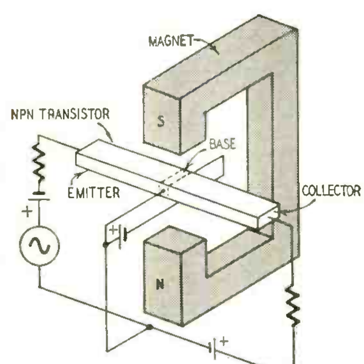


Fig.2

Fig. 2 shows a third method of increasing high-frequency response. A magnet (N-S) is positioned near the base of the transistor. By the "motor law," electrons moving at right angles to the field are deflected perpendicularly both to the *field* and the direction of their *motion*. Thus, the charges moving in the base are deflected in the direction of the collector.

Ordinarily, electrons coming from the emitter are diffused into the base from different directions. If they can be made to travel *directly* from emitter to collector (rather than through some roundabout path), transit time is shortened and the frequency range extended. This is accomplished by the magnet.

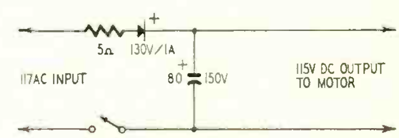
Any tendency to move in an undesired direction is eliminated by the "motor law" described above.

This invention provides a transistor which is a structural compromise between the junction and point-contact units. It retains the desirable characteristics of the junction transistors while substituting the lower base resistance and shorter transit time of the point-contact transistor. This is attained by a great decrease in the cross-sectional area of the emitter or collector junctions. END

try This one

A.C.–D.C. PHONO MOTOR

My phonograph turntable is a military surplus type with a 115-volt a.c.–d.c. Green Flyer motor. When I substituted a Pickering cartridge for a crystal type, the hum level increased considerably because the a.c. field around the motor was inducing hum voltages in the coils in the pickup.



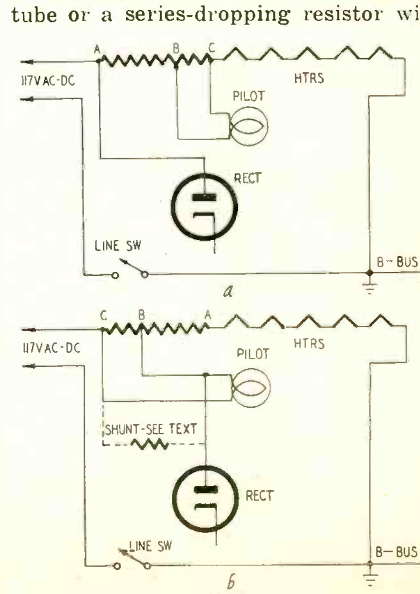
The trouble could not be eliminated with magnetic shielding. I finally solved the problem by using a small d.c. supply for the motor. The circuit of the supply is shown. When this supply is in use, the motor's voltage selector switch must be set for d.c.—*J. V. Cavaseno*

MUTING CHANGER SWITCH

I found that my RC-80 Garrard and several other record changers produce a loud and annoying thump in the speaker when the automatic stop switch opens after the last record has played. This can be eliminated by shunting a .05-μf capacitor across the switch terminals.—*Eduardo Maass*

BRIGHTER PILOT LIGHTS

It is well known that a well-finished cabinet and a bright pilot light have sold many sets. A bright pilot light can also help to sell a repair job. Many of the older sets have either a ballast tube or a series-dropping resistor with



a tap for the pilot light. When first turned on the light is very bright, but after warming up the light output is low. This can be changed with a few minutes' work on the service bench.

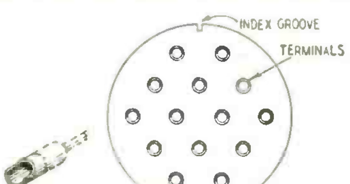
Fig. 1-a shows the general type of series-dropping network, with 4.5 to 5.5 volts across the light bulb after the tubes are warmed up. By simply reversing the resistor connections as in Fig. 1-b and then connecting the plate of the rectifier tube to the tap for the pilot light, the circuit operation becomes essentially the same as if a 35Z5 or similar tube were used. The parallel section of resistor for the pilot light may have to be shunted in some sets.

To determine the shunt resistor value make all connections and measure the voltage across the pilot lamp after operating the set for a few minutes. The voltage across the bulb should be 5.9 to 6.1 (115-volt line) when the set is fully warmed up. If the voltage is higher, shunt the lamp with a 150-ohm resistor and measure the voltage. The exact value of resistance will be determined by the rectifier plate current and the parallel resistance of the series voltage-dropping resistor; 100 to 150 ohms is the average resistance needed.

If the set has a surge resistor in series with the rectifier plate, remove it. The pilot light and dropping resistor now perform the same function.—*L. H. Trent*

AN TYPE CONNECTORS

When soldering leads to AN type or similar connectors with solder-cup connections, it is best to connect first to terminals at the bottom of the connector when the index groove or land is toward the top and the solder cup curved upward. This is because solder and heat



from the iron must be applied to these terminals from the top and this is difficult when there are already wires above the terminal. Also, these wires may be damaged. The diagram shows layout of a typical connector.—*Charles Erwin Cohn*

CHEMICAL DISPENSER

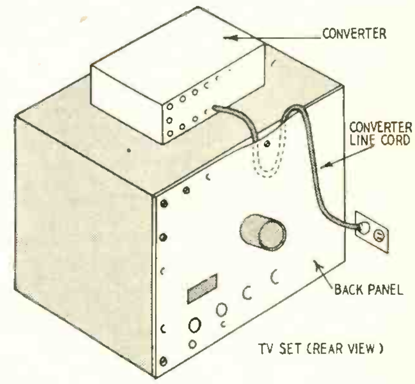
Empty lighter fluid cans with the new switch spout nozzle (Ronson) make handy dispensers for carbon tet, oils and other radio chemicals that may be purchased in bulk.

Simply drill a small hole in the center bottom of the can. Place the can in a shallow pan of the liquid and alternately squeeze and release the sides of the can. When it is full, seal the hole with 40/60 solder. Use as little heat as possible to prevent evaporation.—*G. P. Oberto*

CONVERTER PROTECTOR

The average self-contained u.h.f. TV converter has five leads attached to its back: u.h.f. lead-in, v.h.f. lead-in, signal-output lead, TV power cord and power cord to the converter. All these, tied onto the back of a small converter, leave it perched in a hazardous position near the edge of a TV top. It is easy for the housewife or a technician to dislodge and drop the converter when moving the set away from the wall for cleaning or servicing.

When installing a converter, protect it against damaging falls simply by running its power cord around one of the back-panel screws as shown in the drawing. The cord is thus held tightly between the TV cabinet and back panel so that the converter cannot fall to the floor if it is knocked or dragged off the TV cabinet. Boosters, lamps, clocks, phono preamps and similar accessories can be protected in the same manner.



Doing this may not only save you some grief on future service calls on that particular set, but your thoughtfulness will be appreciated by the housewife if you point out to her how you have tried to prevent an accident and protect her investment.

In doing this it will be necessary to observe the usual precautions with regard to bending and pinching the power-line cord. On most television receivers there is sufficient play in the back panel so as not to create excessive pressure against the power cord, and still keep the panel fairly tight.—*L. H. Wilson*

SAVING BANDSWITCHES

Bandswitches in communications, shortwave and AM–FM receivers and test oscillators may fail prematurely or become erratic or noisy due to arcing when a B plus circuit is broken momentarily while changing bands. Communications receivers have a standby switch that breaks the plate supply circuit. Open it before changing bands and you will increase the life of the bandswitch.

A simple toggle switch can be added to sets and test oscillators that do not have one for standby operation. It is far less expensive and much easier to replace than the bandswitch, and will pay for itself by insuring troublefree operation and long life.—*Samuel H. Beverage*

END

OPPORTUNITY ADLETS

Rates—45c 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 Aug. issue must reach us before June 15, 1955.

Radio-Electronics

25 W. Broadway, New York 7, N. Y.

HIGH-FIDELITY SPEAKERS REPAIRED. Amprite Speaker Service, 70 Vesey St., New York 7, N.Y.

WANTED: Used Hallicrafter S47. All wave receiver. J. W. Bailey. 3528 Campbell Ave., Lynchburg, Va.

"Buy Surplus Radio. Electronic Equipment direct from Government. List $1.00. Box 169AK. East Htfd 8. Conn."

SPEAKER RECONING: Guaranteed workmanship. C&M Recone Co., 255 Tioga St., Trenton 9, N.J.

TUBES—70% to 90% DISCOUNT. Government, manufacturers, jobbers, etc. surplus. Guaranteed 1 year. Free catalog on request. Cadillac Trading, Dept. AA, 231-07 Linden Blvd., Jamaica 11, N.Y.

GEIGER COUNTER KITS $34.50. Geiger Counter & Scintillator Diagrams Catalog Free. R. F. Chambers, 13833 San Antonio Dr., Norwalk, Calif.

DIAGRAMS FOR REPAIRING RADIOS $1.00. Television $2.00. Give Make. Model. Diagram Service. Box 672-RE. Hartford 1, Conn.

TAPE RECORDERS. Tapes. Accessories. Unusual values. Dressner. Box 66S. Peter Stuyvesant Station, New York 9.

USED CORRESPONDENCE COURSES. Books. Bought, Sold. Catalog Free. Educational Exchange, Summerville, Ga.

TUBES—TV, RADIO, TRANSMITTING, AND SPECIAL PURPOSE TYPES BOUGHT, SOLD AND EXCHANGED. Send details to B. N. Gensler W2LNI, 512 Broadway, N.Y. 12, N.Y.

ALL MAKES OF ELECTRICAL INSTRUMENTS AND TESTING equipment repaired. Write for free catalogue on new and used instruments at a savings. Hazelton Instrument Co., 128 Liberty Street. New York, N. Y.

TV SETS $15.95. Tubes 20c. Jones, 1115 Rambler. Pottstown, Pa.

WANTED: AN/APR-4. other "APR.", "TS-", "IE-", ARC-1, ARC-3, ART-13, BC-348, etc. Microwave Equipment. Everything Surplus. Special tubes. Tec Manuals, Lab Quality Equipment, Meters. Fast Action. Fair Treatment. Top Dollar! Littell, Fairhills Box 26. Dayton 9, Ohio.

MATHEMATICS SERVICE, problems, calculations. Electronics, mathematics. Reasonable rates. Mathematics Service. Box 6671. Orlando, Florida.

SPEAKER RECONING. low prices. Michigan Speaker Reconing Service. 930 Metropolis, Marine City, Michigan.

DIAGRAMS: Professional Model Timers, Counters, Intercom Organs, etc. $1.00 each. List free. Parks, 101 S.E. 57th, Portland 15, Oregon.

PHONOGRAPH RECORDS 20c. Catalogue. Paramount, R-313 East Market. Wilkes-Barre, Penna.

USED BOOSTERS: 20-odd used boosters of various makes for sale to one buyer at $10 apiece; all in working order, some only slightly used. Pocono TV Relay, Inc., 155 Broad St., Stroudsburg, Pa.

ALUMINUM TUBING, Angle and Channel. Plain and Perforated Sheet. Willard Radcliff. Fostoria, Ohio.

POWER TRANSFORMERS REBUILT—all makes. TV-Radio or Special. Red Arrow Radio. 924 Metropolis, Marine City, Michigan.

25-50% DISCOUNT, guaranteed. Factory Fresh LP records; 69c and up; pre-recorded tapes. Send 20c for catalogue. SOUTHWEST RECORDS. 4710 Caroline. Houston 4, Texas.

FOR SALE: TELEVISIONS, repairable from $10. also working. W4API, 1420 South Randolph. Arlington 4, Virginia.

16" HI FI ELECTRICAL Transcriptions Catalog 10c. Transcriptions. 166 Barkley, Clifton, N.J.

TV FM ANTENNAS. ALL TYPES INCLUDING UHF. Mounts, accessories. Lowest prices. Wholesale Supply Co., Lunenburg 2. Mass.

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The Model 111 is the only single commercial tube tester that checks all tubes for both EMISSION and MUTUAL CONDUCTANCE separately. Filament current is measured directly on large meter when checking a VOLTAGE SAPPER tube. NEW, MODERN DESIGNED ROTARY SWITCHES allow you to check each tube element individually. NEW TYPE Single Rotary switch for complete short checks. The 111 makes all BIAS, FILAMENT VOLTAGE, GAS, LIFE checks visually on large meter . . . 5 individually calibrated ranges and scales for mutual conductance tests. NEWLY DESIGNED "NO BACKLASH" ROLL CHART lists all tubes including the new type 600 mil series tubes. Provisions are made for testing many color tubes. All CRT's can be checked with accessory adaptor, Model PTA.

111K (kit form) .... **NOW ONLY $69.95**

111W (factory wired) $139.95

PRECISE COLOR or BLACK & WHITE OSCILLOSCOPES ARE NOW USED BY AMERICA'S LEADING MANUFACTURER OF COLOR TV SETS!

SPECIFICATIONS: PRECISE MODEL 300 OSCILLOSCOPE

VERTICAL – Vertical-flat (3db) DC through 5 megacycles with sensitivity of greater than 10 millivolts push-pull-(3.94 Millivolts/cm); Constant Resistance; Push-pull input immediately converted to single-ended normal or reverse phase by shorting bar at inputs 1 and 2; Frequency compensated vertical stepping attenuator selects AC or DC inputs; Push-pull DC amplifiers from input through output; Internal electronic mixing through inputs 1 and 2; five-way binding posts.

POSITIONING — Bridge type positioning on vertical and horizontal does not vary tube characteristics.

HORIZONTAL — Frequency compensated stepping attenuator in horizontal amplifier; Push-pull Horizontal out.

BLANKING — Internal (return trace blanked), external (return trace not blanked). 60 cycle or 120 cycle Blanking through Blanking amplifier circuit.

SYNCHRONIZATION — External, Internal Positive, Internal Negative, Internal 60 cycle or Internal 120 cycle synchronization.

SWEEP RATE — Driven or non-driven linear sweeps from 1 cycle to 80KC in five ranges (1-10 cycles uses external C circuit); Trigger potentiometer.

MAGNIFIER — Electronic magnifier and magnifier positioner allows any part of a signal to be magnified up to ten times (equivalent to 70 inches of horizontal deflection).

CALIBRATION — Internal square wave calibrator and potentiometer for using oscilloscope at a VTVM on Peak to Peak measurements.

CALIBRATION SCREEN — Edge-illuminated scale and graticule may be turned on or off; filtered screen.

OUTPUTS ON FRONT PANEL — Plus Gate output; Sawtooth output; 60 cycle phasing output; 60 cycle unphased output; Calibration output.

FOCUSING — Astigmatism, focus and intensity control.

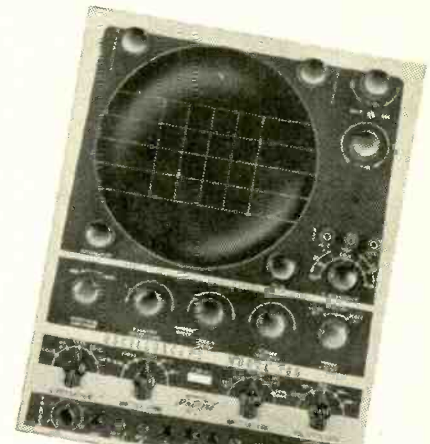
CRT — NEW 7" Tube, normally supplied is medium persistency type 7JP1 (oscilloscope green trace) — high persistency types available at additional cost.

DIRECT — Deflection plates available from rear of cabinet.

INTENSITY MODULATION — Z modulation through modulation amplifier.

GENERAL — Low loss components; Over-designed fused power supply for additional circuitry. Deeply etched aluminum panel; New parts from original manufacturers — (NO SURPLUS); Steel cabinet; 11" x 14" x 17"; complete with instruction book and all components; Accessories: Model 912T(MM) Demodulator Probe and Model 960 Capacity Attenuator Probe available at extra cost — please see specifications on following pages.

There are many additional features and circuits in kit form, which may be added to the Model 300. Please write us for descriptive literature.



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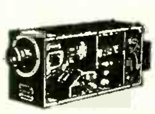

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Changes dull eye-straining black and white pictures into beautiful color tones. Seconds to attach. No tools used. Helps eliminate glare and snow in fringe areas. Order direct. Send $1 for screen size up to 16", $1.25 size 17", $1.50 size 20", $2 size 21", $2.50 size 24", $3 size 27". We pay postage except on C.O.D. orders. Satisfaction guaranteed. Inquiries from dealers also welcomed.

Zingo Products, Johnstown 13, New York

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JACKSON tube testers

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PF REPORTER

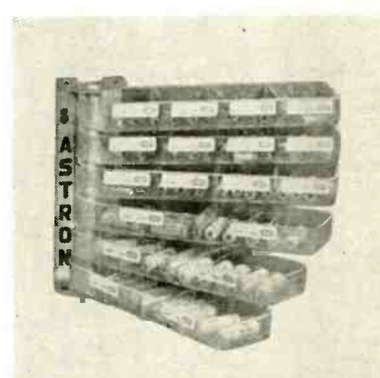
Business

Merchandising and Promotion

Electro-Voice Inc., Buchanan, Mich., developed a series of sales aids for its phonograph cartridges including a disc type interchangeability guide, a new metal merchandiser for stocking and displaying and a new sealed-in-plastic "Blister Pak" package.

CBS-Hytron, Danvers, Mass., a division of Columbia Broadcasting System, changed the brand name of its tubes and semiconductor products to *CBS* to capitalize on public recognition and acceptability of these letters. The company redesigned its packaging to feature the new trademark.

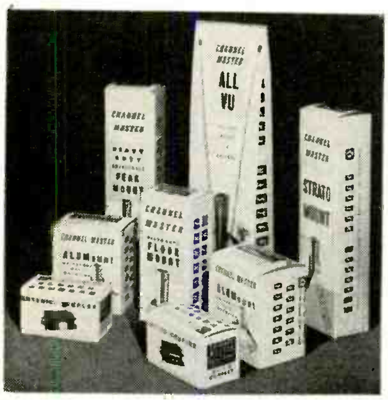
Astron Corp., East Newark, N. J., launched a promotion offering a selection of its *Blue Point* capacitors and a plastic display, "Swing Bin Jr.," at a special low price. The offer is good for a limited time only.



Centralab, division of Globe-Union, Milwaukee, was chosen by the National

Association of Manufacturers to represent a segment of the electronics industry in the association's TV movie series "Industry on Parade."

Channel Master Corp., Ellenville, N. Y., embarked on a new packaging program for its line of TV accessories.



The new program provides uniformly designed cartons for the entire line. The company is also engaged in a promotion around the theme "1955 Is Channel Master's Banner Year." Satin banners dramatizing this slogan are being made available to dealers.

Kuehne Manufacturing Co., Mattoon, Ill., is backing its new weatherproof coated TV towers with a promotion campaign including TV films, envelope stuffers, catalogs, radio spot discs, window streamers and ad mats.

JFD Manufacturing Co., Brooklyn, N. Y., recently conducted a series of dealer forums in Buffalo, N. Y., in cooperation with Radio Equipment Co., its distributor in that area. At the meeting, the company introduced its Silver Bonanza Program which is being developed nationally as a tie-in with the company's 25th anniversary.

Admiral Corp., Chicago, recently held a series of 12 dealer service schools on printed circuits and automation production techniques in the Atlanta, St. Louis and Columbia, S. C., territories.

Walsco Electronics Corp., Los Angeles, produced a new color motion picture "Something to Talk About" for jobber and dealer salesmen who handle its TV antenna line. The picture tells the sales story of Walsco antenna production and testing techniques.

Ram Electronics Sales Co., Irvington, N. Y., is sponsoring a series of TV service technician forums to be held in major TV areas throughout the U. S.

Supreme Publications, Highland Park, Ill., has designed a display stand for its manuals.

Clarostat Manufacturing Co., Dover, N. H., is merchandising its *Fuzohm* protective resistors on an attractive display card kit GL-1 which holds 12 individually packed resistors.

Production and Sales

RETMA reported the production of 1,357,096 TV sets and 2,157,870 radios for the first two months of 1955, compared with 847,504 TV sets and 1,641,213 radios during the same period in 1954.

RETMA announced the retail sale of 647,585 TV sets and 474,947 radios exclusive of automobile sets for January, 1955, as compared to 731,917 TV sets and 310,623 radios in January, 1954.

Mergers

Daystrom Inc., Elizabeth, N. J., announced plans for a merger with Weston Electrical Instrument Corp., Newark, N. J., subject to formal approval by directors and stockholders of both companies.

Fairchild Camera and Instrument Corp., Syosset, N. Y., acquired all the voting stock of Freed Electronics Controls Corp., New York.

Reon Resistor Corp., Yonkers, N. Y., bought Columbia Resistors, Pearl River, N. Y., and moved all the latter's equipment to the home plant in Yonkers.

Brush Electronics Co., a division of Clevite Corp., Cleveland, merged with Technical Instrument Co., Houston, Tex.

Textron American Inc., New York, purchased Ryan Industries, Detroit manufacturer of electronic products for the Air Force, as another step in its nontextile diversification program.

Aerovox Corp., New Bedford, Mass., acquired Luther Manufacturing Co., Olean, N. Y., manufacturer of automatic production equipment.

New Plants and Expansions

Sylvania Electric Products, New York, purchased a 30-acre site in Camillus, N. Y., where it plans to build a new 50,000-square-foot plant as a data processing center.

Phaostron Co., **South Pasadena, Calif.**, manufacturer of *555* multimeter, panel instruments and electronic measuring devices, purchased 13,000 square feet of additional factory space adjacent to its present plant.

Erie Resistor Corp., Erie, Pa., established a new division for the engineering and production of special electrical, electronic and mechanical assemblies.

Espey Manufacturing Co., New York City, consolidated its engineering and production facilities at its plant in Saratoga, N. Y.

Westinghouse Electronics Division announced plans for the construction of a new 350,000-square-ft. plant near Friendship Airport, Baltimore, Md.

Pace Electrical Instrument Co., meter manufacturing division of Precision

Apparatus Co., moved to its new plant in Glendale, L. I., N. Y.

Magnavox Co., Fort Wayne, Ind., is expanding its research laboratories in West Los Angeles, Calif. Dr. Ragnar Thorensen was named director of research for the new laboratories. He formerly directed work on digital computers at U. C. L. A.

Sunshine Scientific Instrument, Philadelphia, purchased all the stock, parts, drawings, jigs, patent rights, etc. to 18 instruments recently designed and developed by the Special Products Division of General Electric. These instruments will now be manufactured, sold and serviced exclusively by the Sunshine company.

Business Briefs

. . . **Raytheon Manufacturing Co.**, Receiving and Cathode-Ray Tube Operations, Newton, Mass., recently held a symposium for its sales representatives, sales engineers and company officials. Norman B. Krim, vice president and general manager of the operations, predicted a two-fold or greater increase in sales of receiving tubes for replacement use by 1965.

. . . **Arvin Industries**, Columbus, Ind., announced plans to discontinue the manufacture of TV sets about June 1. The company will continue in the radio field and plans to expand production of other electrical items.

. . . The **FTC** charged **Admiral Corp.**, Chicago, with falsely advertising its 21-inch picture tube set as providing 20% more screen area than other 21-inch TV sets.

. . . **Stanford Research Institute** and the **National Industrial Conference Board** will sponsor a symposium on "Electronics and Automatic Production" in San Francisco, Aug. 22–23, immediately preceding the annual Western Electronic Show and Convention.

. . . **Electro-Voice Inc.**, Buchanan, Mich., held a two-day Open House and product exhibition for its Midwest distributors. The exhibit was presented for three additional days for the press, local civic and business leaders and the families and friends of Electro-Voice employees.

. . . **Kay-Townes Antenna Co.**, Rome, Ga., was granted a patent for its *Big Jack* TV antenna.

. . . **RCA Service Co.** and **RCA Consumer Products Division**, Camden, N. J., sponsored a survey conducted by Elmo Roper which indicated that a great majority of the nation's 34,500,000 TV set owners are pleased with the nature, quality and prices of the TV service they receive. END

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People

Matthew D. Burns, recently appointed general manager in charge of electronic-tube operations of Sylvania Electric Products, New York City, was elected a vice president.

M. D. Burns

R. S. Withers

Roland S. Withers was appointed general manager of United Motors Service Division of General Motors, Detroit, Mich. He was formerly general merchandising manager of the AC Spark Plug Division.

Grady L. Roark, marketing manager of the General Electric Tube Department, Schenectady, N. Y., was named manager of tube sales, a newly established central sales service organization for electronic tubes and radio and TV components. This move is in line with the company's reorganization plans for the Tube Department.

G. L. Roark

E. Olson

Earl Olson was named vice president in charge of operations for Jensen Industries, Forest Park, Ill. Mr. Olson was formerly the chief engineer for the company.

Al Polak was appointed assistant distributor sales manager of Permoflux Corp., Chicago. He was formerly in charge of plant operation.

Mr. Polak, left, being welcomed by Floyd J. Van Alstyne of Permoflux.

William O. Hamlin was appointed supervisor of Technical Information Service for CBS-Hytron, Danvers, Mass. He comes to the company from Sylvania where he was technical editor of *Sylvania News*.

W. O. Hamlin

William H. Miller was named manager of the newly formed Community Operations Division of Jerrold Electronics Corp., Philadelphia. Other key executives in the new division include: **Robert J. Tarlton**, manager, Community Constructions; **Barbara Loomis**, planning supervisor; **Claire Ostroff**, field management representative, and **Earl Fletcher**, engineering supervisor, among others.

W. H. Miller

Carl J. Harshbarger joined Kay Townes Antenna Co., Rome, Ga., as general sales manager. He was formerly with Westinghouse. In his new position, he will direct advertising, sales and promotion.

C. J. Harshbarger

Obituary

Walter N. Potter, former general manager of the United Motors Service Division of General Motors, died suddenly while on a trip to San Francisco.

Personnel Notes

. . . **William R. Crotty** was promoted to manager of radio and TV sales for the Electronic Division of Erie Resistor Corp., Erie, Pa. He was formerly manager of the Chicago district sales office. **Robert W. Orr**, formerly an electrical engineer with the company, was named to head Government liaison activities for the division. These promotions complete the company's plan for dividing Electronic Division sales into four sections: radio and TV, industrial electronic sales, Government liaison and distributor sales.

. . . **O. I. Thompson**, educational director of De Vry Technical Institute, Chicago, was elected president of the 1955 National Electronics Conference, Inc., which will hold its 11th Annual Conference, Oct. 3–5, in Chicago.

. . . **Alfred Y. Bentley** was promoted to assistant manager of the Allen B. Du Mont Laboratories, Cathode-Ray Tube Division, Clifton, N. J. He was formerly technical assistant to the president.

. . . **Joseph H. Gillies** was appointed vice president in charge of manufacturing for Philco Corp., Philadelphia, in addition to his present duties as vice president and general manager of the Government and Industrial Division.

. . . **Dr. Percy L. Spencer**, a vice president of Raytheon Manufacturing Co., Waltham, Mass., and **J. E. Smith**, assistant vice president and director of engineering for the company's equipment operations, were named Fellows of the IRE.

. . . **Walter A. Weiss** was named general manager of the Radio Tube Division of Sylvania Electric Products, Emporium, Pa. **Herbert A. Ehlers** succeeds Weiss as general manufacturing manager of the division.

. . . **Kendrick K. Lippitt**, vice president in charge of engineering for Technical Appliance Corp., Sherburne, N.Y., and **Robert T. Leitner**, Taco project engineer, spoke at meetings of the IRE and AIEE, respectively.

. . . **E. R. Rutledge** joined Hallicrafters, Chicago, as Eastern regional manager. He was formerly with Stewart-Warner.

. . . **Herbert J. Allemang** was elected a director of National Union Electric Corp., Hatboro, Pa. He is an executive vice president of Eureka Williams Co.

. . . **Franklin F. West** joined Clarostat Manufacturing Co., Dover, N. H., as manager of the new Quality Control Department. He was formerly with Sonotone Corp. END

Radio 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 of the larger libraries still have copies of ELECTRICAL EXPERIMENTER on file for interested readers.

In June, 1921, *Science and Invention* (formerly *Electrical Experimenter*)

3,013 Miles with 2 K.W. Arc Set, by Arthur H. Lynch

The "Loop Aerial" and Its Applications, by Robert E. Lacault

Measuring the Motion of a Telephone Receiver Diafram, by Prof. Lindley Pyle

"Funny-Tone" Radio Receiver, by E. W. Start

Telegraph Tape Recorder, by F. William Jung

A Motor-Driven "Bug" Key, by Norman H. Allen

Utilizing Morse Relay as Coil Interrupter, by Penuel E. Ballard

technical Literature

THE ELECTRON

What's New with the Electron covers new and improved Eimac tubes including the revolutionary 4X5000A, the first Eimac ceramic radial-beam power tetrode.

Eitel-McCullough, Inc., San Bruno, Calif.

THREE BULLETINS

Bulletin SR-3 on varistors (asymmetric nonlinear resistors) contains comprehensive data on applications, characteristics, current ratings, enclosures, terminations and detailed charts and graphs.

Bulletin D-2 on sealed precision voltmeter multipliers offers information on moistureproof construction, temperature coefficient, terminations, wiring, voltage rating, dielectric strength, charts and graphs.

Bulletin B-9 on ½-watt molded deposited-carbon resistors presents data on characteristics, applications, tolerance, wattage rating, terminations, dimensions, insulation, charts and graphs.

International Resistance Co., 401 N. Broad St., Philadelphia 8, Pa.

SUBSTITUTION CHART

CBS-Hytron's *Substitution Chart for Television Picture Tubes* (Second Edition) contains substitution information for all electromagnetically reflected types, regardless of make, including mirror-back (aluminized) types. An eight-page chart indicates interchangeable types as well as substitutes requiring a minimum of service changes. An index lists all picture-tube types and places each in its correct substitution group. Then, by a tabulation of characteristics within each group, the best choice of an individual substitute type is made easy to find.

CBS-Hytron distributors.

TV BOOKLET

A Fleeting Glance at Fleetwood Custom Television suggests ways to custom-install television receivers. Photos of installations feature TV sets controlled by remote tuning units and conventionally controlled sets.

Conrac, Inc., Glendora, Calif.

GERMANIUM DIODES

Bulletin GD-2 lists ratings and specifications on germanium, high-temperature, computer, u.h.f. mixer, meter-protection and general-purpose diodes. Also included is an interchangeability and replacement chart.

International Rectifier Corp., Semi-Conductor Div., 1521 E. Grand Ave., El Segundo, Calif.

AUDIO CATALOGS

Altec Lansing's *Engineered Sound Products* offers information and photos on microphones, preamplifiers, power amplifiers, loudspeakers, microphone accessories, AM-FM tuners, reproducers, mounting assemblies, matching transformers, etc.

High Fidelity Home Music Systems illustrates and describes a power amplifier, AM-FM tuner and phonograph control unit, preamplifiers, speakers, speaker system, speaker enclosures, etc.

Altec Lansing Corp., 9356 Santa Monica Blvd., Beverly Hills, Calif., or 161 6th Ave., New York 13, N. Y.

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.

C-R OSCILLOGRAPHS

A *Quick Reference Instrument Catalog* lists the salient points of Du Mont C-R oscillographs and accessory instruments. The eight-page catalog is divided into three sections devoted to low-frequency, high-frequency and accessory instruments, respectively. A picture of each instrument is shown together with a brief description of its features and applications. Additional technical information is provided in tabular form in each of the catalog's three sections.

Technical Sales Department, Allen B. Du Mont Laboratories, Inc., 760 Bloomfield Ave., Clifton, N. J.

MINIATURE TERMINALS

A four-page catalog describes miniature tubular terminals and contacts for printed-circuit applications.

Malco Tool & Mfg. Co., Dept. RLN, 4025 W. Lake St., Chicago 24, Ill.

BATTERY ELIMINATOR

A two-page catalog sheet *No. 100* describes and illustrates the model KM88 aircraft battery eliminator. Detailed electrical and physical specifications in addition to an outline drawing of the rack mounting type enclosure are included.

Opad Electric Co., 69 Murray St., New York 7, N.Y. END

ESSENTIAL CHARACTERISTICS (of Receiving, TV Picture and Special-Purpose Tubes and Germanium Diodes). Compiled and published by General Electric Co. (obtainable only from General Electric tube distributors). Looseleaf spiral binding, 5½ x 8½ inches, 192 pages. 50 cents.

This book has come into ever greater use because of the large number of tubes described in small space. The most recent edition (ETR-15F) is a 192-page book giving the characteristics of some 2,000 tubes, of which 150 are new. Other new features include a classification chart which permits selecting a receiving tube by the type of application; characteristic curves of representative types; a thumb index and a table of contents. The basing diagrams at the bottom of each page are an important and valuable feature.

RIDER'S SPECIALIZED TAPE RECORDER MANUAL (Volume 1), by Rider Laboratory Staff. John F. Rider Publisher, Inc., 480 Canal St., New York, N. Y. 8½ x 11 inches, 311 pages. $4.50.

Prepared especially for the service technician, this book is devoted entirely to general information, operating instructions and servicing data on nearly 100 tape recorder models made by 14 manufacturers. Electronic circuits are shown with all values and (in most cases) resistance and voltage check tables. The mechanics of the tape deck is shown in photographs and drawings and is accompanied by troubleshooting tables and detailed instructions for clearing up most defects and complaints.

LICENSE MANUAL FOR RADIO OPERATORS, by J. Richard Johnson. Rinehart & Co., 232 Madison Ave., New York, N. Y. 6½ x 9 inches, 430 pages. $5.

This book is designed to assist the reader in passing FCC commercial radio operator's license examinations. The questions include all those in the "Study Guide" issued by the FCC through the Government Printing Office, along with clear concise answers. The eight elements covered include the six relating to radiotelephone and radiotelegraph licenses plus elements 7 and 8 required for aircraft-radiotelegraph and ship-radar endorsements.

An added feature is an appendix in which all questions on a given phase of radio are keyed to the various elements in which they are found so the reader can concentrate on any particular phase (amplifiers, detectors, laws, transmitters, etc.).

MOST-OFTEN-NEEDED 1955 RADIO DIAGRAMS AND SERVICING INFORMATION (Volume 15), compiled by M. N. Beitman. Supreme Publications, Highland Park, Ill. 8½ x 10½ inches, 128 pages. $2.

A compilation of reprints of radio diagrams and servicing information on several hundred models of portables, combinations, clock radios and amplifiers by leading manufacturers.

COMPUTER DEVELOPMENT (SEAC AND DYSEAC) AT THE NATIONAL BUREAU OF STANDARDS (National Bureau of Standards Circular 551). Government Printing Office, Washington 25, D. C. 7½ x 10½ inches, 146 pages. $2.

A report on the bureau's computer program based largely on the experiences with the SEAC (National Bureau of Standards Eastern Automatic Computer) and DYSEAC (Second SEAC). Topics include dynamic circuit techniques, systems design, high-speed memories and input and output devices.

STORAGE BATTERIES (Fourth Edition), by George Wood Vinal. John Wiley & Sons, 440 Fourth Ave., New York, N. Y. 6 x 9 inches, 446 pages. $10.

Latest edition of the standard work, originally published in 1924, on the physics, chemistry, applications and operation of secondary batteries, this book stresses scientific principles without becoming too highly technical. Selection and care of batteries for automotive, railway, telephone, marine, aircraft, mining and lighting applications are covered in detail. Interesting and instructive reading for all persons who use or maintain storage batteries and battery-operated equipment.

INDUCTION AND DIELECTRIC HEATING, by J. Wesley Cable. Reinhold Publishing Corp., New York, N. Y. 6 x 9 inches, 576 pages. $12.50.

This book is a carefully organized treatment of the latest applications of industrial induction and dielectric heating. Divided into two sections, dealing with induction and dielectric heating, respectively, it contains sufficient theory to enable the reader to understand fully the basic operation of both types. Coil and electrode design, jig construction and work-handling methods are covered in detail. Equal coverage is given to such specific metal-working applications as forging, melting, brazing and hardening by induction heating and to plastic fabrication, woodworking, and other applications of dielectric heating.

MICROWAVE LENSES, by J. Brown. John Wiley & Sons, 440 Fourth Ave., New York, N. Y. 4 x 6½ inches, 126 pages. $2.

A highly mathematical treatise reviewing much of the material on microwave lenses heretofore available only in a few scattered technical reports and magazine articles. Chapter headings are: Introduction, Radiation Patterns, Solid Dielectric Lenses, Metallic Delay Dielectrics, Metal-Plate and Rodded Dielectrics, Wide-Angle Scanning, Nonhomogeneous Lenses, Path Length Lenses and Lens Aerials.

TABLE OF THE GAMMA FUNCTION FOR COMPLEX ARGUMENTS (National Bureau of Standards Applied Mathematics Series 34). U. S. Government Printing Office, Washington 25, D.C., 105 pages. $2.

This table is of fundamental importance in pure and applied mathematics and exceptionally useful in atomic and nuclear research. It makes the complex gamma function as easily accessible to interested workers as the more familiar exponential and trigonometric functions.

YOUR TELEVISION ANTENNA SYSTEM, compiled by Radio-Electronics-Television Manufacturers Association and Association of Better Business Bureaus. 5½ x 8½ inches, 12 pages. Distributed through BBB offices, single copies free to interested parties.

In spite of its small size, this may be one of the year's most valuable books to the TV service technician and installation man. Beginning with a highly simplified discussion of what an antenna is and does, it nevertheless leaves the idea with the reader that satisfactory selection and installation are a function of the "installation man or dealer serviceman."

The questions of why and where are given a heading each, and a couple of pages are devoted to the question of "How to care for your TV antenna system." The owner is informed that age, weather, heat, cold, soot or salt, and deterioration of the transmission line may reduce picture quality. Antennas should be inspected regularly (for which job "your service technician" is qualified) to maintain peak performance and make necessary repairs and replacements. END

CORRECTION

The diameter of the coils was not specified for the set in Fig. 2 of "Emergency Receiver" in the April issue. The forms are approximately ⅜ inch in diameter. Slight variations can be made in the diameter without adversely affecting the tuning range. The bandswitch should be a three-pole rather than a double-pole type as specified in the parts list. A legend on the underchassis view points out an output transformer. This is actually an interstage type as indicated on the diagram.

Our thanks to Fred Butterfield of Brooklawn, N. J., for this correction.

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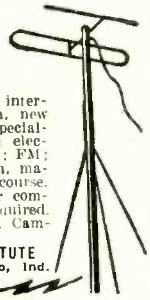

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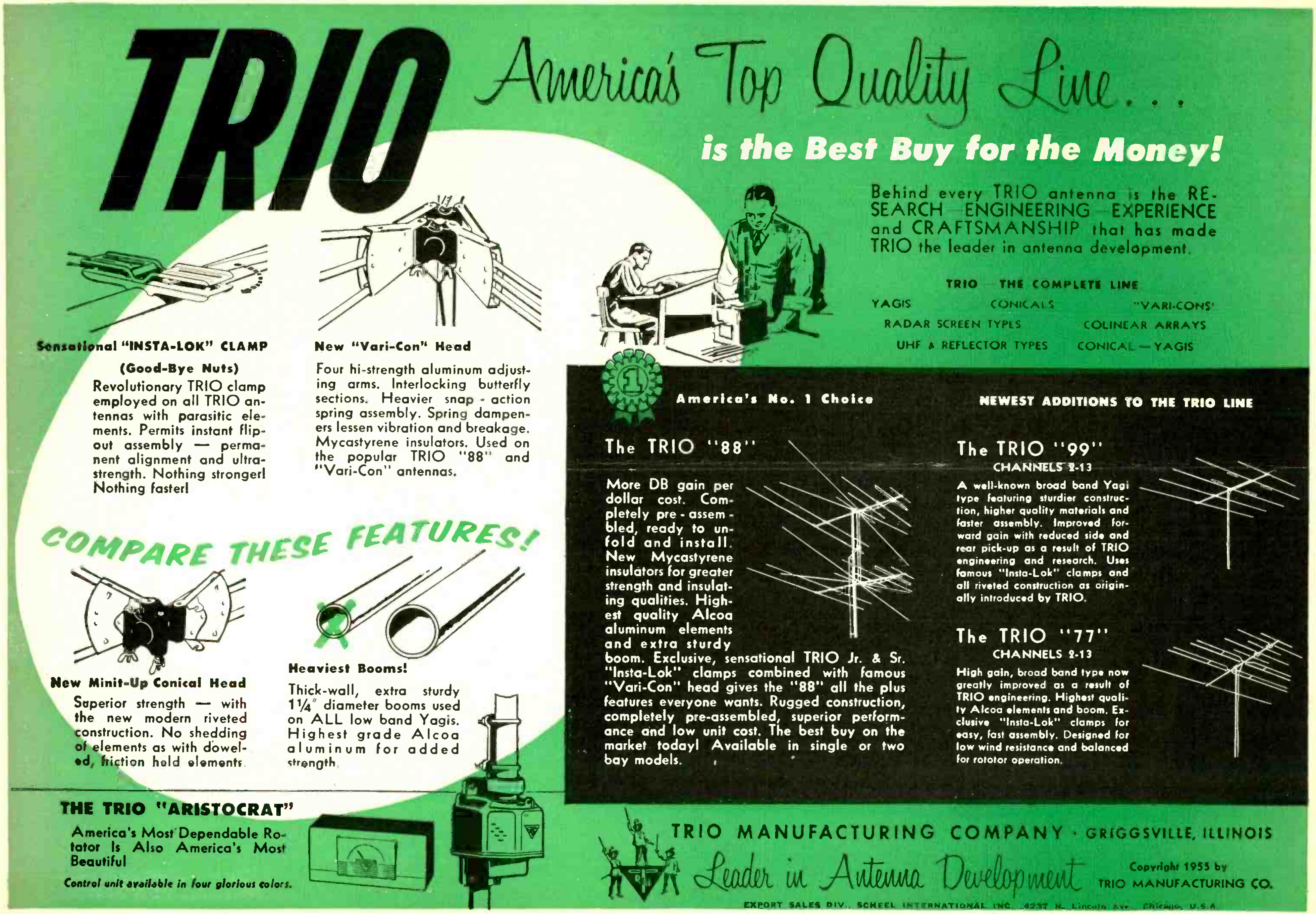

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ADVERTISING INDEX

Radio-Electronics does not assume responsibility for any errors appearing in the index below.

Aermotor Company	122
Allied Radio Corp.	15
Almo Radio Co.	100, 124
American Microphone Co.	105
American Phenolic Corp.	96
Amplifier Corporation of America	104
Arkay Radio Kits, Inc.	113
Atlas Sound Corp.	116
Audel Publishers	114
Barjay Co., The	115
Barry Electronics Corp.	129
Belden Mfg. Co.	10
Bell Telephone Labs.	22
British Industries Corp.	114
Brooks Radio & TV Corp.	89
CBS Hytron (Div. of Columbia Broadcasting System)	24
Cannon Electric Co.	75
Capitol Radio Engineering Institute	11
Century Books	112
Channel Master Corp.	21
Chicago Standard Transformer Corp.	115
Circle Electronics Products Co.	124
Cleveland Institute of Radio Electronics	9
Collins Audio Products Co.	92
Colordaptor	125
Concord Radio	125
Coyne Electrical School	104, 107, 125
DeVry Technical Institute	7
Edlie Electronics	123
Electro-Voice, Inc.	6
Electronic Instrument Co. (EICO)	27, 28, 102, 113, 120
Electronic Measurements Corp.	88
E-Z Way Towers, Inc.	102
General Cement Mfg. Co.	26
Goodmans Loudspeaker	98
Hawkins, P. E. Co.	124
Heath Co.	67-71
Hudson Specialties Co.	120
Hughes Research & Development Labs.	14, 97
Indiana Technical College	112
Instructograph Co.	124
Instruments For Service, Inc.	104
Jackson Electrical Instrument Co.	117
Jensen Industries	116
Jontz Manufacturing Co.	116
Lafayette Radio Corp.	101
Leotone Radio Corp.	100
Macmillan Co., The	121
Mallory, P. R., & Co., Inc.	99
McGraw-Hill Book Co., Inc.	100
Moss Electronic Distributing Co.	94, 95
National Radio Institute	3, 13
National Schools	5
Opportunity Adlets	117
Phaostron Co.	18
Philco Corporation	23, 74
Precision Apparatus Co., Inc.	126
Precise Development Corp.	117
Progressive Electronics Institute	113
Progressive "Edu-Kits", Inc.	90
RCA Institutes, Inc.	19, 87
RCA Tube Div. (Radio Corp. of America)	91, Back Cover
Rad-Tel Tube Co.	108
Radiart Corp	12
Radio City Products	129
Radio Craftsmen, Inc., The	120
Radio Merchandise Sales	113
Radio Products Co.	100

RADIO SCHOOL DIRECTORY PAGE 127

Baltimore Technical Institute
Candler System Co.
Grantham School of Electronics
Indiana Technical College
Indianapolis Electronic School
Milwaukee School of Engineering
RCA Institutes, Inc.
Tri-State College
Valparaiso Technical Institute
Western Television Institute

Radio & Television Training Association	25
Raytheon Mfg. Co.	Inside Front Cover
Rider, John F., Inc.	112
Rinehart & Co., Inc.	102, 129
Rockbar Corporation	98
Sams, Howard W. & Co., Inc.	79
Sangamo Electric Co.	110, 111
Sherwood Electronic Laboratories	122
Simpson Electric Co.	109
Stan-Burn Radio & Electronics	125
Stanley Electronics Corp.	114
Steve-El Electronics Corp.	124
Surplus Emporium	117
Sylvania Electric Products, Inc.	20, 83
Tab	130
Teletest	113
Terado Co.	103
Transvision, Inc.	119
Trio Mfg. Co.	128
Triplett Electrical Instrument Co.	Inside Back Cover
Tung-Sol Electric Co.	8
Uranium Propectors' Equipt.	125
Vaco Products Co.	106
Webster Electric Corp.	93
Wholesale Radio Parts Co.	112
Winegard Co.	16, 17
Xcelite, Inc.	121
Zingo Products	117

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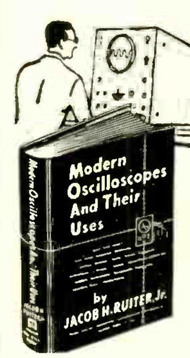

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T28V12ACC	12 Amp (1% Ripple)	$145
T28V24A†	0-28 VDC at 24 Amp	$135
T28V24ACC†	24 Amp (1% Ripple)	$195
T28V50A†	0-28 VDC at 50 Amp	$260
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New! Basic Supplies, 115 VAC In

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ONE YEAR GUARANTEE
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0C3	.88	3B4	2.70	6BE6	.54	6SU7	4.20	12J5	.48		
0D3	.78	3B7	.56	6BG6	1.58	6T7	1.27	12K8	.48		
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1E7	.49	5X4G	.78	6CD6	1.58	7A8	.68	14AF7	.95		
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1G5	.69	5Y4	.62	6D8	.81	7B4	.81	19T8	1.49		
1G6GT	.69	6A3	1.29	6E5	1.09	7B6	.72	19V8	1.96		
1H4G	.49	6A5	2.98	6F5	.91	7B8	.82	24A	.92		
1H5GT	.72	6A6	.81	6F6	.76	7C4	.26	25A6	1.79		
1H6	.69	6A7	1.09	6F8	.86	7C7	.68	25BQ6	1.30		
1J6G	.79	6A8GT	1.09	6G6	.92	7E6	.54	25L6	.46		
1L4	.48	6AB4	.62	6H6	.57	7E7	.72	25Y5	.84		
1LA4	1.01	6AB7	.78	6J4	4.59	7F7	.82	25Z6	.60		
1LB4	1.09	6AC5	1.19	6J5	.46	7F8	1.18	26	.79		
1LC6	.89	6AC7	.68	6J6	.58	7H7	.72	28D7	1.29		
1LD5	.98	6AF6	1.18	6J7	.72	7N7	.90	34	.69		
1LE3	.99	6AG5	.71	6K6	.61	7S7	1.29	35/51	.60		
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1LN5	.78	6AH6	.88	6L5	1.09	7X6	.89	35B5	.54		
1P5	.78	6AK5	.62	6L6	.98	7Y4	.64	35C5	.71		
1Q5	1.19	6AK6	.74	6L7	.80	10	.49	35Y4	.68		
1R4	.96	6AL5	.48	6N7	.80	12A6	.48	35Z3	.69		
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1S4	.88	6AQ5	.52	6Q7	.81	12AH7	.92	38	.58		
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1U4	.52	6AS7	3.48	6S8	.92	12AU6	.61	50A5	.72		
1U5	.54	6AT6	.42	6SA7	.67	12AU7	.58	50C5	.54		
1V2	.68	6AU6	.48	6SC7	.74	12AV6	.52	50L6	.60		
1X2A	.88	6AV5	.84	6SF7	.74	12AW6	.84	71A	.74		
2A4	2.37	6AV6	.48	6SG7	.62	12AX7	.78	75	.82		
2A5	.78	6AX4	.81	6SH7	.46	12AY7	1.22	76	.68		
2A6	1.49	6B4	1.12	6SJ7	.69	12BA6	.69	77	.68		
2A7	.89	6B5	1.18	6SK7	.54	12BA7	.94	83V	1.22		
2B7	.89	6B7	91	6SL7	.62	12BD6	.65	117Z3	68		

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$9.45 Lots of 3

Hi-accuracy precision VOM 1000 Ohms per V. Reads AC & DC Volts 0, 5, 25, 250, 1000 V. DCMA: 0, 1, 10, 100 MA. Ohms 0, 10, 100 K. Size 1¼" D. 4⅝" L. 3¼" W. Test Leads
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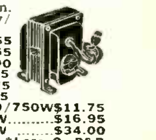

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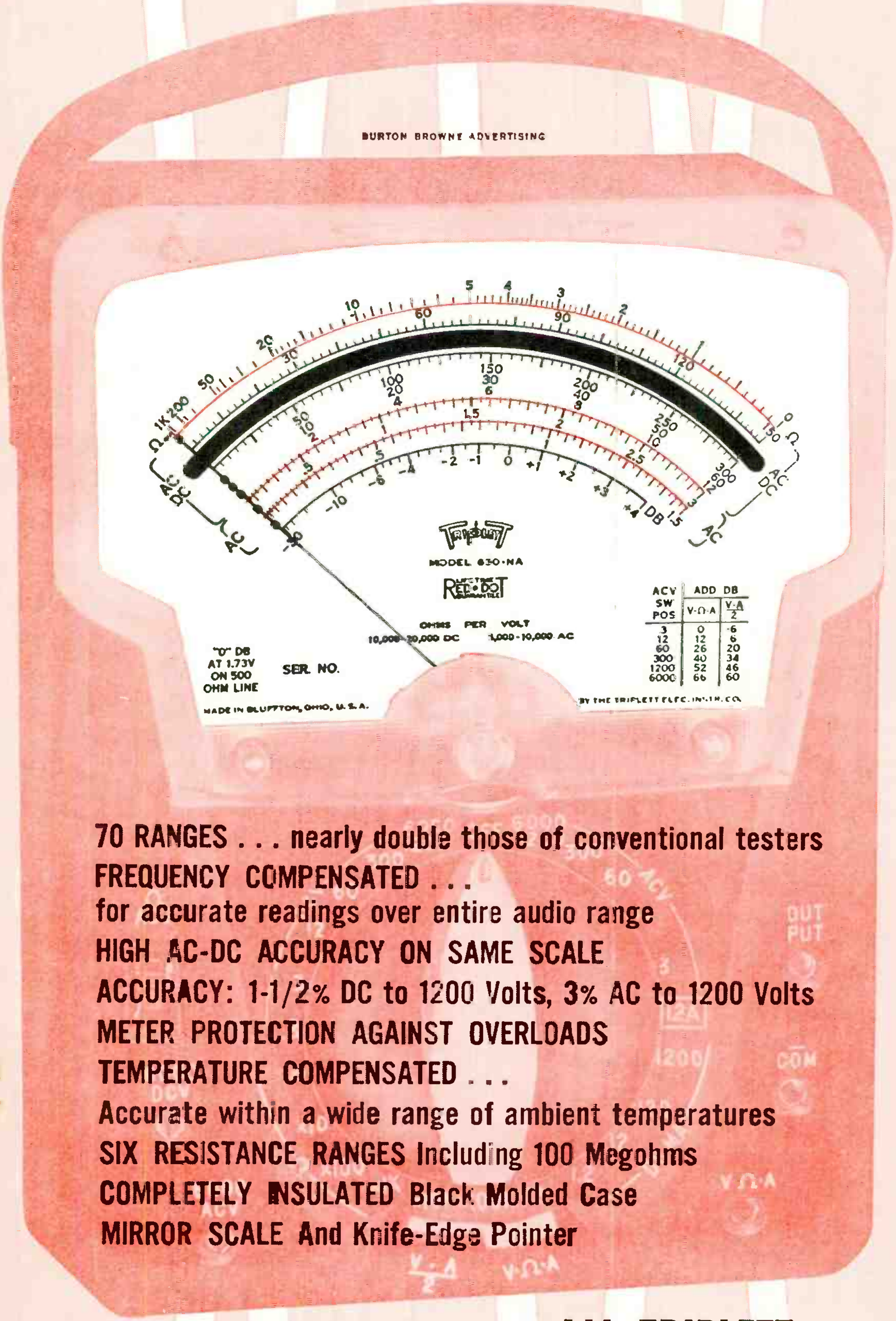

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