COMPLETE HOME INTERCOM SYSTEM

DECEMBER 1956

RADIO-ELECTRONICS

TELEVISION • SERVICING • HIGH FIDELITY

HUGO GERNSBACK, Editor

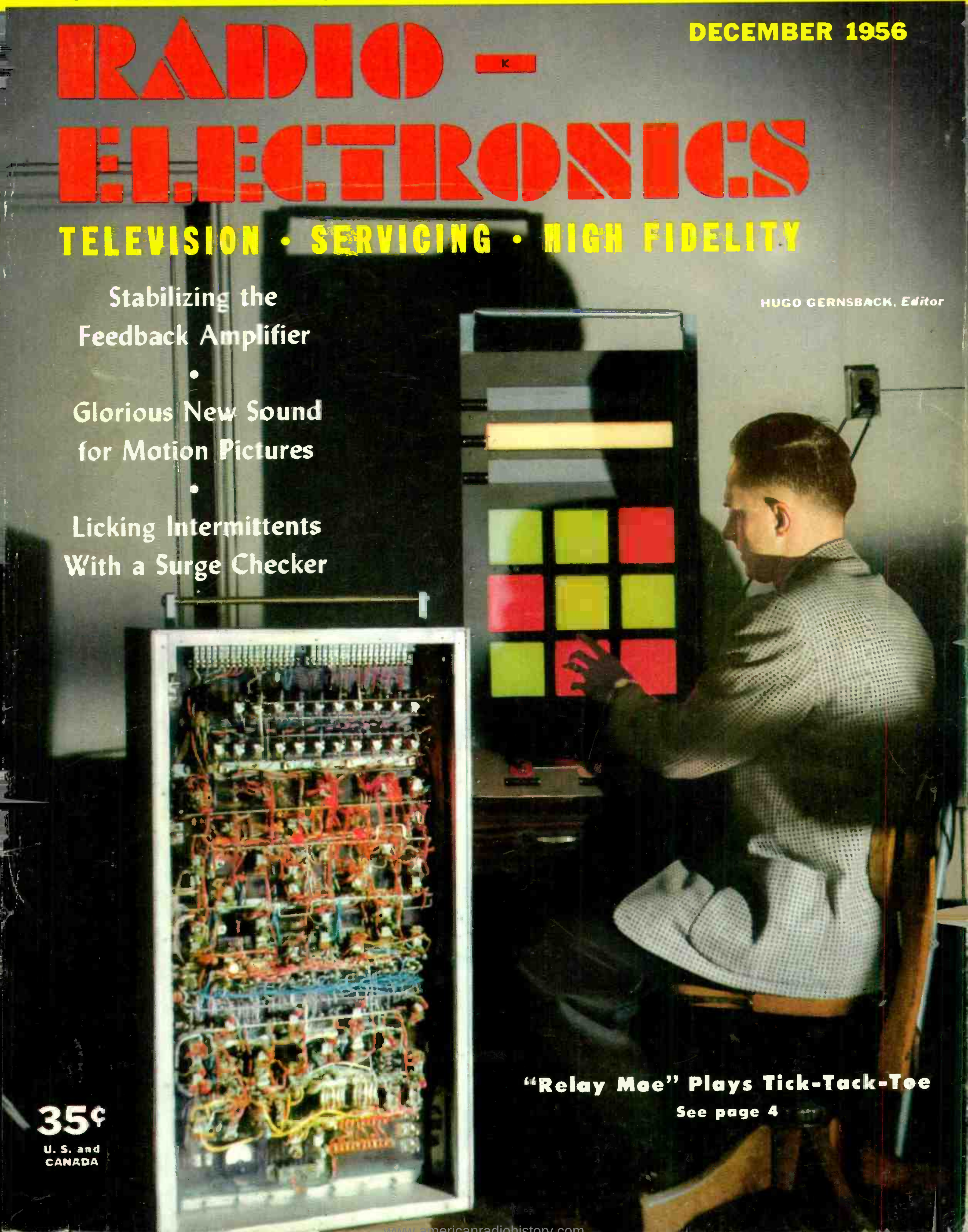
Stabilizing the Feedback Amplifier

•

Glorious New Sound for Motion Pictures

•

Licking Intermittents With a Surge Checker



"Relay Moe" Plays Tick-Tack-Toe

See page 4

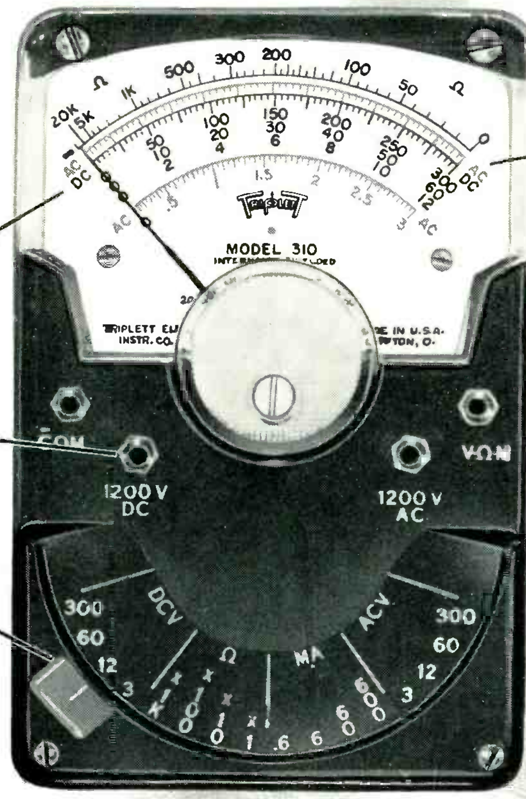
35¢
U. S. and CANADA

ACTUAL SIZE

complete with selector switch . . .

TRIPLETT

ELECTRICAL INSTRUMENT CO.
Bluffton, Ohio



- 5,000 ohms per volt. A.C.
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- BANANA-TYPE JACKS—positive connection and long life.
- EXCLUSIVE SELECTOR SWITCH speeds circuit and range settings. The first and only miniature VOM with this exclusive feature for quick, fool-proof selection of all ranges.

CARRYING CASE

Handsome leather carrying case with adequate space for Model 310 tester and accessories. Trouser belt slips through loop on back of the case for out-of-the-way carrying. MODEL 369 CASE—U.S.A. Dealer Net **$2.90**

Model 310 MIGHTY MITE

the only complete miniature V-O-M (AC-DC)

ONLY $29.50 Dealer Net

LOOK AT ALL THESE RANGES

DC VOLTS: 0-3-12-60-300-1200 at 20,000 Ohms/Volt.
AC VOLTS: 0-3-12-60-300-1200 at 5,000 Ohms/Volt.
DC MICROAMPERES: 0-600 at 250 Millivolts.
DC MILLIAMPERES: 0-6-60-600 at 250 Millivolts.
OHMS: 0-20,000-200,000 (200-2000 at center scale).
MEGOHMS: 0-2-20 (20,000-200,000 Ohms at center scale).
OUTPUT: Convenient chart in instruction book.
SEE IT AT YOUR JOBBER
AND IT'S ONLY ONE OF TRIPLETT'S MIGHTY NINE VOM LINE!

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Combination V-O-M—VTVM

630-NA
For Best Testing Around The Lab, Production Line or Bench

630
The Popular All-Purpose V-O-M

630-A
A Good Lab and Production Line V-O-M

630-T
For Telephone Service

666-HH
Medium Size For Field Testing

625-NA
The First V-O-M With 10,000 Ohms/Volt AC

666-R
Medium Size With 630 Features

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- Parts to conduct many experiments and build Continuity Checker, RF Oscillator, TV Circuits, Audio Oscillator, TRF Receiver, Signal Generator.
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- These are a MUST for all technicians.

YOU DO MANY PRACTICAL JOBS. You do servicing, circuit analysis and many other down-to-earth experiments. You build a modern TV set from the ground up . . . with equipment kits we give you, including a new large screen picture tube and professional Multitester, at no additional charge.

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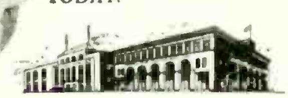

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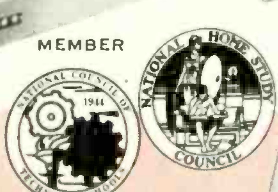

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DECEMBER 1956, Vol. XXVII, No. 12

RADIO-ELECTRONICS

Formerly RADIO CRAFT • Incorporating SHORT WAVE CRAFT • TELEVISION NEWS • RADIO & TELEVISION*

ANNUAL INDEX

EDITORIAL

AUDIO—HIGH FIDELITY

ELECTRONICS

WHAT'S NEW

TEST INSTRUMENTS

RADIO

TELEVISION

ON THE COVER

(Story on page 50)

An electronic player of children's games pits its skill against one of its constructors, Julius Skalski of Berkeley Enterprises.

Color original by Tom Carew

Average Paid Circulation over 184,000

NEXT MONTH: COMPLETE TV STATION LIST • HOW THE APPLE TUBE WORKS • BLACK-AND-WHITE ADJUSTMENTS IN COLOR TV

Associate Member Institute of High Fidelity Mfrs., Inc.

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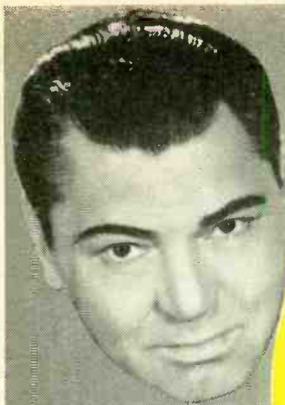

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Jack Dempsey says:

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See, too, How DeVry Tech Helps A Man Get Started in this Field

Nick Barton, Illinois, a DTI grad, now has his own business and tells us he is "literally snowed with work."

George D. Crouch, California, was a retail store clerk. He took the DeVry Program, and today is in business for himself.

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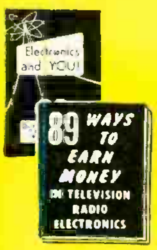
Get the Facts FREE from DEVRY TECH



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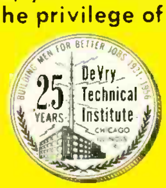

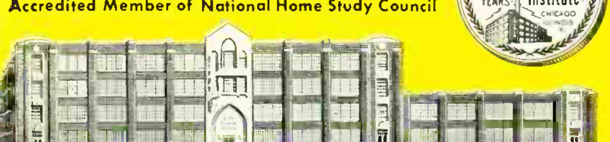

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PERSONAL RATING CHART

1. **AGE**—If you are between the ages of 17 and 55, place the numeral 5 in the square at right. If above or below those ages, mark yourself 3. ☐
2. **EDUCATION**—If you have graduated from high school, mark 5 in the square at right. If you finished 8th grade, mark 3. ☐
3. **DEPENDENTS**—If you are free to come to Chicago, rate yourself 5. If you prefer to study at home and hold your present job, put down the number 3. ☐
4. **ABILITY**—If you've had any experience in handling a soldering iron or doing simple home wiring, rate yourself 5. If you feel you can follow simple "How-to-do-it" instructions, mark down 3. ☐
5. **AMBITION**—Are you interested in training for a real future in a promising field? Mark down 5. Or do you simply want to prepare for a better job with more money? Put down 3. ☐

If you are subject to military service, please mark "X" here. ☐

MAIL CHART AND COUPON NOW!

DEVRY TECHNICAL INSTITUTE
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I would like late facts about the many opportunities in Television-Radio-Electronics, including the 3 free publications, and how DeVry Tech may prepare me for my start in this billion-dollar field.

Name ____________ Age ____
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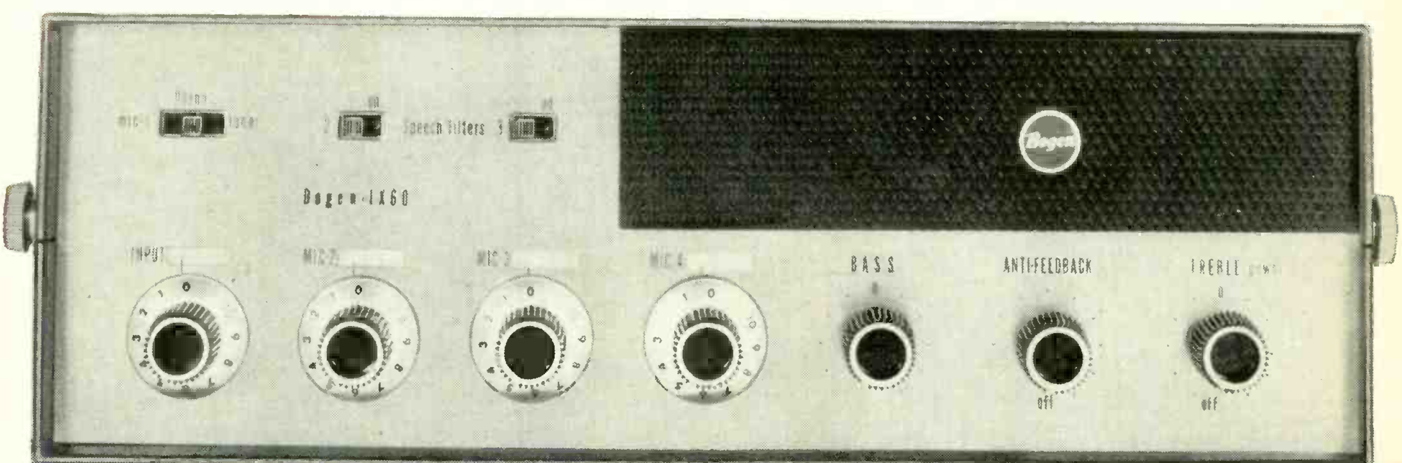
portable or permanent . . . make more sales, more profits



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(1) Get in touch with your BOGEN representative immediately, or (2) mail for all FLEX-PAK specifications and prices by checking the coupon on the facing page. NOTE: we also supply famous-make indoor and outdoor speakers, microphones and other accessories for all your BOGEN public address system installations.

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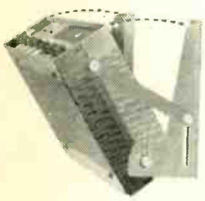
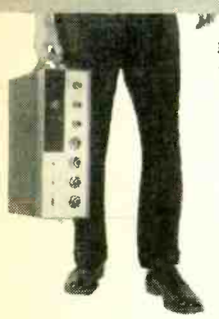
LOOSEN 4 THUMBSCREWS AND THE LID'S OFF for easy access for fast servicing.



FOLDS BACK WHEN NOT IN USE in easy-sliding accessory wall-mount bracket.

4 THUMBSCREWS ATTACH ACCESSORY RECORD PLAYER MOUNT. (Note: "cooling area" protects phono mechanism.)



BRIEFCASE PORTABILITY thanks to slim design, handy on-end carrying straps.

WRITE-IN ON EACH GAIN CONTROL prevents embarrassing mistakes in volume settings. (Easy to erase markings.)

LOCKING PANEL (accessory) protects against tampering with settings. Covers entire control panel, not just on-off switch.

A BOGEN FLEX-PAK PA SYSTEM FOR EVERY USE...EVERY BUDGET

The amplifier-control units shown here are representative of more than twenty different models available to you—in all desired wattages; handsomely finished in dark gray with brushed aluminum face plate. Dealer net prices range from $45 to $155 for "full control" amplifiers.

DELUXE "LX" SERIES

LX30 30-WATTS

4 Microphone Inputs (panel switch converts one mike channel for phono or tuner)

Built-in Remote Gain-Control Circuit

Exclusive Anti-Feed-back Control

Speech Filters

Separate Bass and Treble Tone Controls

Size: Height: 5⅜"
Width: 16¼"
Depth: 13"

Wgt.: 25 lbs.

LX60 60-WATTS

with accessory LPA-4 4-speed Manual Phono

Except for slightly greater weight (29½ lbs. without phono) and added power, the LX60 has same features and controls as LX30 shown above.

LPA-3 (3-speed) or LPA-4 (4-speed) phono mount includes manual record player, pan, legs, end pieces, couplings for easy mounting.

SUPERB "L" SERIES

L330 30-WATTS

with accessory LPA-4 Manual Phono

3 Microphone Inputs (panel switch converts one mike channel for phono or tuner)

Speech Filters

Separate Bass and Treble Tone Controls

Size: Height: 5⅜"
Width: 14¼"
Depth: 13"

Wgt.: 24 lbs. without phono

LOM PREAMPLIFIER CONTROL

5 Separate Microphone Gain Controls plus Master Gain Control.

1 Microphone channel converts to phono or tuner with selector switch on panel.

Illuminated Level (VU) Meter.

Separate Bass and Treble Tone Controls—plus Speech Filters for four microphone channels.

Size: Height: 5⅜"
Width: 16¼"
Depth: 11"

Wgt.: 20 lbs.

ECONOMICAL "K" SERIES

K130 30-WATTS

with accessory KPA-3 Manual Phono

1 Microphone Input

1 Phono Input

Speech Filter

Separate Bass and Treble Tone Controls

Size: Height: 6¼"
Width: 14"
Depth: 8"

Wgt.: 16 lbs. without phono

KO100 100-WATTS

Powerful line amplifier. Built especially for long-term, dependable performance with no service problems.

Size: Height: 7⅜"
Width: 17⅜"
Depth: 6½"

Wgt.: 28 lbs.

Bogen

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A UNITRONICS CORPORATION AFFILIATE

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Dept.NX, David Bogen Co., Inc., P. O. Box 500, Paramus, N. J.

Gentlemen: Please send me descriptive literature and price information on your BOGEN FLEX-PAK *public address equipment.*

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ADDRESS________________________________

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☐ *Please send me 24-page, illustrated brochure, "What You Should Know About Sound Systems."*

☐ *Please send me your 56-page, illustrated book, "Understanding High Fidelity," by L. H. Bogen and L. Biancolli. (I enclose 25c.)*

the Radio month

ELECTRONIC LIGHT AMPLIFIER which can increase by up to 1,000 times the brightness of projected light images, was demonstrated by RCA scientists in connection with General Sarnoff's 50th anniversary in radio. The electronic light amplifier (see photo) consists of a thin screen formed by two closely spaced layers, one of photoconductive material and the other of electroluminescent phosphor. Between these is a very thin layer of opaque material to prevent feeding back of light. The layers are sandwiched between two transparent electrodes and voltage is applied across the entire assembly.

When an extremely dim light image falls directly on the photoconductive layer, it permits a corresponding pattern of electric current to flow through to the electroluminescent layer. Under the influence of this current pattern the electroluminescent phosphor emits light, forming a high-brightness image of the original picture. The photoconductive material acts as an insulator in the absence of light; the electroluminescent material remains dark until it is excited by an electric current.

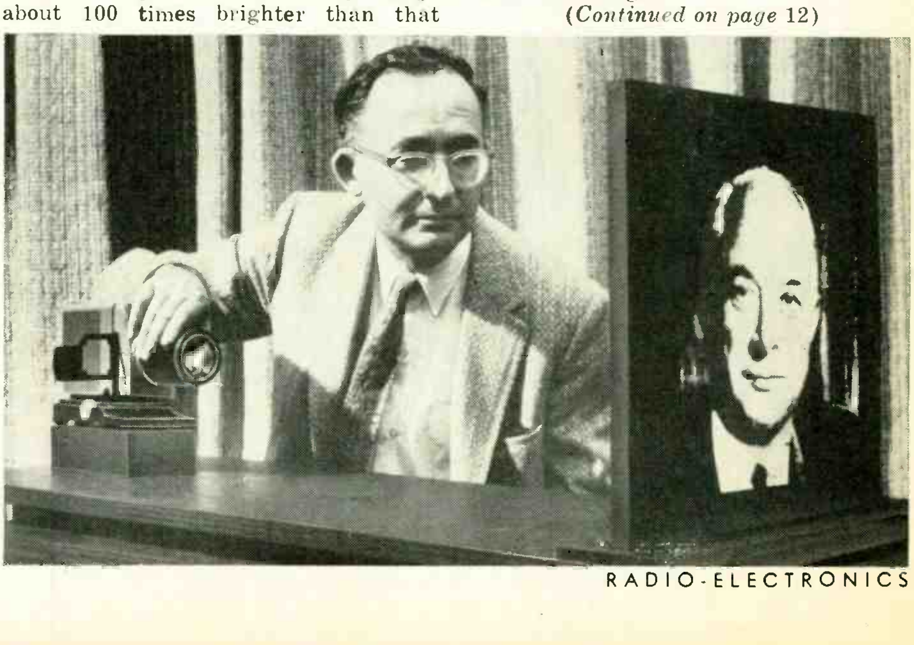
In the demonstration of the light amplifier, an image too dim to be seen clearly by the human eye was projected against the photoconductive layer on one side of a panel. On the other side of the panel, the image formed by the light emitted by the electroluminescent phosphor appeared as an extremely bright picture of television quality.

The application of the light amplifier to the amplifying fluoroscope for industrial X-ray use was also demonstrated. It produces an X-ray image about 100 times brighter than that obtained with the conventional fluoroscopic screen, permitting viewing in a normally lighted room.

DR. LEE de FOREST, Father of Radio, has been made an Officer of the Legion of Honor. The Cross of the Legion was presented to him in a ceremony in Paris by M. Maurice Lemaire, French Minister of Industry and Commerce, on the occasion of the 50th anniversary of De Forest's invention of the triode vacuum tube. Speaking at the ceremony was Prince de Broglie, permanent secretary of the Academy of Sciences; M. Henri Damelet, president of the Federation of Radioelectric Industries; Minister Lemaire and other notables. Each paid high tribute to the decisive contributions of Dr. de Forest.

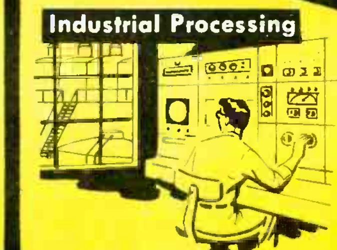
SARNOFF GOLDEN ANNIVERSARY in radio was celebrated with a dinner in honor of the RCA board chairman. Brig. Gen. David Sarnoff began his career on Sept. 30, 1906, as a messenger boy with the Marconi Wireless Telegraph Co. of America. Speaking to hundreds of friends and associates who gathered to pay him tribute for 50 years of service in radio, television and electronics, and deluged with congratulatory messages from notables and organizations throughout the world, Sarnoff predicted 20 major developments, both political and technical, within the next 20 years. They included the collapse of Soviet Communism, outlawing of war, vastly increased use of nuclear and solar energy, "farming" of oceans, control of weather, worldwide color and person-to-person TV, guided missiles carrying mail and freight.

(*Continued on page* 12)



ATTENTION: MEN 17 to 55


Handling Materials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In plant after plant, many machines are being designed to run themselves. This is called "Automation." The jobs of some men who used to run these machines are gradually disappearing. Every year sees more changes; more unskilled jobs being replaced. But it's *making* many new jobs too—good-pay, solid-future jobs in plants, offices and elsewhere—for men who are trained in Automation Electronics.

NOW IS THE TIME TO GET YOUR TRAINING

The design, operation and maintenance of controls that regulate the new "automatic equipment," is a promising field of the future. It's still uncrowded. There's time to get in on the ground floor if you act now.

NO PREVIOUS TECHNICAL TRAINING NEEDED

Many men 17 to 55, regardless of present job, even men without previous technical training or advanced education, can train for good jobs in Automation Electronics. DeVry Technical Institute offers effective training in your own home with movies, plenty of practical equipment and easy-to-read texts. Or get all of your training in DeVry's large well-equipped training laboratories in Chicago . . . one of the finest of its kind!

WE HELP YOU GET STARTED IN THE FIELD

When you've completed the DTI training, you'll have the know-how—the practical training you need to hold down a good job in Automation. Our effective Employment Service will help you get started toward many wonderful and exciting opportunities. You have nothing to lose—and much to gain. Send that coupon now so we can tell you about it.

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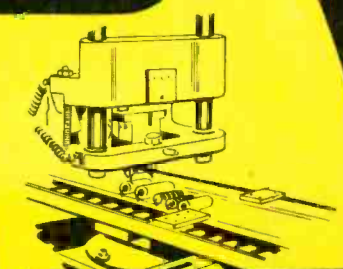
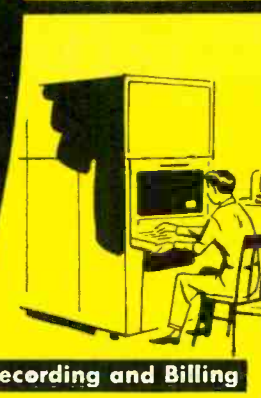
For 25 years, DTI has been building men for better jobs. Our files contain many letters from men who have won success in electronics and who give much credit to their DTI training.

GET INTERESTING NEW BOOKLET

The interesting story of "Automation and YOU" is yours for the asking. Simply fill in . . . mail the coupon. See how DeVry's training programs may prepare YOU for a start in this coming new field.


Making Electronic Devices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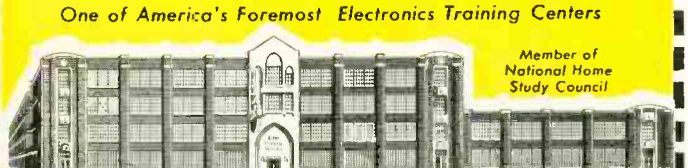
One of America's Foremost Electronics Training Centers



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SELLS TRAFFIC!

Capitalize on the growing two-set television market with this beautiful 5 color Telecoupler display. Cash-in on the increased Christmas sales of both black & white and color tv sets by displaying and selling AMPHENOL'S popular two-set coupler

AMPHENOL

TELE-COUPLER

see your **AMPHENOL** distributor

 (Continued from p. 8)

Five years ago, on Sarnoff's 45th anniversary of service in radio, he asked for three "presents" from RCA scientists for his 50th anniversary. At the dinner, Dr. Engstrom announced that the gifts, representing major advances in electronics, were ready. Shown on color slides, they included an electronic air conditioner with no moving parts, a magnetic tape recording and playback system for black-and-white and color television and an electronic light amplifier.

SINGLE-GUN COLOR TUBE in mass-produced color TV receivers is goal of Du Mont program. Using the single-gun Chromatron of Chromatic Television Labs., plans are to produce a color receiver using a much simpler circuit than now found in commercial sets. It is hoped to complete this program within a year.

Calendar of Events

Electronics Fair of Long Island, Dec. 6–8, New York State University, Farmingdale, N. Y. (RADIO-ELECTRONICS exhibits in Booth 42.)

1956 Eastern Joint Computer Conference, Dec. 10–12, Hotel New Yorker, New York City.

RETMA Symposium on Applied Reliability, Dec. 19–20, Bovard Hall, University of Southern California, Los Angeles, Calif.

Milwaukee High-Fidelity Music Show, Jan. 4–6, Milwaukee, Wis.

3d National Symposium on Reliability and Quality Control in Electronics, Jan. 14–16, Hotel Statler, Washington, D. C.

Minneapolis High-Fidelity Music Show, Jan. 18–20, Minneapolis, Minn.

Very-Low Frequency-Symposium, Jan. 23–25, NBS Laboratories, Boulder, Colo.

ATOMIC CLOCK, the world's most accurate timepiece, is exact to within 5 seconds in 300 years. Tabbed the Atomichron, the clock's pendulum is the cesium atom which oscillates at a constant frequency of 9,192.631830 mc. A clock dial may be attached to the device to tell time. The clock is immediately available to industry, and a few units have already been sold.

The Atomichron was developed by the National Co. Basically, the frequency of a 5-mc crystal oscillator is multiplied 1,836 times, yielding a signal of 9180 mc, approximately the resonant frequency of cesium. An atomic beam tube filled with cesium gas then detects any variation of the multiplied frequency from the cesium resonant frequency and applies a correction to the

An Open Letter To Independent TV & Radio Service Dealers

Way back in the forties when you had only to combat the suspicion and mistrust of the public — a mistrust created through unfavorable and unfair criticism in press and magazine — the Raytheon Manufacturing Company, recognizing this threat to your existence, started the Raytheon Bonded Electronic Technician Program in a sincere effort to help you survive. This program has helped thousands upon thousands of independent service dealers from coast to coast to establish themselves as reputable businessmen, increase their profits and gain the full respect of their customers.

The program has been carefully controlled. Membership in the Raytheon Bonded Dealer group has been kept limited and selected for 2 reasons: (1) Raytheon wants only the finest service organizations to bear this proud distinction, and (2) it represents a substantial investment for every dealer registered.

Today, the growth of Manufacturers' Service Organizations creates new problems for you in maintaining and increasing the business you have worked so hard to earn. To help you win and keep customer confidence, we are going to lift the quotas on the number of Bonded Dealers we will back. We know that many of you operate to standards that will enable you to qualify for the Raytheon Bond. We recognize your need for this support and gladly offer this helping hand.

We regret that this offer can be made for a limited time only. If you are interested in getting the help of the Raytheon Bond, get in touch with your Raytheon Sponsoring Bonded Tube Distributor right now. He will be delighted to show you how the Bond will help you build your business. And helping you — the independent service dealer — to prosper is something we at Raytheon are dedicated to do.

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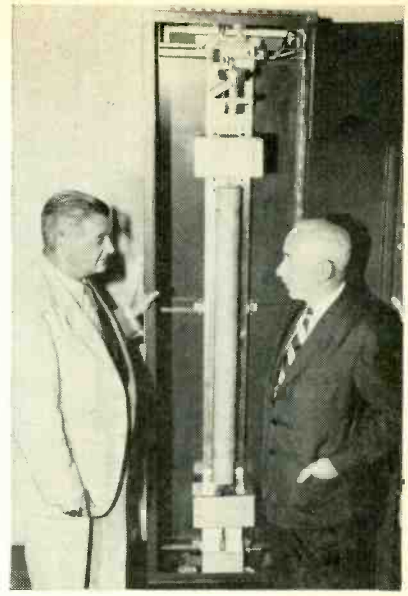

Rear section of Atomichron showing atomic beam tube. Left, Dr. Zacharias of MIT, key figure in the development; right, H. Guterman, board chairman of National Co.

5-mc crystal oscillator through an afc system. Output stability is maintained for the life of the instrument.

Principal applications for the atomic device are as a reference-frequency standard for calibration, as an elapsed-time measuring instrument, for communications monitoring and control. The Atomichron is based on fundamental discoveries by Prof. I. J. Rabi of Columbia University, who in 1945 outlined a blueprint for using the atomic frequencies as "cosmic pendulums" in an atomic clock that would tell time much more accurately than any other time-measuring device conceivable. The Bureau of Standards has done some work along this line and produced an experimental atomic clock a few years ago.

110° TV PICTURE TUBE has an overall length of only 14½ inches as compared with a length of 20 inches for a comparable 90° tube. The 110° represents the diagonal deflection of a tube having a diagonal of 21⅜ inches and a viewing area of 262 inches. It weighs less than 23 pounds.

The new tube has a straight electron gun and does not use an ion-trap magnet. Image sharpness over the entire screen is maintained with an electrostatic focusing lens system. Another interesting feature of this aluminized tube is its extremely narrow neck diameter—1⅛ inches. This permits the use of a deflecting yoke having increased deflection sensitivity. Only slightly more power is required for deflection than with a 90° tube.

The new 110° tube has an integral glass-button base with straight-through leads fitted with an indexing plug. This arrangement eliminates any possibility of loose base-pin connections. Developed by RCA, samples of this tube are being distributed to industry in 17- and 21-

(Continued on page 18)

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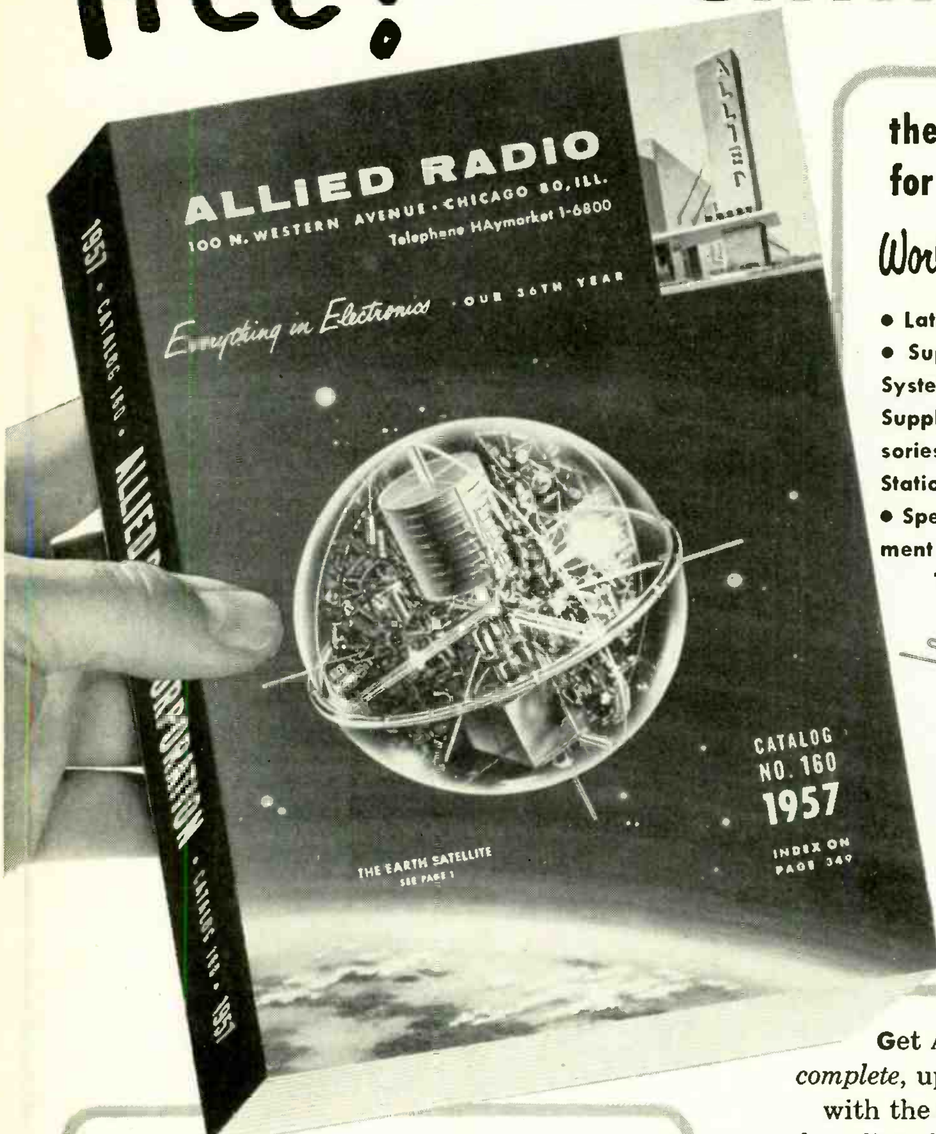

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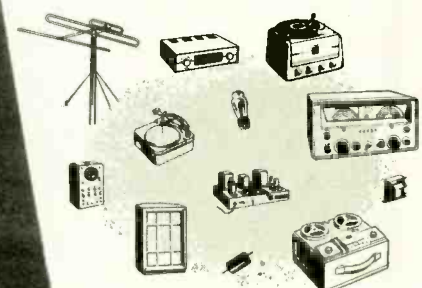

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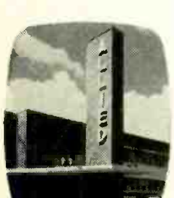

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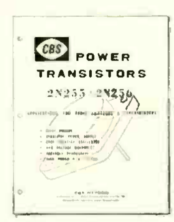
TYPICAL OPERATING DATA

	2N255	2N256	
Battery voltage	6	12	volts
Class B push-pull output	5	10	watts
Class A output	1	2	watts
Distortion at max. output	Less than 10		per cent
Power gain, Class A	24	27	db
Total max. dissipation*	6.25	6.25	watts
Alpha cutoff frequency	200	200	kc

*With chassis as heat radiator.

Free . . . "*CBS Power Transistor Applications*"

This easy-to-read booklet gives data and operating notes for the CBS 2N255 and 2N256 in addition to six simplified power transistor circuits: Regulated power supply . . . code practice oscillator . . . d-c voltage multiplier . . . relay control . . . portable phonograph . . . and mobile public address system. It's free . . . from your CBS Tube distributor. Or write direct. Ask for CBS Power Transistor Applications, PA-16.



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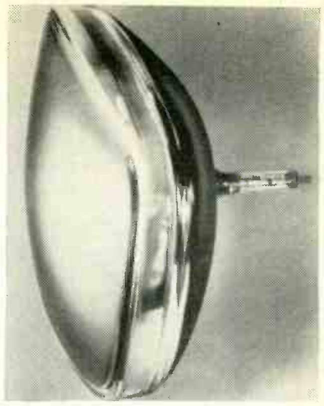
RADIO MONTH (Continued from p. 14)



inch models. RCA also plans 14- and 24-inch tubes. Other picture-tube manufacturers are also making the new tube. Westinghouse said it would be in production of the 110° tubes by the first quarter of 1957, and Philco, says its subsidiary, Lansdale Tube Co., is now in production of 14- and 17-inch models of these wide-angle tubes and is making shipments.

RADIO-CONTROLLED QUARTER-BACK provides the most revolutionary football concept since the flying wedge. No more did coach Paul Brown of the Cleveland Browns rotate guards to deliver instructions to quarterback George Ratterman. George's helmet, wired for sound, is an invention of George A. Sarles, radio hobbyist.

Coach Brown spoke into a microphone which fed a 4-watt AM transmitter. The signal was then picked up by a five-transistor radio receiver built into the quarterback's helmet.

The helmet outside appears like any regulation type. Inside, a receiver, about 2 inches in diameter and ½ inch thick, is fastened to its top. A small earphone is attached alongside the left ear guard. The antenna is formed from strips of silver which line the inside of the helmet and are covered with lacquer and paint. The receiver is powered with a small battery, good for 30 hours of continuous service.

Apparently not appreciative of this new electronic technique, Bert Bell, commissioner of the National Football League, banned the device after several games. Sports writers and fans had objected to brainless quarterbacks.

FOUR NEW TV STATIONS have gone on the air since our last report:

WSYE-TV Elmira, N.Y.	18
WAGM-TV Presque Isle, Me.	8
KDIX-TV Dickinson, N.D.	2
KSIX-TV Corpus Christi, Tex.	10

One station has gone off the air:

WTOM-TV Lansing, Mich.	54

Station WNOW-TV, York, Pa., channel 49, left the air since our last report but returned to operation during the same period.

Station WSYE-TV (above) is operating as partial satellite of station WSYR-TV, Syracuse, N.Y., channel 3.

The total of TV stations now operating in the U.S. and its territories is 489 (394 vhf, 95 uhf), including 22 noncommercial of which 5 are uhf. END

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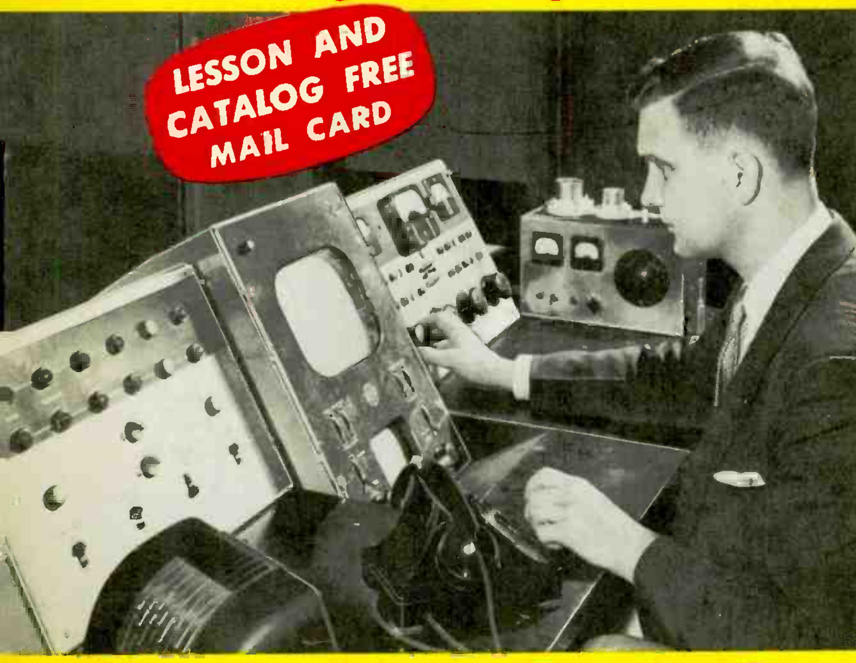

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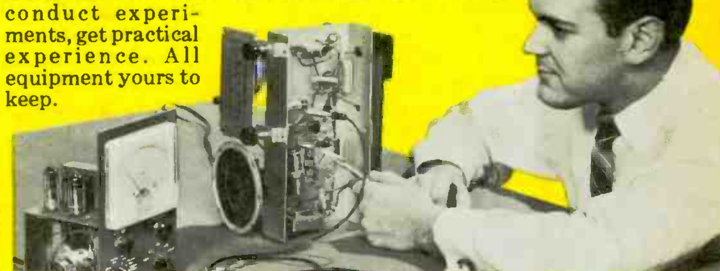

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Soon after enrolling, many N.R.I. students start earning extra money fixing neighbors' radio sets. Many earn enough extra to pay entire cost of course and provide capital to start their own full time Radio-TV business after getting N.R.I. Diploma. If you want a job with a future, find out how you can train at home for Radio-Television. Mail Postage Free postcard for Sample Lesson. See how practical it is to learn at home. Get 64-Page Catalog, too. See equipment you get, outlines of courses, facts about opportunities in this growing field. Prices of N.R.I. Courses are low, terms easy.

See Other Side

N.R.I. Training leads to good pay jobs like these. **BROADCASTING:** Chief Technician, Chief Operator, Remote Control Operator. **SERVICING:** Home and Auto Radios, P. A. Systems, Television Receivers, Electronic Controls, FM Radios, Hi-Fi. **SHIP AND HARBOR RADIO:** Chief Operator, Assistant Operator, Radiotelephone Operator. **POLICE RADIO:** Transmitter Operator, Receiver Serviceman. **GOVERNMENT RADIO:** Operator in Army, Navy, Marine Corps, Coast Guard, Forestry Service Dispatcher, Airways Radio Operator. **IN RADIO PLANTS:** Design Assistant, Transmitter Design Technician . . . **AND MANY OTHERS.**

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Engineer with Station WHPE

"I operated a successful Radio repair shop. Then I got a job with WPAQ and now I am an engineer for WHPE." VAN W. WORKMAN, High Point, N. C.

N.R.I. Started His Way up

"I was a cab driver earning $35 a week. Then I enrolled with N.R.I. Now tester with TV maker." J. H. SHEPHERD, Bloomington, Ind.

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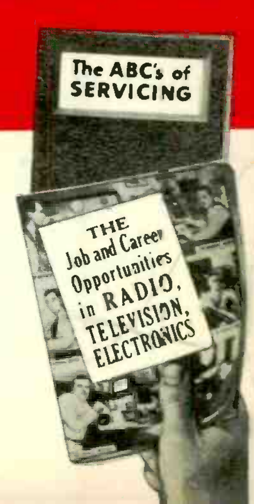

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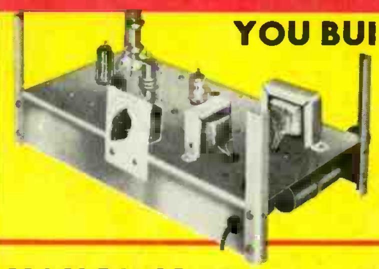

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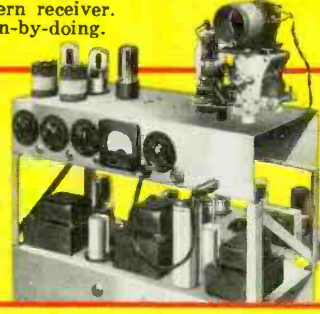

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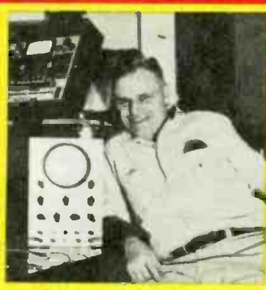
Chief Engineer with Station

"I am Chief Engineer of Station KGCU in Mandan, N. D. I also have my own spare time business servicing high frequency, two-way communications systems." R. BARNETT, Bismarck, N. D.



Paid for Instruments out of Earnings

"I am doing very well in spare time TV and Radio. Sometimes have three TV jobs waiting and also fix car Radios for garages. I paid for instruments out of earnings." G. F. SEAMAN, New York, N. Y.

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"We have an appliance store with our Radio and TV servicing and get TV repairs. During my Army service, N.R.I. training helped get me a top rated job." W. M. WEIDNER, Fairfax, S. D.

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Correspondence

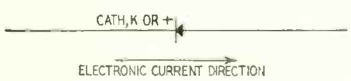
MORE FUSS ABOUT PLUS

Dear Editor:

Exasperation is at least the alternate mother of invention. And recently I became thoroughly exasperated with the orthodox symbol for selenium (or other contact) rectifiers. In using this orthodox symbol one must always understand that the maximum (easy or forward) current will flow in *electronic* direction, precisely opposite to the arrowhead direction. (See Fig. a.)

For example, in his article "Much Fuss About Plus" (RADIO-ELECTRONICS, April, 1956, page 102), Mr. Prensky correctly hooks up the milliammeter, battery and rectifier as in Fig. b, to obtain the maximum current flow through the meter.

Note the emphasis here on *electronic* direction of flow. It is the concept accepted by most, if not all, of us who have grown up in electronics since the 1920's. The older (Ben Franklin) concept was that battery current flows around from "+" to "−." But now we believe, in accordance with electron-tube theory, that the current flows through the hot cathode (from battery −) to the cold plate or anode (battery +).



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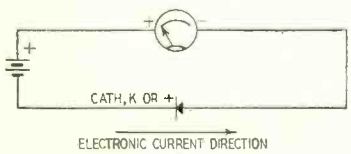

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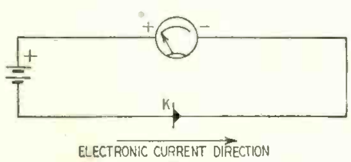
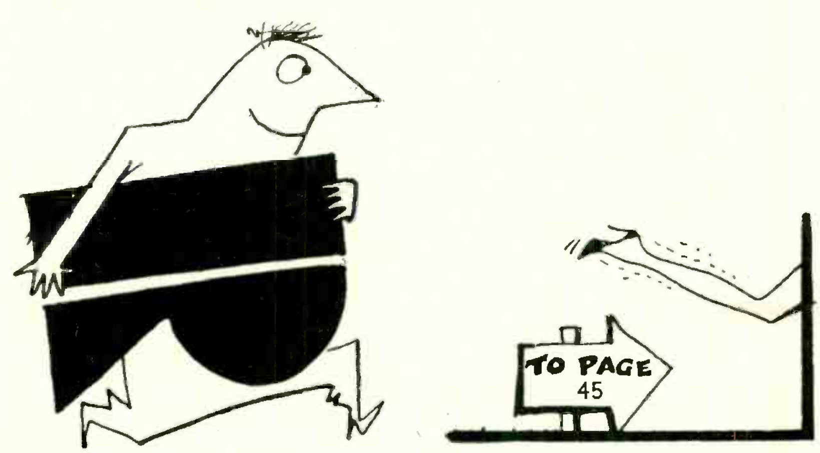


c

The rectifier arrowhead, as drawn, indicates current flow in accordance with the old Ben Franklin theory. Thus, if you use this symbol but at the same time trace out all your circuits in terms of the newer electron theory, the arrowhead is pointing precisely the "wrong" way. Indeed, so much "wrong" is the way that, when we work with complicated circuits like voltage triplers and quadruplers, we become thoroughly confused, even to the point of making catastrophic practical errors. So it was that I became thoroughly exasperated



CORRESPONDENCE *(Continued)*

with the standard symbol and, as a nonconfusing expedient, adopted the practice of turning the arrowhead around (Fig. c) so that it would indicate the *electronic* direction in which the current flows.

We now have a rectifier symbol whose arrowhead indicates the electronic direction of easy or forward or maximum current flow. It is a logical symbol and one that will not introduce any ambiguity into circuit analysis. It is still early in the game and an excellent time to standardize.

A mere symbol may seem a small thing. Yet without such symbols, including words, we simply could not think. If you believe you are able to think without symbols, just try to frame a wordless thought! So if our thought is to proceed at all, and moreover clearly and easily, we must have clear and easy symbols. Never again will I, brought up in the electron-tube theory of current flow, use the old symbol for a rectifier. Too confusing.

JOSEPH H. SUTTON
Kansas City, Mo.

TUBE JOCKEYS

Dear Editor:

TV tube jockeys flourish hereabouts, no less than elsewhere, but we must have a special breed—sort of an elite corps. Witness the following case histories as reported by televiewers who called me in after the jockeys had left their several magic lanterns still unfixed. Match these, if you can.

Case 1. Complaint: extremely weak, violently pulling picture. After swapping tubes furiously for some time, the jockey finally removed the lead-in from the antenna posts, moistened his fingertips and experimentally stroked the two conductors. After about a minute he gravely announced that "Something is wrong with the antenna. Probably a broken wire. Anyway, the signals are very weak." (And just to think I dumped over a hundred bucks in a field-strength meter!)

Case 2: Complaint: White vertical line in picture about quarter of the way across the screen from left-hand side. Tube jockey's explanation: "That big tree across the road is splitting the beams from the TV stations. It's like radar, you know; the tree just naturally cuts a section out of the picture."

Case 3: Complaint: Snowy pictures, unusable about 6 days out of 7 (due to poor location behind range of steep hills). Referring to jockey he'd called in ahead of me, customer reported: "This man worked on the set for a long time and finally said the only way to get pictures here was by using two boosters. Only he said he was afraid to try it on account they'd *probably blow out the tuner.*"

Is it to laugh? Or to weep?

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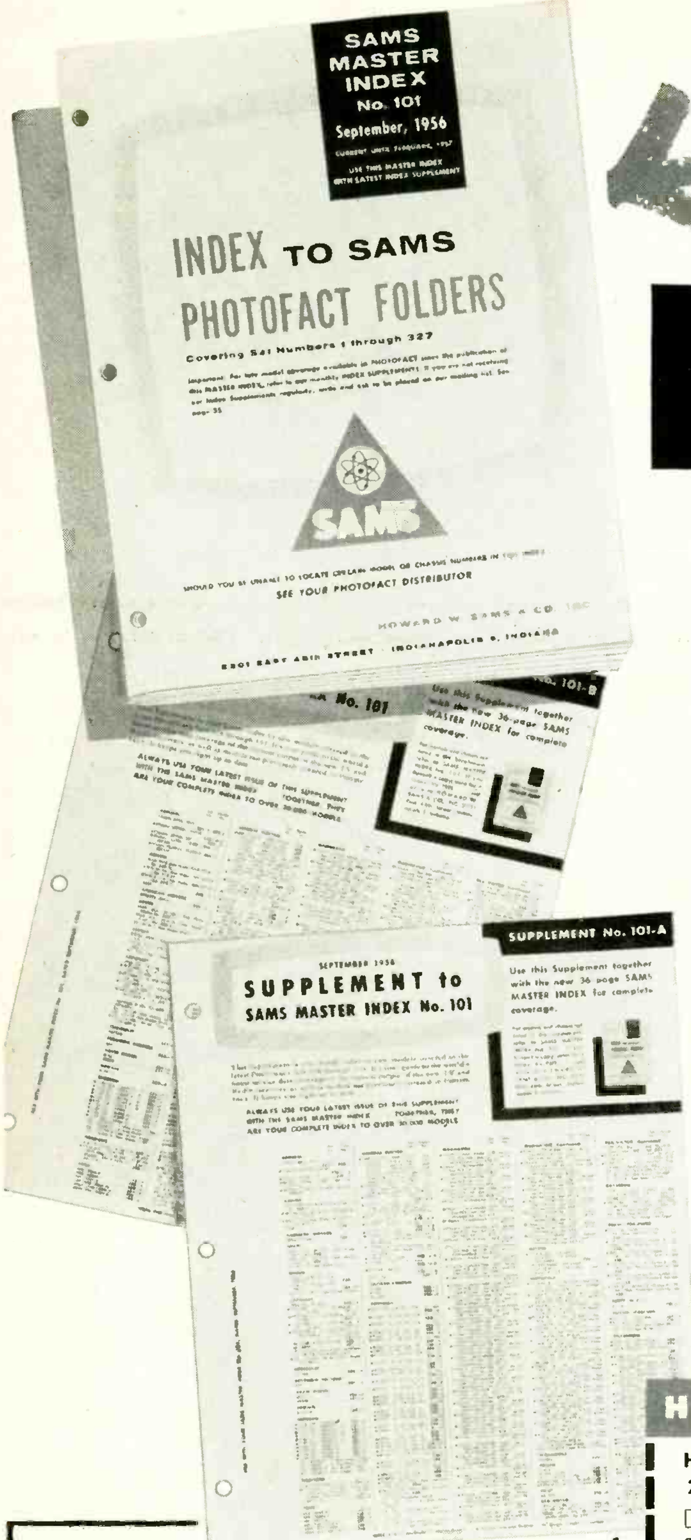

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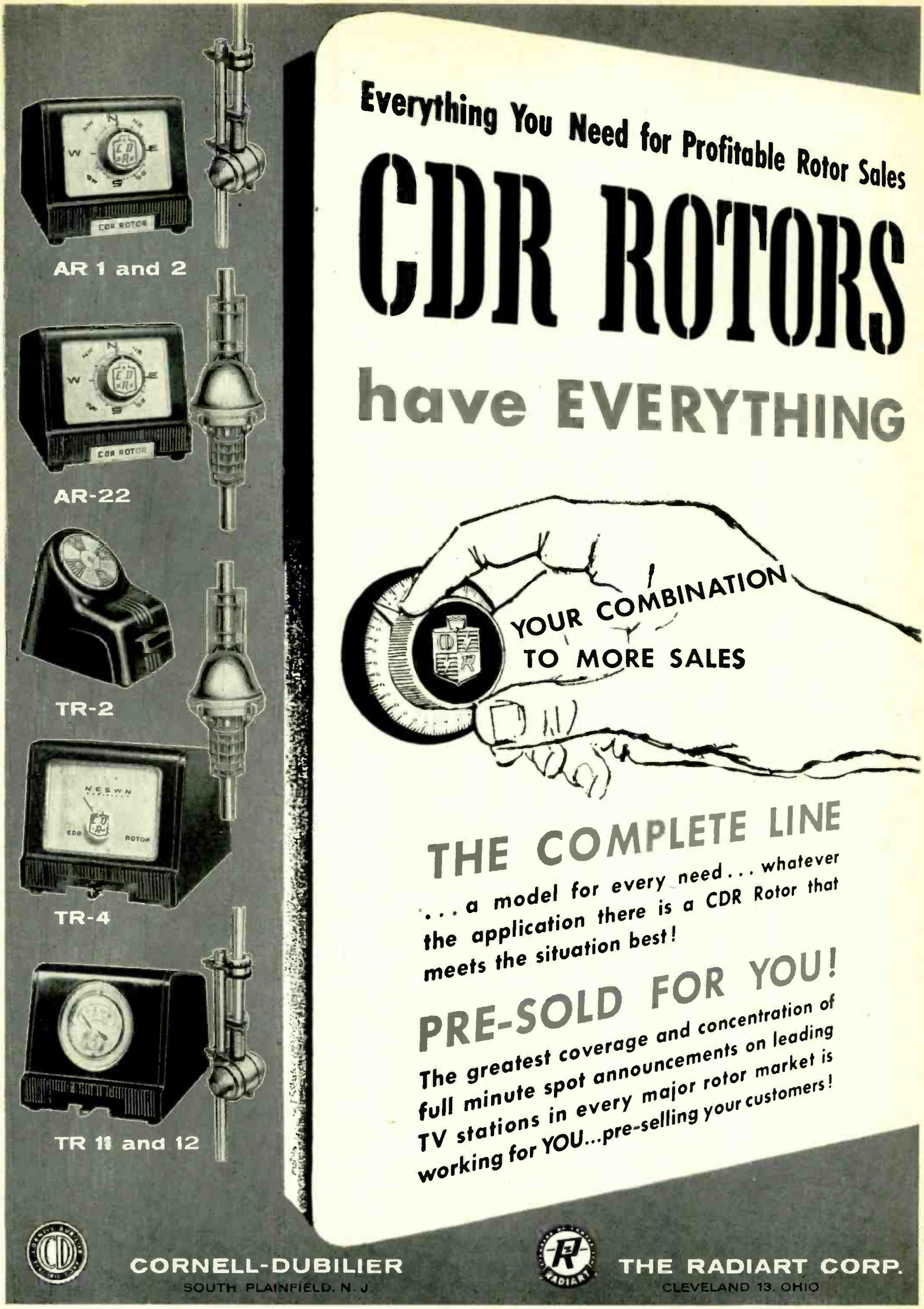

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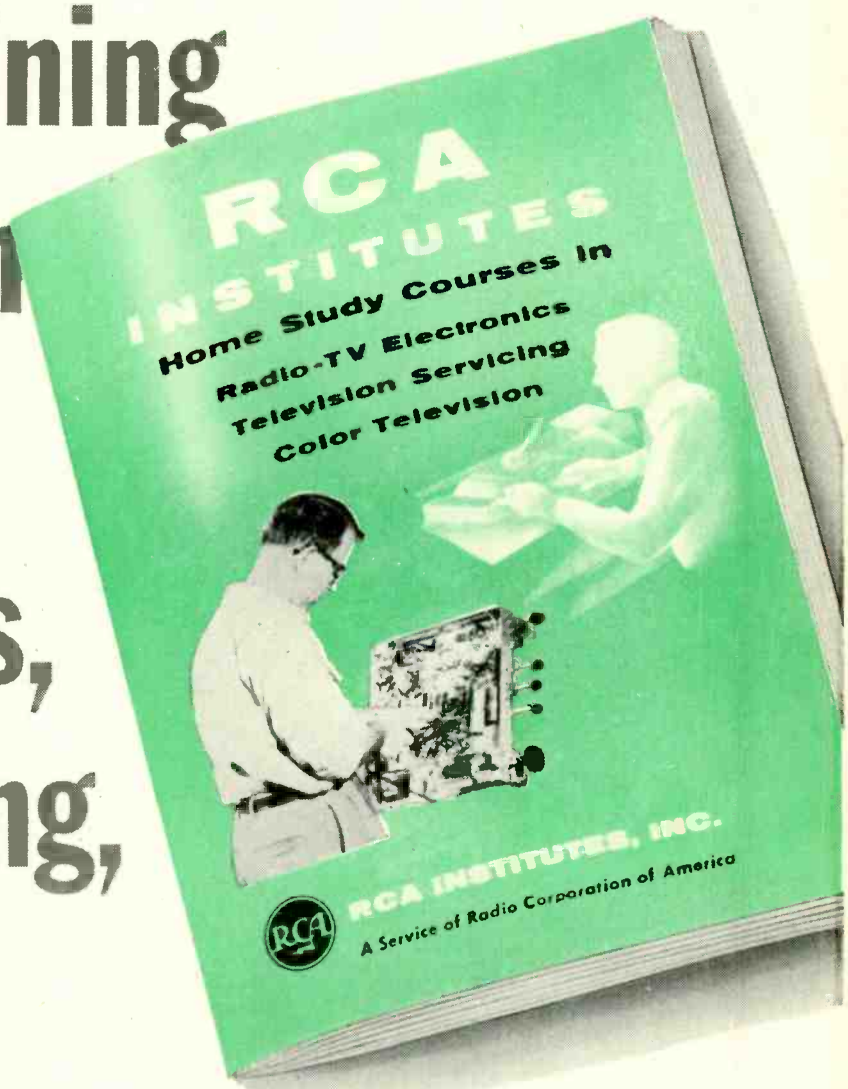

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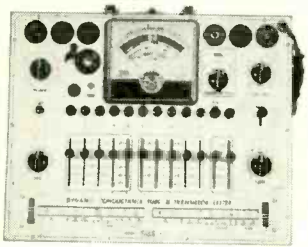

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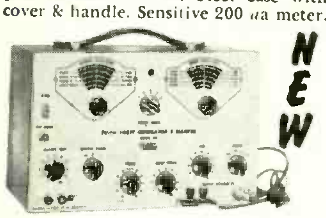

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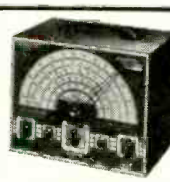

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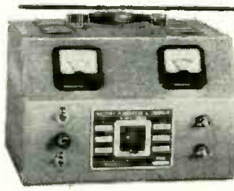

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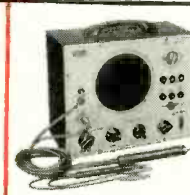

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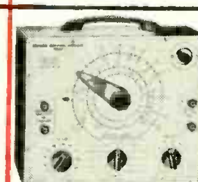

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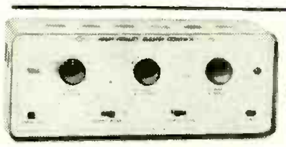

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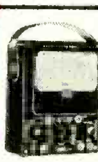

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RADIO - ELECTRONICS

Hugo Gernsback, Editor

FIFTY YEARS OF THE VACUUM TUBE*

. . . The Most Outstanding Milestone in Radio and Electronics . . .

THE year 1956 marks the 50th anniversary of the amplifying radio vacuum tube—Dr. Lee de Forest's three-element audion. While de Forest invented audions before 1906, they did not contain the all-important and vital grid. His patent application of this tube came a bit later (Jan. 29, 1907), but 1906 was the actual date of the birth of the modern vacuum tube.

And what a milestone it proved to be in the history of radio! Imagine for a moment that the audion had not been invented: There would have been no electronics, no radios, no broadcasting, no ocean phone, no talking motion pictures, no amplifiers, no radar, no television, no klystrons, no cyclotrons that made possible fission and atomic energy, no radio-guided missiles—and hundreds of other radio wonders, plus myriads of new ones to come. Truly the progress of modern radio and electronics would have been set back for almost a generation.

It will always remain a vivid fact which we must never forget: de Forest gave us these priceless gifts—gifts that changed our lives and our habits, annihilated distances, carried the spoken word and music through all space on this planet—as well as into outer space—a reality which in time will unite humanity as nothing has ever done before.

The uninformed always will parrot the now-hackneyed cliché: "If *he* hadn't invented the vacuum tube, somebody else would have." Maybe so—but it *was* de Forest who did it first.

De Forest never was the "lucky" type of inventor who just stumbled accidentally upon an epoch-making invention—as for instance Dr. Roentgen's discovery of the X-ray. No, he literally "sweated it out." Fortunately, he was gifted not only with a never-to-be-satisfied curiosity but with an imagination of heroic dimensions.

During his first semester at Yale University, one of the professors gave a lecture which was to change the entire course of de Forest's life. The lecture was on the electromagnetic wave theory with a demonstration of Heinrich Hertz' experiments. This caused such a flare-up in the young student that he made this entry in his notebook:

"I shall learn all about the atom . . . shall guess its shape . . . shall postulate its causes and attractions . . . and I SHALL INVENT THE REASON FOR IT."

It has been my great pleasure to have known Lee de Forest since 1906—over 50 years. I have come to know him very well, and I have had many opportunities to study him at close range over the years. I have been fortunate to have known Edison, Tesla and other inventors equally well, and therefore believe myself qualified to judge the outstanding qualities of such men.

One cannot be long in de Forest's company before realizing that among his greatest characteristics is his inherent modesty. He speaks in measured, quiet phrases. His unusually deep-set eyes proclaim the man of science, the indefatigable worker, the type of man who never gives up a quest in search of light and truth. His complete disregard of his attire, his frugal living, his constantly preoccupied air, point to his tireless toil and zest for new worlds to conquer. Indeed, at 83, he still keeps busy at his Los Angeles research laboratory.

Financial transactions bore de Forest to distraction—and unfortunately for him the world has seen fit to take advantage of this: a pittance for his vacuum tube, his regeneration invention, his radiophone (broadcasting) as well as dozens of his more than two hundred inventions.

Harassed by patent suits against him and countersuits which he had to bring against others, the comparatively modest amount of money that he received for his inventions soon vanished. Once, because he was so rash as to tell a Federal court that with his radiophone a man would soon be able to talk across the ocean, the Father of Radio almost went to jail! If not for the pleas of a good attorney, he would have been imprisoned for his temerity in predicting modern broadcasting!

Nothing ever came easy to the great inventor. The invention of the audion was no exception. It was an epic in frustration, in dogged plodding against seemingly insuperable, mountainous difficulties. There are too many witnesses who worked with him and who certified how he started with his Welsbach gas-flame audion and step by step, through literally thousands of separate experiments, finally battled himself to the three-element grid audion. In spite of all this evidence, there are even today jealous, narrow-minded intolerants who say with total disregard for the facts, "Oh, de Forest, he just stuck a grid into the Fleming valve!" This is like saying, "The Wright Brothers flew, because they stuck a propeller on an old kite."

It is eminently befitting that the *De Forest Pioneers, Inc.*, a membership organization of Lee de Forest's friends and contemporaries, who had been associated with him in various ways during the days of the audion, should honor him on the 50th anniversary of his great invention.

This was done on the morning of Nov. 12, 1956, when a large bronze plaque bearing a portrait of Dr. Lee de Forest, with appropriate wording, was unveiled. The locale was the site of the old Parker Building, on the southeast corner of 19th Street and Fourth Avenue, New York City. It was in this building that he invented the grid audion, the first three-electrode vacuum tube, 50 years ago.

The plaque was unveiled by Rear Admiral William Halsey, USNR, in the presence of Admiral Ellery W. Stone, USN, president of De Forest Pioneers, Inc.; many members of the society; Brig. Gen. David Sarnoff, chairman of the board of the Radio Corporation of America, and other notables.

Let all of us—the entire radio-electronic fraternity—congratulate Dr. Lee de Forest on the 50th anniversary of his epoch-making invention—the audion. Then let us wish him continuous good health, a long and happy life and many new laurels. —H. G.

*Parts of this article appeared in our editorial "De Forest—Father of Radio," in the January, 1947, issue of this magazine.

The Editors wish you a Happy Christmas and a Wonderful New Year

STABILIZING FEEDBACK AMPLIFIERS

Types of oscillation, conditions producing them, the stability criterion

By NORMAN H. CROWHURST

TO AVOID confusion between kinds of instability let's start by defining the different things that can constitute instability. The one most evident is continuous oscillation. In feedback amplifiers, particularly, this usually occurs outside the audio spectrum, either at a very high or very low frequency.

If the high-frequency oscillation is of sufficient amplitude to load fully some or all amplifier stages, it results in *high-frequency blocking*. This is characterized by the output of the amplifier seeming exceptionally quiet until one tries to pass an audio signal through it. Then the audio signal breaks through in varying degrees, according to the strength of the high-frequency blocking, in an extremely distorted form. The sound resembles what one would imagine it to be like if the audio voltages had to break down a spark gap before they got through. Low-intensity sounds don't get through at all, but large ones break the gap down and manage to carry some other small ones through with them. Then, when the level drops, everything becomes quiet again. The waveform, as seen on a scope, is shown in Fig. 1.

Low-frequency oscillation results either in audible motorboating (since the oscillation is not sinusoidal), the variety most easily recognized, or in an approximately sinusoidal low-frequency waveform which is inaudible because it is subsonic.

However, the latter may result in intermodulation distortion because it carries peaks of the true audio signal beyond the output limit of the amplifier, as shown at Fig. 2. If you use an ac input to a scope, the real cause may not be evident because the blocking capacitor may stop the low-frequency component from registering on the scope displacement. It may just be noted that the clipping point on the top and bottom of the wave seems to fluctuate in some erratic manner.

A way in which this form of instability can be spotted, sometimes, is by taking dc readings at various points in the amplifier: plate, cathode, etc. The dc readings will go up and down with a slow fluctuation at the same rate as the low-frequency instability. And instead of moving with a ticking or sawtooth waveform, which is responsible for motorboating, the instrument pointer will wave up and down sinusoidally.

So much for the continuous types of instability. They are more definite than the others. The remaining kinds are parasitic and conditional oscillation.

Parasitic oscillation

This occurs at some point on a waveform and may be hard to detect as an entity audibly because the parasitic frequency is inaudible—it does not show up audibly on a sinusoidal wave. However, it may well interfere with some of the higher frequencies on the same wave and produce a form of intermodulation distortion that sounds muddy. The waveform for sine-wave input looks on the scope like Fig. 3. The amplifier generally breaks into oscillation at one point on a large-amplitude waveform and then dies out.

Conditional oscillation

The third variety of instability can be called conditional oscillation. There are two ways this can be caused and the results can be slightly different—although there may be cases where this difference is so marginal that it cannot be used to discover which kind of instability is occurring.

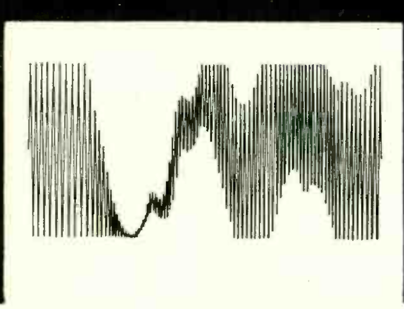
One way is to run into overload. This means that the amplifier behaves normally all the while the program level stays inside the clipping point. But as soon as the program runs into clipping, the amplifier bursts into oscillation and nothing will stop it except turning the unit off and starting over again.

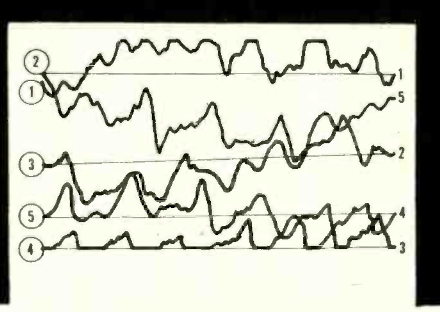
The second way usually differs in the means by which it is initiated—not by going up to the clipping level, but by a somewhat smaller signal (but not a very low one). This means that the amplifier may be all right while playing very quietly. But as soon as a slightly louder program is passed through it, oscillation begins.

Superfically there is not much difference between these forms and in practical cases also the margin may be narrow. *But in cause there are two different cases here!* To explain these forms of instability in feedback amplifiers and find ways and means of curing them, we need to understand why they occur.

Stability criterion

A feedback amplifier is stable provided that the feedback does not get to being positive and of sufficient amplitude to cause oscillation at any frequency within the range of the amplifier. Considering the overall gain around the feedback loop, rolloffs are bound to occur at the end of the response—in direct-coupled amplifiers at the high-frequency end only; in the





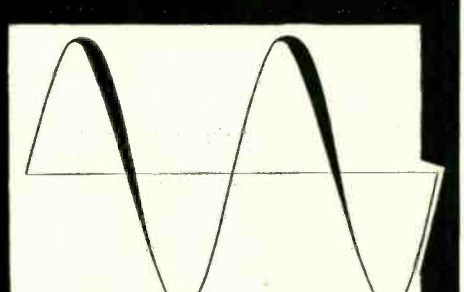


Fig. 1, left—High-frequency blocking. Fig. 2, center—Scope display when an amplifier oscillates inaudibly at a very low frequency. Circled numbers show start of trace and corresponding uncircled numbers show the trace ends. Fig. 3, right—sine-wave input produced by parasitic oscillation.

more usual R-C-coupled amplifiers at both ends of the response. Associated with the progressive attenuation that these rolloffs introduce is a phase delay at the high-frequency end and a phase advance at the low-frequency end.

The problem in achieving stability is one of insuring that the attenuation around the loop—that is, through the amplifier and back through the feed-back to the input point again—becomes sufficient so that the fed-back signal is less than the input signal before the phase shift reaches 180°.

When the phase shift reaches 180°, the feedback has changed from negative completely over to positive so that, if the fed-back signal is equal to the input signal, we have the condition necessary to maintain oscillation. To determine whether this happens at any frequency we can draw the gain and phase characteristics of the amplifier loops (Fig. 4) and spot the point where the gain has dropped to unity, then check on the lower diagram to see that the phase is less than 180°. Or else, we can spot the point where the phase reaches 180° and check to see that the overall gain has dropped to less than unity. (A margin of about 30°, at unity gain, as shown, is desirable for excellent stability.) This entails looking at two curves, so the Nyquist diagram is a convenient way of presenting this information on a single picture.

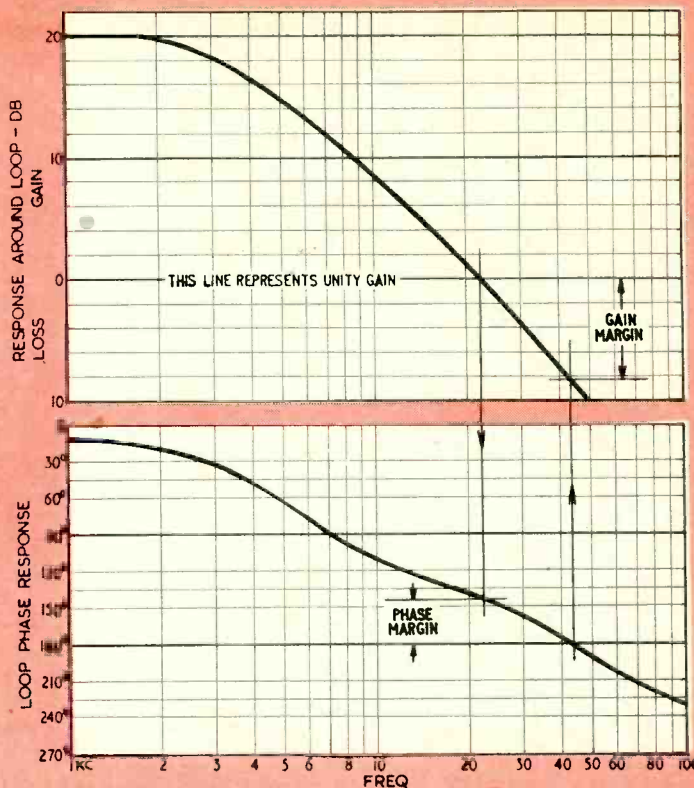


Fig. 4—Typical gain and phase response of an amplifier.

Nyquist diagram

This consists of plotting a polar curve of the response so that the distance of a point on the curve from the origin represents the gain around the loop at any particular frequency and the angle of this line from the origin represents the phase shift. This presentation is illustrated in Fig. 5.

Using this form of presentation the condition for stability can be expressed simply by stating that the curve must pass inside the point representing a gain of unity in the negative direction, as shown at Fig. 5-a. (Note that gain in Fig. 5 is a straight voltage ratio, whereas it is expressed in decibels in Fig. 4.)

If the curve passes outside this point, as at Fig. 5-b, the amplifier is unstable because the amount of feedback at 180° phase shift is greater than unity. Hence the amplifier will oscillate good and hard at the frequency represented by this point on the curve.

There are advantages to each method of presenting this information, but we will not go into a discussion of this right here or we will not fulfill the purpose of this article. More detail on the Nyquist diagram appears in *High-Fidelity Circuit Design* (see footnote) if any reader wishes to pursue the subject further. What we want to see is how the loop gain presented in either of these methods is controlled and in what way practical parameters in the amplifier brings about such conditions.

As was explained in the series of articles by George Fletcher Cooper on

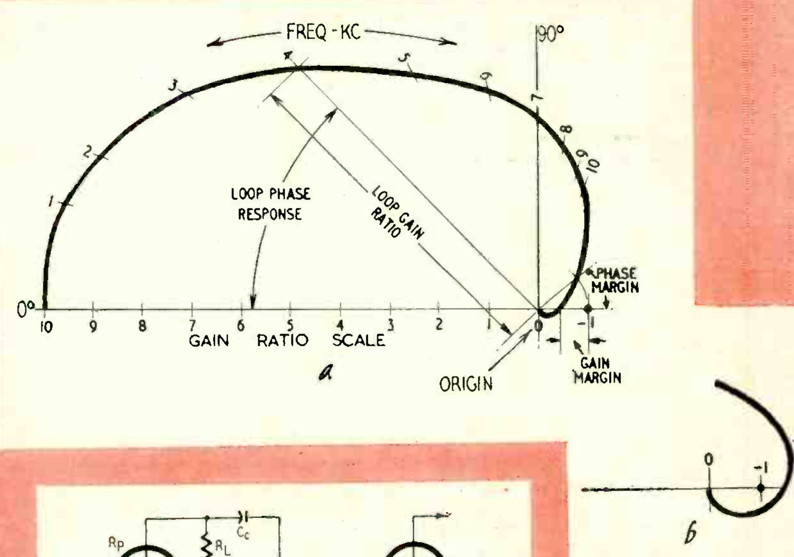


Fig. 5—Nyquist diagrams: a representation of information in Fig. 4; b, curve encircles the critical point, signifying instability. For simplicity, only response above 1 kc is shown.

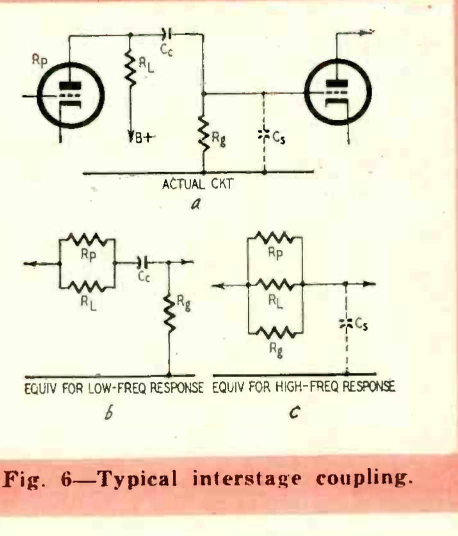


Fig. 6—Typical interstage coupling.

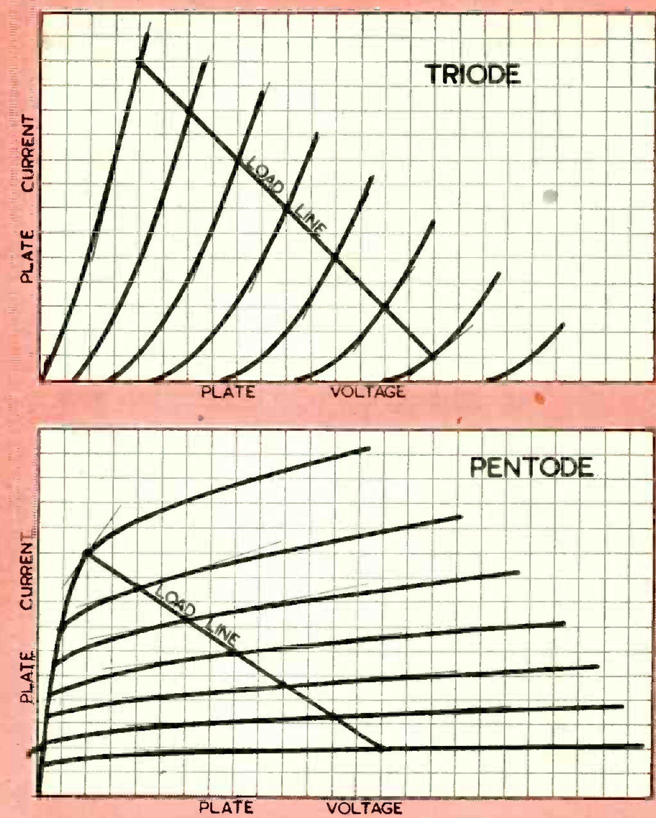


Fig. 7—Plate-current, plate-voltage curves for typical triode and pentode.

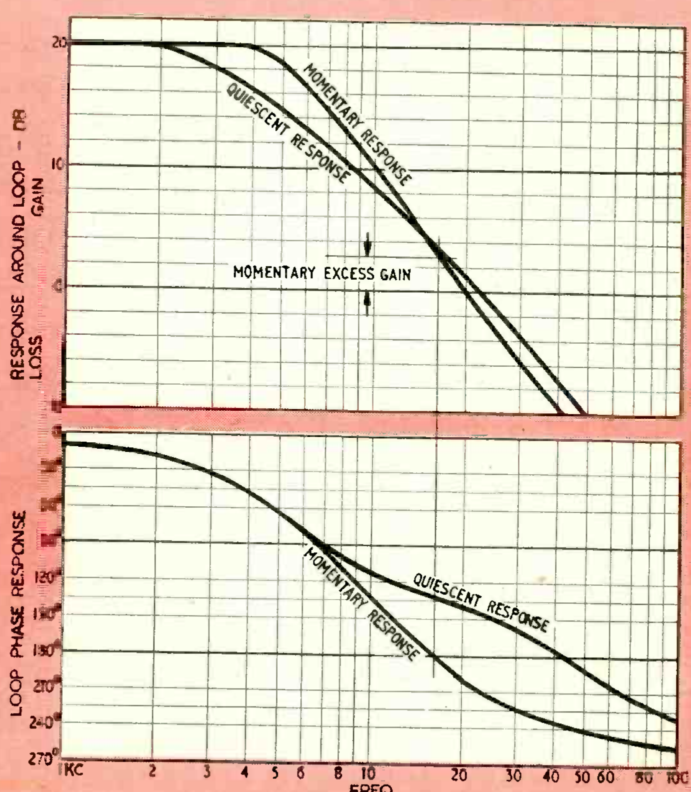


Fig. 8—With small signals response follows *quiescent response.* With large signals response changes *at one point in waveform* to position indicated as *momentary response.*

"Feedback Amplifier Design"*, the roll-off response at each end of the spectrum is contributed to by each of the coupling networks in the amplifier and also by various subsidiary circuitry such as decoupling arrangements. What has not been too clearly explained is how the quantities so contributed can vary with the character of the signal passed through the amplifier in such a manner as to produce some of the kinds of oscillation described.

Take the simple coupling arrangement of Fig. 6-a. Here the relevant quantities are the plate resistance R_p, the plate load resistor R_L, the coupling capacitance C_c and the grid resistor R_g of a following stage. The high-frequency response is controlled by the total stray capacitance C_s.

The low-frequency response is controlled by the relation of the reactance C_c to the total resistance with which it appears to be in series. This consists of R_g on one side and the parallel combination of R_p and R_L on the other side. This is shown at Fig. 6-b.

The high-frequency response is controlled by the relation of the reactance of total stray capacitance C_s to the total circuit resistance with which it appears in parallel. This consists of R_p, R_L and R_g all in parallel (Fig 6-c).

If the amplifier has been designed for minimum distortion, the amplification at all points on a waveform is uniform. Hence the stray capacitance due to Miller effect will be constant so one can regard the reactance component C_s for the high-frequency roll-off as remaining constant under all conditions. The reactance C_c for the low-frequency is naturally constant.

The quantity that varies is R_p. This is illustrated in Fig. 7 for both the pentode and triode. At different points along a load line the value of R_p is represented by the slope at which the characteristics, representing plate current and plate voltage variation for different fixed values of grid voltage, cross the load line. Although the load line has been chosen for minimum distortion in such a way that the intersection points along it representing equal steps in grid voltage are at uniform intervals—which is the condition for minimizing distortion—very often the angle at which the curves cross the load line is not uniform.

This means that the value of R_p in the computation of frequency response will vary *at different points on the audio waveform* although the overall gain does not vary. Multiply this effect by the number of stages in the amplifier and the result is that the amplitude phase characteristic can vary considerably at different points on the audio waveform. This is illustrated in Fig. 8 and the corresponding effect on the Nyquist diagram is shown in Fig. 9.

Another factor that can vary with different points on the waveform is

* RADIO-ELECTRONICS, Oct., 1950–Nov., 1951. Included in *High-Fidelity Circuit Design.* Gernsback Library, Book 56.

the primary inductance of a transformer since it is not constant as the current through it varies. This particularly applies to an output transformer where the instantaneous values of inductance may change throughout an audio waveform.

From cause to effect

Now how does this explain the different phenomena that we have listed? First the case of the parasitic oscillation shown in Fig. 3.

This is usually caused by the change of plate resistance that occurs in some single-ended part of the amplifier. It will shift the time constants of the high-frequency rolloff at various points in the waveform and the response will go beyond the stability criterion in one direction of the audio signal fluctuation. This causes oscillation at a high frequency to appear at this point on the waveform, the frequency being controlled by the point at which the Nyquist diagram goes beyond the stability criterion. As the waveform causing this variation in transfer response returns toward the quiescent zero of the system, the loop gain characteristic returns to the stable side of the stability criterion and the oscillation dies.

The next case is the amplifier that oscillates when more than a small signal is passed through it.

This can happen in an amplifier that uses tetrodes and pentodes in class-AB push-pull for the output stage. Here the plate resistance, during the quiescent condition, is very much higher than when a signal passes through, causing the plate currents to swing up into the working range of each tube. This means that, not only does the value of R_p change during the waveform, but its *average value* throughout the entire waveform falls. Thus the average response throughout the waveform changes. This may well result in the overall loop gain curve moving over to an average condition where it encircles the critical point at which instability begins. Once this happens the high-frequency oscillation maintains this operating condition within the amplifier and the oscillation continues indefinitely or until the amplifier is switched off.

The other form of oscillation caused in this way is one that has been described before and is ascribed to a condition demonstrated with the Nyquist diagram as being conditional stability. If the attenuation and phase characteristics are such (Fig. 10) that the response goes around the point *without enclosing it*, the amplifier, while operating under this condition, cannot oscillate. But if the gain is reduced by any cause so the amplitude of the whole curve drops, the curve will then enclose the critical point for stability and oscillation starts.

Once oscillation commences there is sufficient gain in this amplifier to set up a saturating oscillation. This produces something like square waves and the gain during the whole period of the square-wave oscillation averages out so as to keep the Nyquist curve in a position to maintain oscillation.

Viewed otherwise, the gain changes during this square-wave oscillation, being at a maximum during the steep side and falling away at the top because of the saturation condition. This fluctuation of gain throughout the waveform maintains the peculiar form of oscillation that results.

However you explain it, the result is that the amplifier breaks into oscillation as soon as clipping occurs because, during the instant of clipping, the gain of the amplifier momentarily disappears and this is all that is needed to initiate this kind of instability.

The cure

The remedy for all these kinds of instability is much the same as for the continuous kind: Attention to the different circuits of the amplifier to produce a condition where the whole system is *inherently* stable. Any kind of conditional or parasitic oscillation is really a marginal condition that does not quite succeed in being continuously unstable. What is needed is a safer working margin.

The approach to this is to change the circuit values so as to obtain a greater spread in the time constants contributed by all the components that cause the rolloff attenuation and phase shift. This makes the rolloff more gradual so that a greater degree of attenuation can occur before the phase shift becomes as big.

There are a variety of ways to tackle this. But unless we want to get into a complete design problem the simplest way is to just try changing various values and see which ones appear critical and which do not seem to help appreciably. The ones that appear critical are the best bets to proceed with to find a value that gives a good margin of safety.

The high-frequency blocking form of oscillation may not be due to instability around the complete loop. It can often happen just in the output stage or in any single stage of the amplifier, due to a tuned-plate tuned-grid effect. This occurs at some very high frequency, the inductance of the plate lead with the plate capacitance forming one tuned circuit while the inductance of the grid lead with its effective capacitance to ground forms the other.

This is particularly liable to happen with many of the high-efficiency tubes, and the best remedy is a well known one: inserting suitable antiparasitic resistors in the grid and plate circuits. Suitable values are from 5,000 to 50,000 ohms in the grid circuit and from 100 to 500 ohms in the plate circuit. Similar resistors sometimes help in the screen circuit.

The important thing is that the resistors be connected as close as possible to the tube pins themselves—it is the actual lead that forms the inductance of the tuned circuit and the resistance must be placed between the tube and the inductance that causes the trouble. The capacitance is built into the tube so it cannot be isolated.

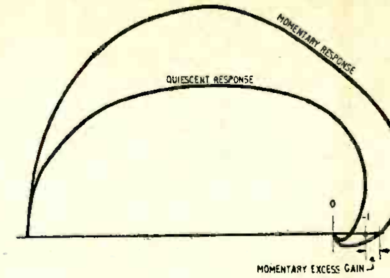


Fig. 9—Information of Fig. 8 converted into Nyquist diagram form.

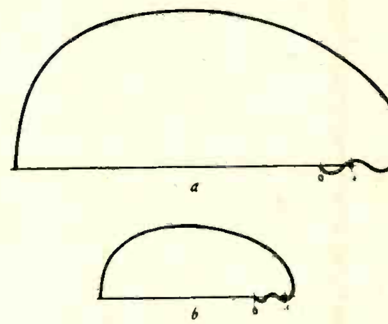


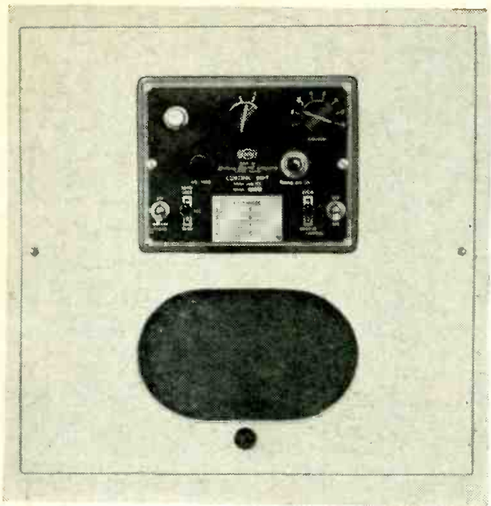
Fig. 10—Nyquist diagram illustrates form of conditional stability: a, amplifier is stable because loop goes inside –1 point; b, reducing gain of amplifier to one-half makes it unstable.

Motorboating usually is due to decoupling circuits. The inaudible type of motorboating, however, may be due to a bad choice of coupling components which can cause an almost perfect sine wave at a very low frequency due to the amplifier's becoming unstable. This is not uncommon in feedback amplifiers. The cure for this is changing various coupling capacitor values until a suitable combination is found that gives sufficient spread to get rid of the gain before the phase shift gets too big.

The audible variety of motorboating that goes plop, plop is more often due to bad decoupling arrangements somewhere. The best cure is to try various decoupling capacitor values. If this does not correct the trouble, try a different decoupling arrangement.

Remember that two stages together cannot be unstable by themselves. Instability of this kind occurs due to the fluctuations in the third-stage plate circuit feeding back to the plate circuit of the first stage, or some similar arrangement. This means that, combining the decoupling of the second and third stages of a three-stage amplifier, or maybe operating them both without decoupling and using decoupling just for the first stage, may give the best cure for this kind of instability.

Sometimes the more elaborate the precautions taken to safeguard the situation, the more unexpectedly oscillation turns up. The simplest circuit is usually the best circuit. END



The control unit and the master speaker recessed in the kitchen wall.

Complete Home Intercom System

By JOHN F. MILLAR

My wife and I first discussed having an intercom in our new home several years ago, when the house was still in the sketch and planning stage. The original idea was to have a simple two-way hookup between a kitchen master station and each of the other rooms, including the basement workroom and the children's basement playroom. Further thought suggested that an alternate master station in the living room would be useful during the evening when the children would be upstairs so that they could call Mother or Dad in the living room without shouting down the stairway. It also seemed logical to include another alternate master on the second floor.

So the plan now called for three master stations and six substations. To keep the cost to a reasonable figure I decided that only one amplifier would be used and the alternate masters would be connected by suitable switching circuits at the kitchen control panel. My wife suggested that the system could also be used to distribute the living room radio program as there would be a speaker located in every room.

The next problem considered was the type of wiring. Fortunately, I came across some shielded cables at surplus prices. A heavy-duty military type, they were available in 14-foot lengths with either two or six conductors. They were ideal for the purpose so a wiring diagram was drawn up and enough cable purchased to install in the walls of the house when it reached the 2-by-4 stage.

Pairs of cables (a two- and a six-conductor) were run vertically from the second floor to the basement and terminated in each room in standard electrical outlet boxes. Provision was made at this time for the amplifier to be located on the upper shelf of one of the kitchen cupboards and the master control panel to be recessed in one of the kitchen walls. Cables were run between these points and also to the basement so that later the whole system could be connected by joining the wires in the basement. The final cable connections are shown in block diagram form in Fig. 1.

Circuit development

After the house was finished the time arrived for the design and construction of the intercom units. A fairly large number of switchings would be needed to change from one function to another and it was of course essential that operation be simple so that the children would find it easy to use. Accordingly, I decided to use relays for the control circuits and arrange things so that only a simple push-to-talk switch could be needed at each substation. The development of the circuits is shown in Figs. 2, 3 and 4.

Fig. 2 indicates the three functions required. Fig. 2-a represents the normal condition (radio distribution) — each station is connected to the amplifier output and the radio program line to the input. Fig. 2-b shows the master speaker only connected to the amplifier output and receiving a call from a substation connected to the input. Fig. 2-c shows the master station calling a selected substation. Wiring to the substations for conditions A and B can be satisfied by one wire common to all substations. Condition C requires a separate wire to each substation. A ground return wire is common to all three conditions and all stations. For relay control, an extra wire (not shown) is needed, common to all stations. Thus each substation requires a total of four

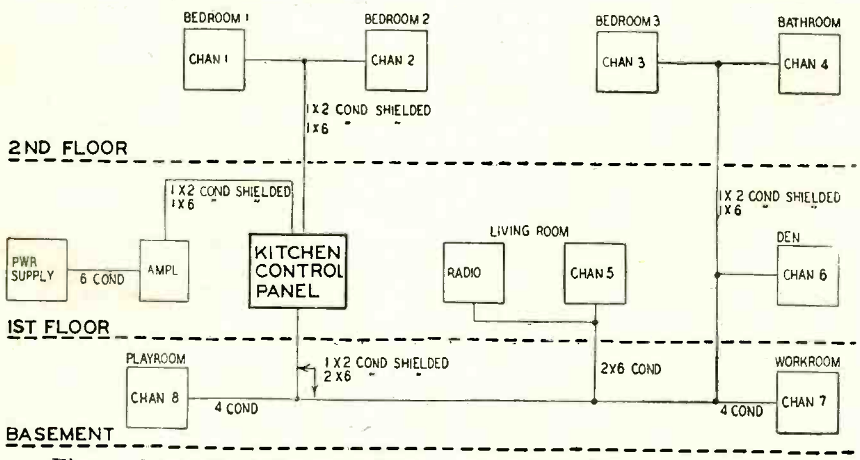


Fig. 1—Basic block diagram shows cable connections between rooms.

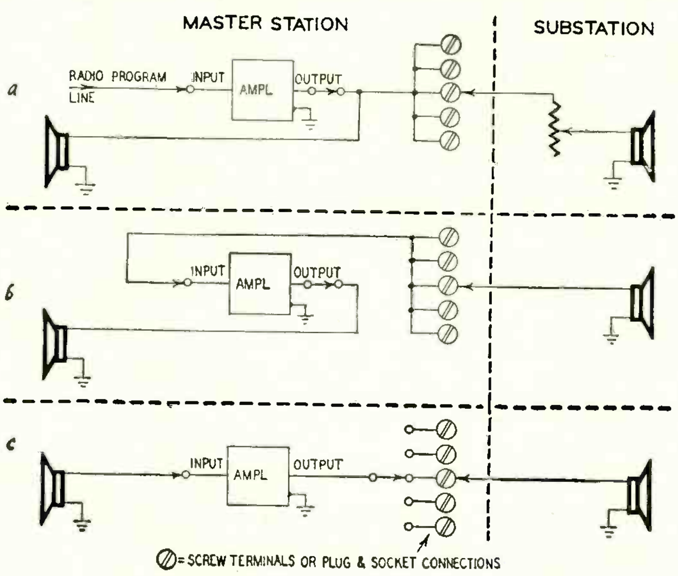
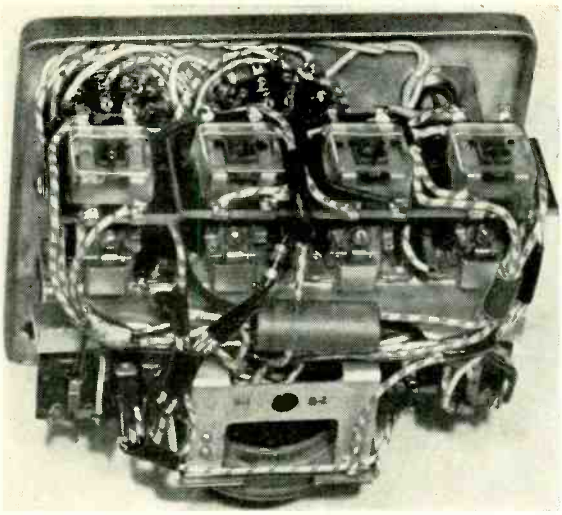
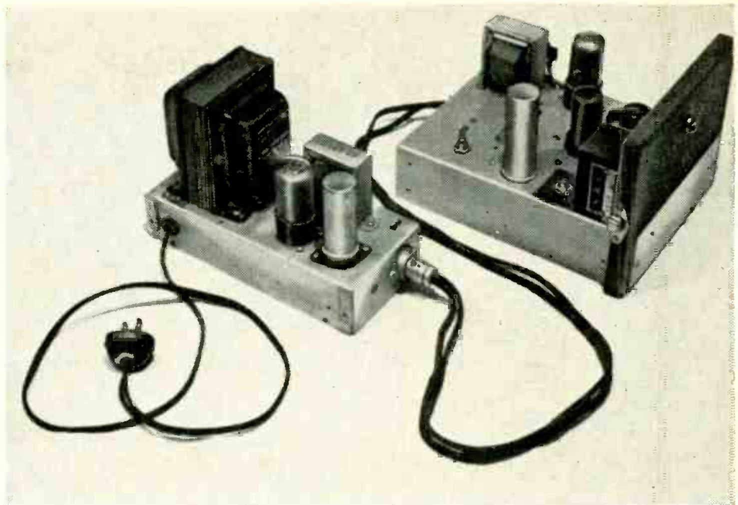


Fig. 2—Operating conditions of system.



Rear view of control unit.



Top view of amplifier and power supply.

wires—one private line for receiving calls and three common lines, namely, a combined *talk* and *radio program*, a relay control and a ground return.

Fig. 3 shows a practical circuit which combines all three sets of conditions of Fig. 2 for a master station and a typical substation. *This is the basic circuit of our system.* For clarity, separate spdt switches are shown in the diagram. In practice these could be contacts on two multicircuit relays. Switches S1, 2 and 3 change the circuit from *radio* to *intercom;* switches 4 and 5 reverse the input and output connections of master and substation for intercom use. The operation of this circuit is as follows:

1. With the switches in the positions shown, the input of the amplifier is connected to the radio input line and the output is connected to all stations in parallel so that any station can receive the radio program through an individual volume control.

2. To originate a call from the master to a substation, switch 6 (a spst spring-loaded type) is depressed to the talk position and shorts out both relay coils. This reverses all contacts of switches 1 to 5, changing the circuit from *radio* to *intercom* and connecting the amplifier input to the master speaker. The output is connected to the substation selected by switch 7.

3. To answer the call or originate a call at the substation, switch 8 is depressed to the TALK position. Its upper section connects the speaker directly to the talk line (bypassing the volume control) while at the same time its lower section shorts out the relay coil controlling switches 1, 2 and 3, reversing their contacts and connecting the talk line to the amplifier input and the master speaker to the output. Switch 8 at the substation is a two-circuit three-position lever switch with the lower position spring-loaded. Note that the substation can receive a call with switch 8 in either the RADIO or LISTEN position.

With this circuit operating controls are reduced to a minimum. Those at the master station are the push-to-talk switch (S6), the channel selector (S7) and the radio volume control. At the substation only S8 and the volume control are needed.

Final control circuit

In the final version of the system (Fig. 4) the circuit is essentially that of Fig. 3 with the added elements required to control the *remote master* stations. Relay contacts and their associated coils have corresponding numbers. The dpdt relays (RY2, 5 and the upper section of 6) correspond to switches 1 to 5 of Fig. 3. Switch 3 is the master talk–listen switch corresponding to switch 6 of Fig. 3. Switch 3 can short out the coils of both relays 5 and 6 while a substation through the relay control line can short out relay 6 only. The lower section of relay 6 actuates relays 1 and 2 which change the circuit from radio to intercom. Relay 1, actually located on the amplifier chassis, is needed to modify the input circuit of the amplifier when changing from radio to intercom. Switch 4 is the channel selector of the master station.

Operation is the same as that described for Fig. 3—operation of a talk–listen switch at both master and substation for two-way conversation.

The important difference between the two circuits is that, in Fig. 4, master control can be transferred to either of two remote points (channel 1 or 5) by switches 1 and 2. When switch 1 is changed from the local to the remote position, the circuit is modified as follows:

1. Relay 4 is actuated to transfer the intercom output from the kitchen speaker to that of either channel 1 or 5 via S2-b and the channel selection of S4 to either of the remote selector switches via S2-a.

2. At the same time control of relays 5 and 6 is shifted to the relay control lines of either channel 1 or 5 via switches 1-c, 2-d and 2-e.

3. Switch 3 is shifted to the top of relay 3 via S1-b so that the kitchen master can overrule the remote master setting and still originate calls.

4. If channel 1 has been selected for remote master operation by S2, relay 3 is actuated by S2-c to transfer the radio line of channel 1 to a point separate to that of the other substations to prevent feedback during intercom operations.

Remote master 1 (in the parents' bedroom on the second floor) has only three output channels. These include the kitchen channels 6 and 7 to the basement workroom and the den. There is no need for this master to cover the second-floor rooms. The living room

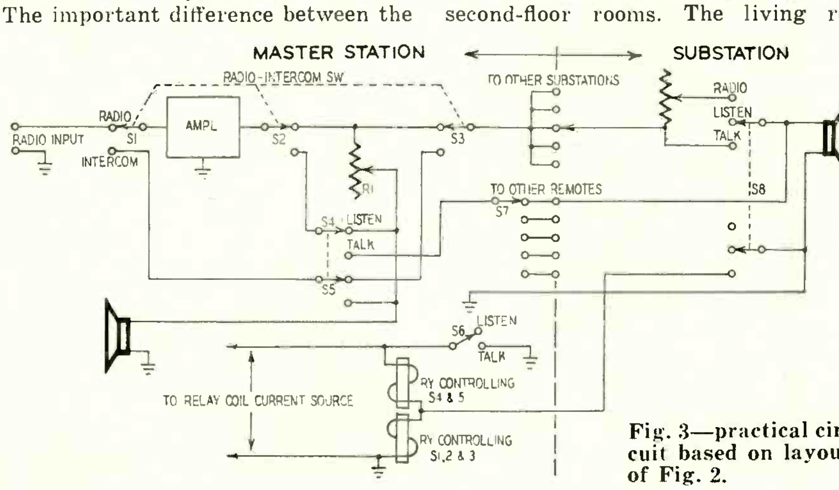


Fig. 3—practical circuit based on layout of Fig. 2.

master (channel 5), on the other hand, has six output channels, omitting only the kitchen and the bathroom. This station requires no radio line so only a spst spring-loaded lever switch is needed for intercom operation.

The relays are mostly surplus dpdt units with a coil resistance of 250 ohms. They were originally intended for 24-volt service, requiring a current of 96 ma. However, by slightly reducing the tension of their springs, it was possible to make them pull in sharply with 70 ma. This operating current is obtained by placing the relay coils in series in the negative side of the power supply, essentially as shown in Fig. 5.

The capacitors across the coils (Fig. 4) reduce thumps in the system; the 47-ohm resistors in series with the control switch contacts prevent sparking. *The diagram indicates unenergized relay coils by showing the contacts in the upper position.* The relays are so arranged that, when 5 and 6 are shorted out, 1 and 2 are inserted in the circuit so that voltage surges through the power supply are minimized.

Amplifier and power supply

Fig. 6 shows the circuits of the amplifier and power supply. The amplifier consists of a 6SJ7 voltage amplifier feeding a 6J5 driver and a 6V6 output stage. Because the amplifier was to be used for music as well as an intercom, it was necessary to improve the frequency response and reduce distortion. This is done with a corrective filter across the primary of the output transformer and inverse feedback from the voice coil winding back to the cathode of the 6J5. The values shown were determined with the help of a square-wave generator and an oscilloscope to obtain a flat response of the 6J5 and 6V6 stages from 60 to 12,000 cycles, using a single speaker as load.

Additional frequency correction is used at the input for both radio and intercom. Treble boost of the radio input compensates for the loss at the grid of the 6J5 due to the .001-μf shunt capacitor. This capacitor prevents oscillation during intercom operation due to stray feedback in the cables. The values of the frequency-correction network at the intercom input were determined from listening tests to obtain the most natural response from the substation "microphones."

The primary of the intercom input transformer is grounded only at the common ground tiepoint at the control unit. This is essential to prevent feedback which will occur if the input and output circuits simultaneously share a

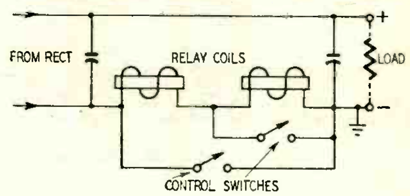


Fig. 5—diagram shows basic circuit for energizing the relay coils.

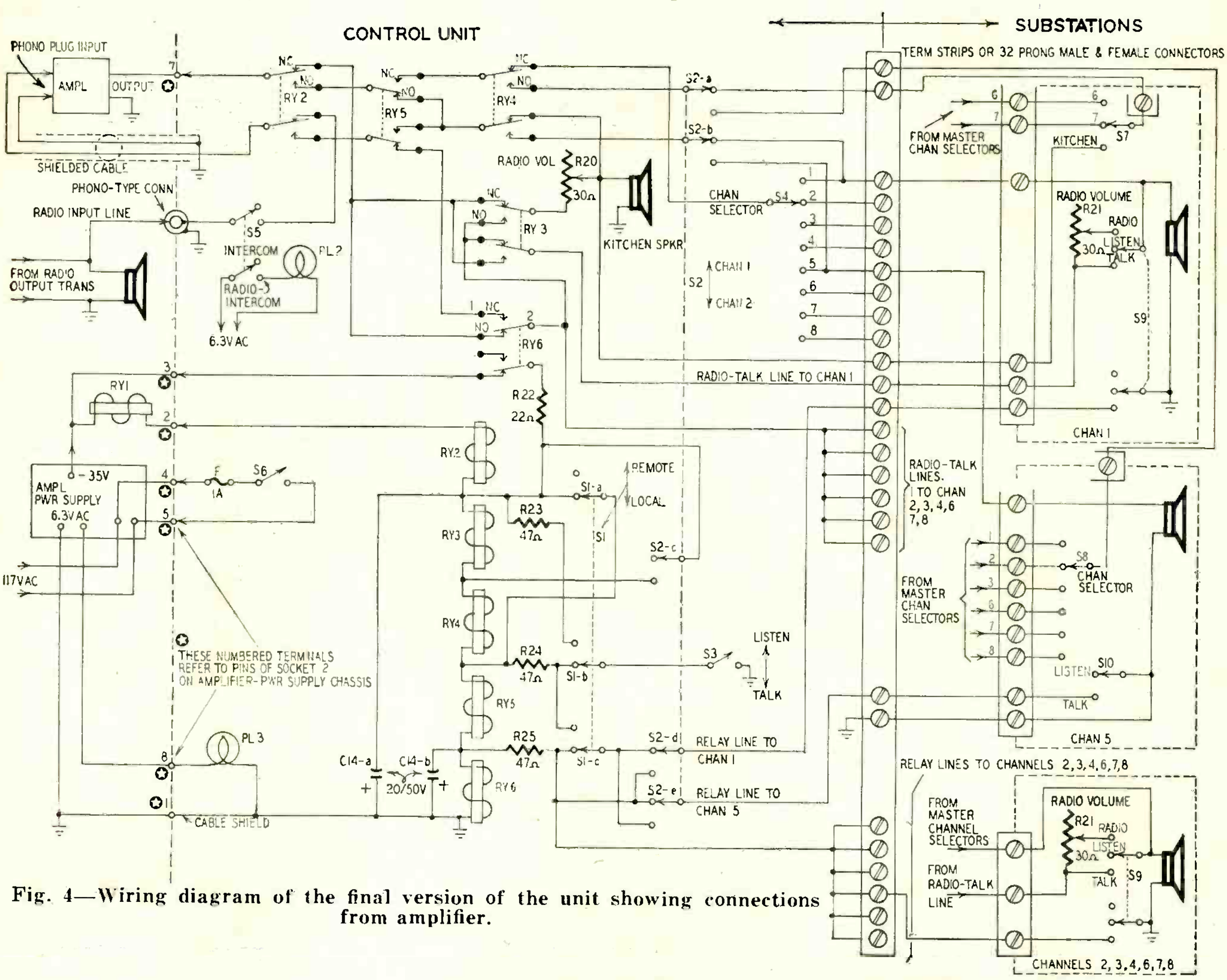
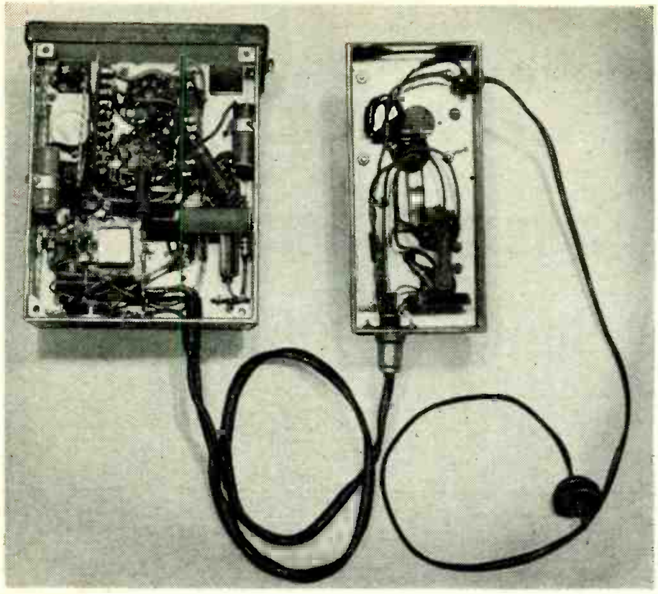


Fig. 4—Wiring diagram of the final version of the unit showing connections from amplifier.

R20—30 ohms, wirewound rheostat
R21—30 ohms, wirewound rheostat (7 or as needed for remotes)
R22—22 ohms
R23, 24, 25—47 ohms
All resistors ½ watt
C14—20-20 μf, 50 volts, electrolytic
PL2, 3—pilot lamps and assemblies
F—1-amp fuse and holder
RY2, 3, 4, 5, 6—surplus dpdt relays, coil resistance 250 ohms (see text)
S1—3-pole 2-position switch, nonshorting
S2—5-pole 2-position switch
S3—spst switch, normally open, spring-loaded
S4—1-pole 8-position rotary switch
S5—dpst switch
S6—spst switch
S7—1-pole 3-position rotary switch
S8—1-pole 6-position rotary switch
S9—2-pole 3-position lever switch, positive indexing in top position; spring return from bottom to center position
S10—spst momentary or push-button switch
Chassis for control unit
5-inch speakers, as needed
Outlets for substations, 4-pin miniature sockets (see text)
Length of 4-conductor cable with 4-pin plug, for substations
Cabinets for substations



Amplifier and power supply—underchassis.

common wire more than 2 or 3 inches long. This problem was encountered in setting up the remote master circuit for channel 5 and necessitated a separate ground return line for this station as shown in Fig. 4.

The power supply is conventional except for the resistive input to the filter, which helps reduce the peak current demand, prolonging the life of the rectifier tube. This 1,000-ohm resistor is also part of the voltage divider needed to obtain the 250 volts required for the amplifier. The 10-watt 20,000-ohm resistor at the amplifier and the relay coils form the balance of the voltage divider. The combination provides a total current through the relay coils of 70 ma, needed for good snap action of the relays.

Hum problems were minimized by building the power supply and amplifier as separate units. They are placed on the cupboard shelf about 12 inches apart.

A six-wire cable connects the power supply and amplifier and also passes on the connections for the line switch to socket 2 of the amplifier. The connections from the amplifier to the control unit are picked up through an octal plug on the end of a six-conductor shielded cable which enters the kitchen wall at the amplifier shelf. The input connection from the control unit to the amplifier is made through a two-wire shielded cable terminated in a phono plug.

Construction details

The control unit is built into a surplus Bendix control box which contained many of the required parts when purchased. These included lever switches 1 and 3, rotary switches 2 and 4, toggle switches 5 and 6, pilot light 3 and the fuse. The Bendix control box also had a 37-pin Cannon plug for cable connections. I was able to locate the correct matching socket so that the problem of terminating the 32 wires entering the control unit was considerably simplified.

The relays are mounted in line on a piece of aluminum bent to a U shape. Wiring and lead dress are not critical as the audio circuits at this point are all low-impedance. The only circuit problem is arranging the wiring so that the grounded side of the 6.3-volt pilot-light circuits is not common to any part of the audio input circuit, thus avoiding 60-cycle hum.

The shields of the seven cables entering the socket at the control unit are bonded together and connected to three separate pins to minimize contact resistance.

The outlets for the substations in each room are four-pin miniature Amphenol sockets (type 71CPG4) mounted on small aluminum plates attached to the outlet boxes. The plates, painted to match the walls, are inconspicuous. The substation speakers are low-priced 5-inch PM types with 3.2-ohm voice coils. Housed in small walnut cabinets, each has an 8-foot length of four-wire cable terminated in a four-pin Amphenol plug (type 91MPM/4L) to fit the wall-mounted sockets.

The speaker cabinets are enclosed at the back with Masonite panels lined with a sound-absorbing wadded paper (Kimpak). Totally enclosing the cabinets in this way provided a considerable improvement in the low-frequency response.

The speaker in the basement playroom is mounted on a panel recessed flush with the wall for better appearance. The workroom unit is panel-mounted on the workbench.

The radio volume controls at each speaker are small 30-ohm wirewound rheostats and the lever switches are Centralab No. 1477. END

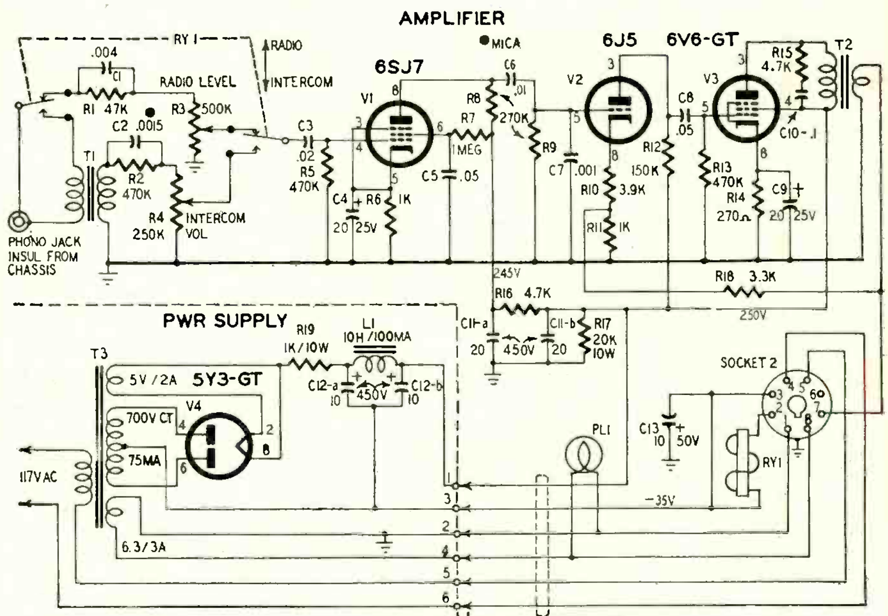


Fig. 6—Schematic diagram of amplifier and power supply, and connections.

R1—47,000 ohms
R2—470,000 ohms
R3—500,000 ohm pot
R4—250,000-ohm pot
R5—470,000 ohms
R6, R11—1,000 ohms
R7—1 megohm
R8, R9—270,000 ohms
R10—3,900 ohms
R12—150,000 ohms
R13—470,000 ohms
R14—270 ohms
R15—4,700 ohms
R16—4,700 ohms
R17—20,000 ohms, 10 watts
R18—3,300 ohms
R19—1,000 ohms, 10 watts
All resistors ½ watt unless noted
C1—.004 µf
C2—.0015 µf
C3—.02 µf
C4—20 µf, 25 volts, electrolytic
C5, C8—.05 µf
C6—.01 µf
C7—.001 µf
C9—20 µf, 25 volts, electrolytic
C10—0.1 µf
C11—20-20 µ, 450 volts, electrolytic
C12—10-10 µf, 450 volts, electrolytic
C13—10 µf, 50 volts, electrolytic
All capacitors 600 volts unless noted
T1—input transformer, voice coil to grid
T2—output transformer, 5,000-ohm primary to 3.2-ohm secondary
T3—power transformer, 700 volts ct @ 75 ma, 5 volts @ 2 amps, 6.3 volts @ 3 amps
L1—choke, 10 henries, 100 ma
Octal sockets (5).
RY1—surplus dpdt relay, coil resistance 250 ohms (see text)
Socket 1, 6 pins
Plug 1, 6 pins
V1—6SJ7
V2—6J5
V3—6V6-GT
V4—5Y3-GT
Socket 2, 8 pins
Length of 6-conductor cable
PL1—pilot lamp and assembly
Chassis for power supply
Chassis for amplifier
Line cord and plug
Phone jack, insulated from chassis

Glorious new sound for motion pictures

By AARON NADELL

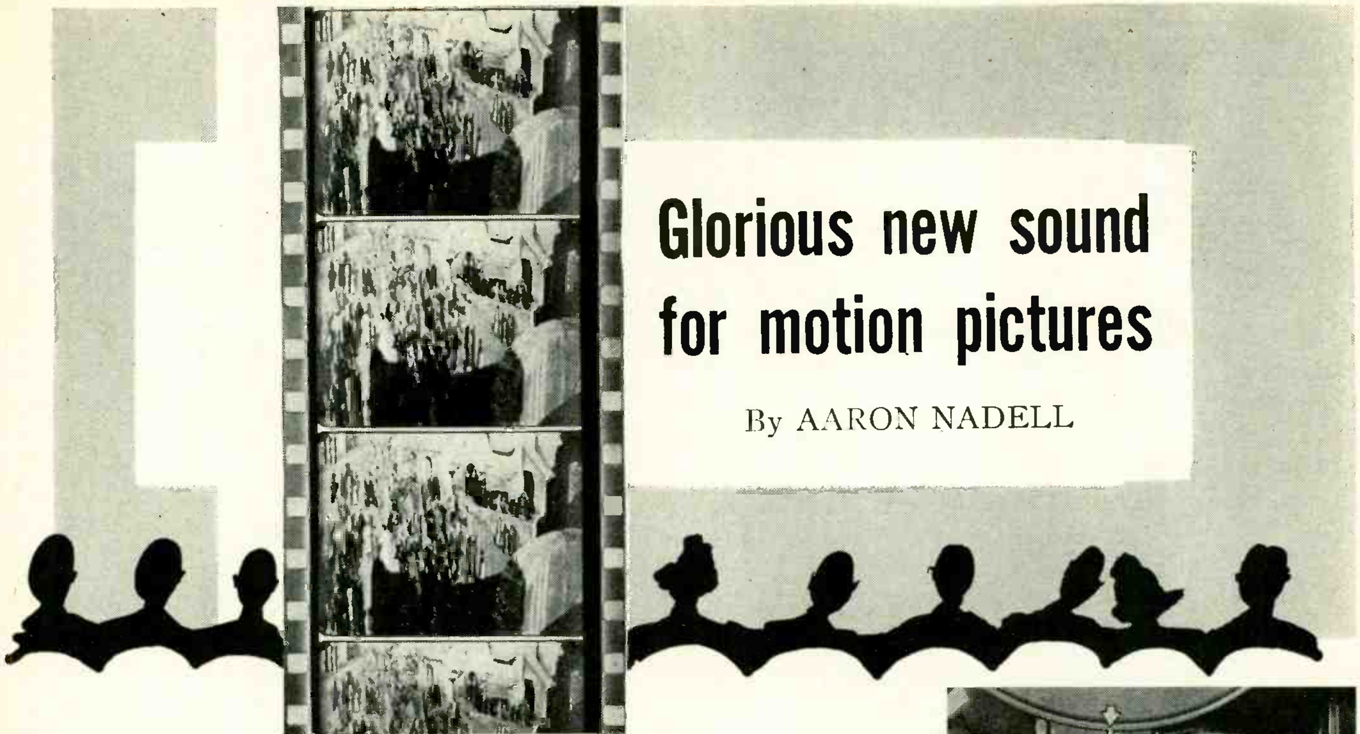


Fig. 1—CinemaScope film with four magnetically recorded soundtracks.

AUDIO reproduction in the motion-picture theater is no longer the straightforward process it used to be. For the past 3 years theater owners, projectionists and sound service personnel have been going through hectic (and expensive) times. Totally new audio equipment is installed, used for a few months, ripped out before it has begun to pay its cost and replaced by still newer contrivances. Electronic devices not known in any other audio-frequency application have been developed specifically for the motion-picture theater.

The Society of Motion Picture & Television Engineers strives to develop performance standards for a situation that does not remain the same long enough to be standardized in any aspect. Showmen spend money as if it were water, re-equipping theaters that have only just been re-equipped. And the public responds by coming to the box office—sometimes.

The cause of this merry-go-round in the theater is the competition of television. Formerly the little inexpensive neighborhood movie was the place to park the kids or to kill an empty evening. Audio quality was good, but not exactly hi fi. Then came TV to provide pretty much the same technique for keeping kids interested and quiet, and to absorb the spare time of older persons. Several thousand smaller theaters closed their doors. Something *had* to be done.

The first things done were described in RADIO-ELECTRONICS, March, 1952, in my article "TV Marries the Movies." The theater industry adopted the ancient and simple principle: "If you can't beat 'em, join 'em." Large-screen TV equipment was developed specifically for the theater. Three systems were evolved. In the simplest, the image on a 7-inch tube, operated at 80 kv, was projected by optical methods to an intensely reflective theater screen. The brightness was inadequate; substitution of the metallized screen for the diffusing screen formerly used in theaters increased brightness in the center seats at a sacrifice of light in the side seats.

For larger theaters the amount of light that could be obtained from a TV tube, even at 80 kv or more, could not begin to compare with the brilliance of a motion-picture arc lamp burning 10 kw. Therefore an indirect method of TV presentation was worked out for larger theaters. The TV receiver was combined with a motion-picture camera and an automatic film developer; a continuous strip of film ran through camera, developer and theater projector. The TV show was photographed as received, automatically developed and projected from film to a theater audience with a time delay measured in seconds.

A third and still more elaborate TV device for theaters was described in RADIO-ELECTRONICS, October, 1952, in an article entitled "The Eidophor Projector." Eidophor, as there explained, is a combination TV receiver, refrigerator, vacuum pump, arc lamp and projection lens system. It utilizes the TV signal to modulate the light of an

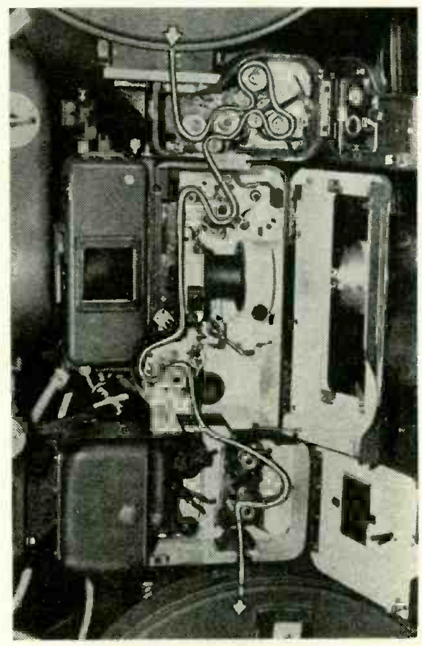


Fig. 2—General Precision "penthouse" four-track magnetic soundhead mounted above International Projector mechanism.

electric arc and thus provide a video image bright enough to fill a large theater screen.

The marriage between TV and the movies failed. Programming was one trouble. Why pay to see it in a theater if you can see it for free at home? The industry's efforts to develop its own programs, which would be available in theaters only, ran into difficulty with transmission costs and FCC regulations. The two methods worked out for large-theater use—the TV-plus-camera method and the Eidophor—were both highly expensive; the former came into limited commercial use for a time; Eidophor to date has not been used commercially.

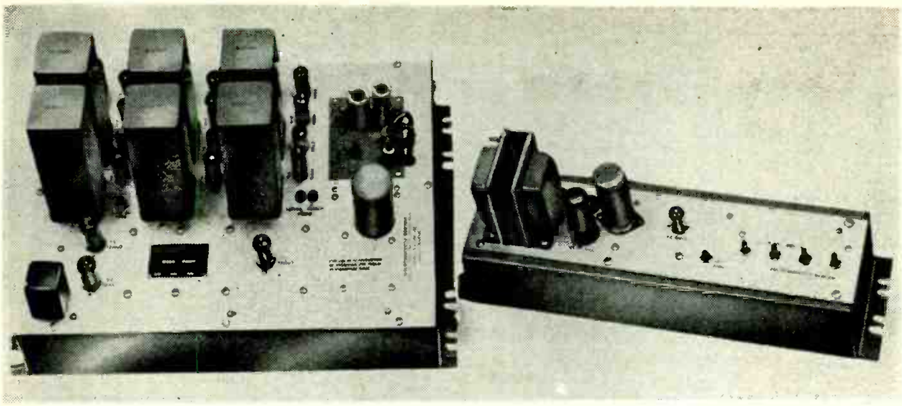


Fig. 3—Fairchild PerspectaSound Integrator handles subaudible frequencies.

Cinerama turned the tide

On Sept. 30, 1952, a new and unheard-of motion picture, with incredibly wonderful audio opened in New York and inaugurated a new era. Cinerama reversed the drooping graph of American theater business and shot it upward. The public stormed to see. People came out at the end of each showing to tell one another with tears in their eyes how wonderful it was! Cinerama's audio is super-hi fi. It is so near to total perfection that Milan's world-famous La Scala opera permitted Cinerama to reproduce the triumphal scene in Aida. The reproduction is such that the Cinerama patron can close his eyes and judging by ears alone almost persuade himself he is really at the opera and not in a movie. The af output at the crescendos must be up in the hundreds of watts—and it is "clean."

The Cinerama system today uses seven microphone channels in recording; seven magnetic soundtracks on a separate, synchronized, 35-mm film; seven theater amplifying channels; five back-screen speakers and two sets of "surround" speakers. Cinerama people claim no audio magic; only the inherent advantages of magnetic recording and amplifiers big enough for their job.

Cinerama as such is not suited to ordinary movie use. It is too vast and overpowering for intimate drama, and it is extremely expensive. For practical purposes it has been followed by CinemaScope ("the poor man's Cinerama"), by three-track stereosound, dimensional sound, Panaphonic sound, PerspectaSound, Warnerphonic sound, etc. The most popular of the new theater sound systems still active are shown in the table.

Multiple-channel audio facilities automatically entail an advantage. Each channel must have enough power to fill the theater while the others are silent. Consequently, when all channels work at once and at full volume the upper limit of the dynamic range is increased several times. In Cinerama and Todd-AO, which use seven and six audio channels, respectively, the total sound power is multiplied by a factor of seven or six. Some forms of CinemaScope utilize four audio soundtracks and four amplifying channels, multiplying the upper limit of the dynamic range by a factor of four. PerspectaSound has only one track, but three amplifying channels.

RECENT THEATRE SOUND

Type	Soundtrack	Tracks	Rate fpm*	Channels
Standard	Optical	1	90	1
Cinerama	Magnetic	7	146.25	7
CinemaScope 35	Magnetic	4	90	4
CinemaScope 55	Magnetic	4	90	4
CinemaScope 35	Optical	1	90	1
PerspectaSound	Optical	1	180	3†
PerspectaSound	Optical	1	90	3
Superscope	Optical	1	90	1
Todd-AO	Magnetic	6	140.6	6
Cinemiracle	Not yet in use; details not yet available. Similar to Cinerama.			

* feet per minute † film runs laterally

Types of dimensional sound

There are two types of dimensional sound in use. One is truly stereophonic, embodying two or more soundtracks which are not identical but represent the sound as it was heard by two or more microphones placed in different locations. These are amplified and reproduced independently, in separate amplifying channels and through separate sets of loudspeakers. The sounds heard by the patron, not only come from different points of origin behind the screen, but differ in pattern.

The other type of dimensional sound is called directional, to distinguish it from true stereophonic sound. There is only one soundtrack—one recording. But there are either two or three amplifying channels and sets of loudspeakers, and the gain in each channel is varied by some form of control recording—in PerspectaSound, for example, by three subaudible control tones which shift the one-track sound between right, center and left channels. The sounds can be made to originate at different points behind the screen but cannot be differentiated according to spatial origin—that is, it is not possible to make the sound of the violins of the orchestra come from one side of the screen and that of the wind instruments from the other, simultaneously, as can be done with a full stereophonic system. The advantages of directional over stereophonic sound lie in the economy of using a single-track sound source and therefore are not very great; nevertheless directional sound is strongly favored by some producers.

CinemaScope. The original CinemaScope, and the type used for some years, was on standard motion-picture film 35 mm wide and could be played through standard projectors, provided these were suitably modified. More recently Twentieth Century-Fox has introduced another size film, 55.625 mm wide. This is called CinemaScope 55.

As can be seen in Fig. 1, the CinemaScope film carries four soundtracks. These are magnetic recordings. Three of them play through three amplifying channels and three sets of back-screen speakers. The fourth track and amplifying channel operate side- and rear-wall speakers for special effects. The narrow track is the special-effects recording.

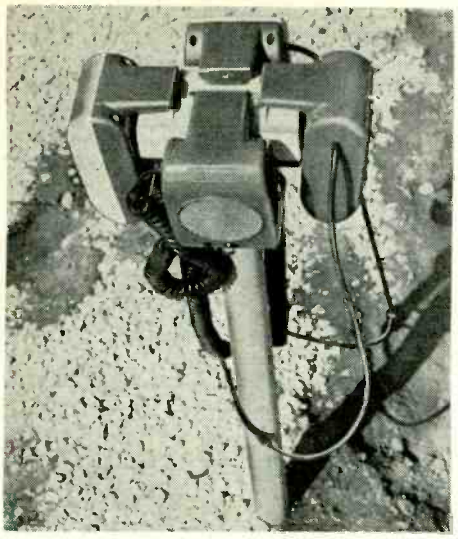
This quadruple CinemaScope soundtrack must be played through a quadruple magnetic reproducer. Fig. 2 shows a "penthouse" soundhead containing such a reproducer installed between the upper (supply) magazine and the projector mechanism. Below the projector mechanism, between it and the lower magazine, is the conventional optical soundhead. The equipment of Fig. 2 can reproduce either conventional single-track optical recordings or CinemaScope quadruple-track magnetic recordings, depending on which type film is threaded in.

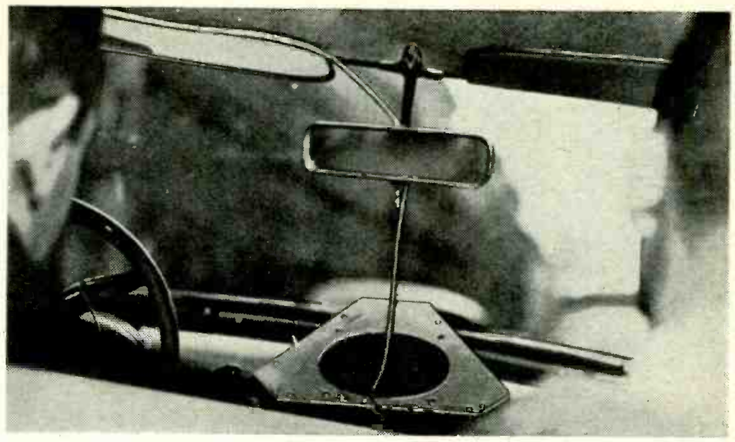
PerspectaSound. Paramount's PerspectaSound is a directional but not stereophonic system. It is associated with a special and different picture system called VistaVision.

PerspectaSound, used with VistaVision prints, is recorded as a single conventional optical track. This track can be played through any conventional theater sound system in the usual way. However, the track also carries three subaudible control frequencies. These frequencies, if they are used, are applied to the "integrator unit" shown in Fig. 3. Through this unit the three special frequencies control the gain of each of three audio channels and thereby create directional sound.

Other recent systems

Todd-AO (named for Michael Todd and American Optical Co., its sponsors) represents a successful effort to capture the major attractions of Cinerama while eliminating some of the drawbacks. The screen is deeply curved. There are six magnetic soundtracks, five controlling five sets of speakers located behind the screen and the sixth for the "surround" speakers located on the side and rear walls. There is, however, only a single projector and single arc lamp. Thus the difficulties of keeping a triplex projection system perfectly matched are eliminated. The Todd-AO projection print is double the usual width; that is, 70 instead of 35 mm. Of the six magnetic tracks two





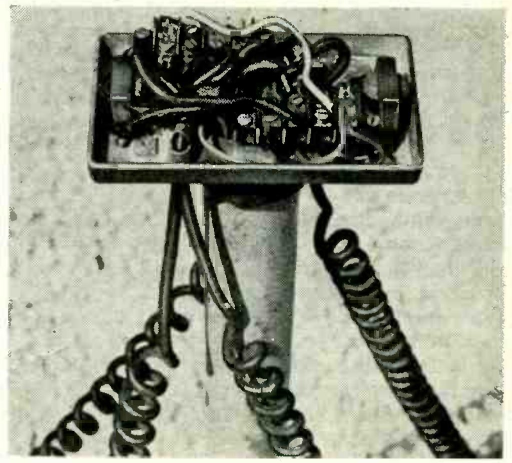


Fig. 4 (top left)—Stereosound for automobiles—speakers are distinguished by face colors.

Fig. 5 (above)—Three speakers are in single assembly; use single volume control. Other two are at sides.

Fig. 6 (right)—Connections for Fig. 4 setup.

are outside each line of sprocket holes, between them and the film edges; one inside each line of sprocket holes, between them and the line of pictures.

Superscope is a system combining essentially the laterally compressed picture of CinemaScope with a single optical soundtrack and thus is very similar to CinemaScope 35 Optical. Superscope sound is conventional.

Warner Brothers some years ago introduced a system of directional sound called Vitasound. It consisted of a single optical soundtrack plus a second or control recording and thus greatly resembled the PerspectaSound which Paramount subsequently developed. But, instead of subaudible frequencies recorded in the optical track, Vitasound used one line of sprocket holes for the location of the control track (the control track occupied the available space between each sprocket hole and the next). The discontinuity introduced into the control recording by the sprocket holes which interrupted it was treated as a low-frequency modulation and filtered off. The higher frequencies of the control recording were then used to vary the volume of sound and to switch sound from speaker to speaker.

Subsequently Warner brought out a full sterophonic system called Warnerphonic, utilizing four magnetic tracks recorded on a separate 35-mm film. These are reproduced on a rack which is physically isolated from the projector but synchronized with it.

Panaphonic sound achieved directional results with only one amplifier channel but three or four sets of loudspeakers. The amplifier output was switched back and forth among the speakers by relays. The relays were operated by two control tracks, located one in each sprocket hole line, and by two photoelectric cells responsive to the two control tracks.

Stereosound

Among the operational problems of stereosound is the still largely unsolved riddle of how to reconcile multiple sound sources with common auditorium acoustics. This is a problem unknown to those who concern themselves only with living-room audio problems. A living room, being comparatively small, has a reverberation time of only a small fraction of a second. But in a large theater the normal reverberation time is several seconds and acoustical difficulties proportionately harder to overcome. Even with old-fashioned single-channel sound it may prove troublesome to obtain equal distribution of volume, at all frequencies, throughout the whole seating area. To accomplish this—to punch enough sound into corners or under an overhanging balcony—it is sometimes necessary to orient a speaker so some of its sound will be reflected into the weak area from a convenient wall surface. Another trick, occasionally used when single-channel systems are equipped with multiple back-screen speakers wired in parallel, is to "cross" the speakers so the one on the right supplies sound to the left side of the theater and vice versa—utterly fatal to dimensional illusion!

Stereosound in automobiles?

It might seem that the last theater to install stereosound would be a drive-in. How is the illusion of directionality to be achieved in the constricted interior of the patron's car? And why is it wanted? Yet inventors have devised ways to get stereosound into autos.

Two contrivances to that end are pictured in Figs. 4 and 5. One is the simple arrangement of putting four speakers instead of two on each speaker post, as in Fig. 4. The patron must be careful to select a right and a left speaker (they are appropriately distinguished), instead of two rights or two lefts, and hang them on his left and right car doors. Fig. 6 shows the speaker post connection box of Fig. 4 opened for servicing.

A second way to put sterosound into the automobile is represented by the equipment item of Fig. 5. This consists of three speakers built into a single unit. The patron takes only one item into his car and places it at approximately the center of the windshield.

The model shown in Fig. 5—Ampex Corporation's—is so built that the two wing speakers face the windshield and their sound is reflected from the windshield to opposite sides of the car interior.

Shape of things to come

At the moment of writing, evolution of new audio procedures for both outdoor and indoor theaters has simmered down, temporarily at least, to a point where it is possible to report what has been happening. For nearly 3 years that was not possible; changes came so fast that a report of them would have been obsolete before it reached print! Only one group of persons, however, can decide whether the present lull will prove brief or permanent—the persons who buy (or don't buy) theater tickets. END

High Fidelity GROWS UP

High-Fidelity Show—AES convention in New York notes steady improvements rather than "revolutionary advances."

By ERIC LESLIE

COMPARED to earlier Audio Shows or Fairs, maturity was the one salient characteristic of the New York High-Fidelity Show held in the Trade Show Building, New York City, at the end of last September. A far cry from the screaming exhibition which only a few years ago was considered a high-fidelity show, this was for the most part a demonstration of equipment constructed for the serious home owner and listener and designed for his living room.

The tendency to package audio in one or two pieces of furniture was marked. But old customs die hard, and the information-room attendant was heard advising one would-be purchaser of a \$1500 TV–tape recorder–player–record player–amplifier–enclosure combination that the only way to get true high fidelity was to listen to the separate units and select an ensemble that matched and suited him. More than one music lover, however, appeared to be willing to let the manufacturer's experts do the matching and to trust that what suited them might suit him.

With increasing stress on the everyday aspects of music and sound, the sensational and experimental angles were proportionately de-emphasized. No startling or revolutionary developments were unveiled. Nearest thing was the demonstration by Pickering and JansZen of low-frequency electrostatic speakers (Both had exhibited high-frequency units at last year's show). Weathers of pickup fame also showed a speaker which many at first took to be electrostatic, both from its appearance and sound. However, it used several near-conventional units in a large flat enclosure of unconventional design.

Amplifiers trended toward increased power, those which come first to mind being the Fisher 90-watt laboratory amplifier, the H. H. Scott 80- and 40-watt units and the Dynakit printed-circuit 50-watt amplifier for the do-it-yourself listener.

If components showed no startling advances, demonstration methods did. Accent was on music, not effects. Though levels were occasionally fairly high, there was none of the ear-splitting "brilliance" of earlier shows. Several manufacturers held informal lectures, classes or mass demonstrations to seated audiences. Among the most ambitious of these were Electro-Voice and University, who A–B'ed various setups of equipment and showed the consumer, not only what he might get for various sums of money, but just how it might sound.

One exhibition room—that of Masco—departed entirely from tradition, with dim lighting, tall candles, candies and nuts on a linen-laid table, a tall fountain and stacked chrysanthemums, with just enough functioning audio equipment to provide incidental music. A modest display of complete home radio–audio–intercom systems, with equipment and floor plans so arranged around the walls as not to obtrude, completed the display.

Maximillian Weil (Audak) again proved that recording has approached the 100% fidelity point, with a concert cellist playing an interrupted duet with her own disc recording. A little strategy was used (she invariably stopped during a crescendo and joined the record again during a low passage) with the result that it was impossible for a person in the fifth row to tell without the aid of his eyes just when the cello started and stopped.

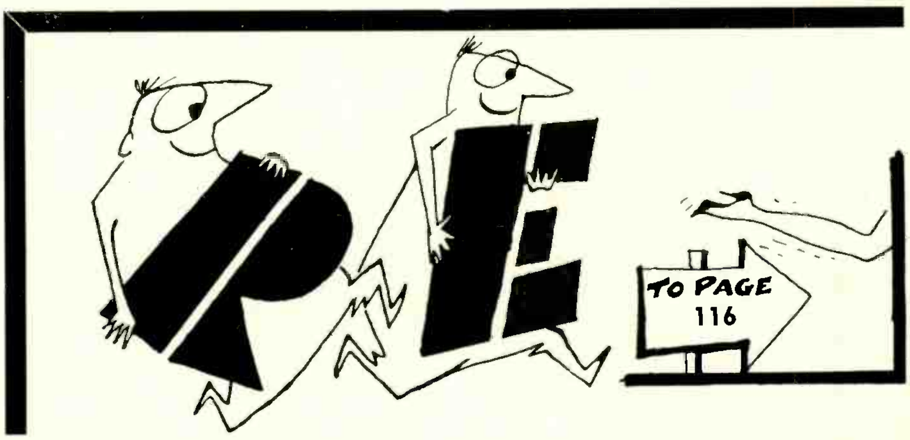
The Audio Engineering Society (AES) convention held in conjunction with the show was not confined by the new conservatism. New theories of stereophonic reproduction were presented by the Ferrograph Co. of Britain and in the paper describing Perspectasound. Other papers ranged from recording techniques through pickup design and transistor amplifiers to enclosure theory and magnetic phenomena as applied to speakers. Electro-acoustics and even psycho-acoustics received their share of discussion.

The AES is almost unique among professional societies in that it recognizes the ultimate user of its products. A complete morning session was devoted to consumer testing and standardization, with papers read by representatives of three organizations to report on products in publications issued for the consumers' benefit. Their reports did not arouse wild enthusiasm among the largely manufacturer-oriented audience, but the fact that they were not only tolerated but invited is highly significant.

While the convention suffered from a certain lack of management (resulting in sudden and baffling program changes) and at times from weak chairmanship, the papers tended to have an originality and impact which contrasted refreshingly with those heard at many similar conventions.

Another lecture session was directed right at the home listener with little or no knowledge of the techniques behind his problem of getting good music in his home. A series of three sessions known as the "Ins and Outs of High Fidelity" consisted of short talks by audio publishers, with long question periods following the short talks. Queries ranged from complex equalization problems to the much more common type like "Do I need an outside antenna for FM?" For the presumably more advanced listener, the information room, staffed by volunteers from the manufacturers' organizations, answered queries.

Some doubt had been expressed about the show administration's policy of charging admission (50c afternoons, 75c evenings) with the idea of eliminating the large crowds of nonserious visitors. But the rooms (much larger than those of former free shows at the New Yorker Hotel) were always comfortably filled, and the attendance almost but not quite justified one exhibitor's saying "If you want a crowd, put on a tax and try to keep 'em out!" END

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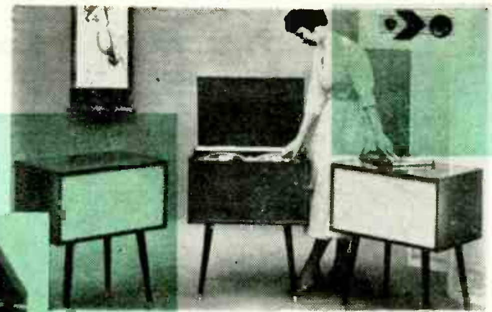
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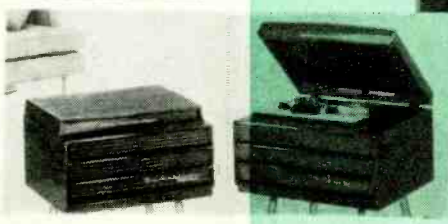
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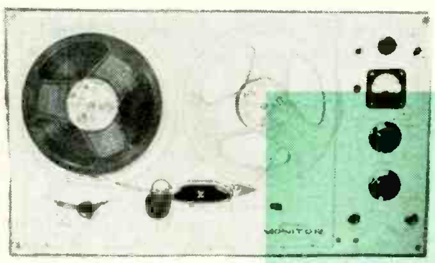

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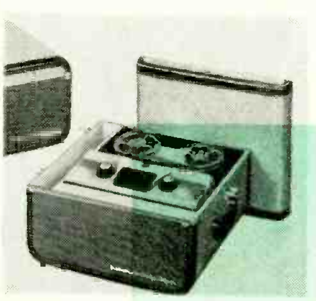
STEREO TAPE comes of age

By HERMAN BURSTEIN

Part II: Complete playback units; individual components

A—Ampex 612-SS stereo tape phonograph system (includes 620 amplifier–speakers).
B—Berlant-Concertone custom 29-7 stereo playback tape–phone combination.
C—RCA 8STP2 Stereotape player and speaker system.
D—V-M 750 table model.
E—V-M's 711 portable stereo playback and monaural recording unit.
F—Electronic Teaching Laboratories Electro-dual Monitor.
G—RCA's 8STP1 portable stereotape player–speaker system.
H—Viking stereo transport.
I—Newcomb 3D-12 stereo amplifier.
J—Fenton Co.'s Brenell Mark IVB stereo transport mechanism.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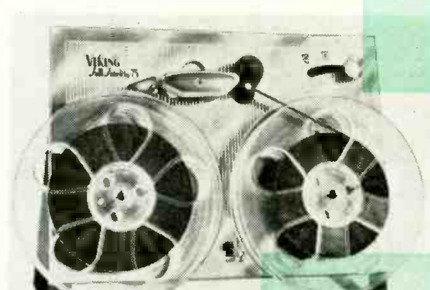

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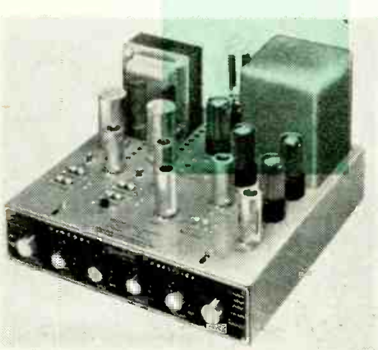
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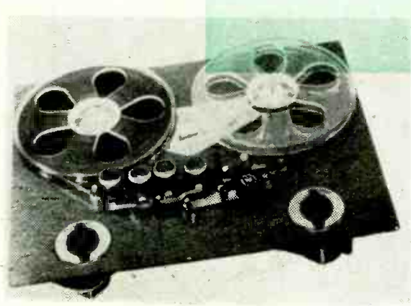
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MOST stereo units are intended for playback only. These include playback preamplifiers and are designed for feeding into dual audio systems (control unit, power amplifier and speaker). All these machines can play monaural tape. However, where an in-line head is used, monaural recordings cannot always be played satisfactorily if both tracks are recorded. Some sound may be picked up from the second track due to crosstalk. The amount of crosstalk varies with the design of the head, and some manufacturers feel that they can use one section of an in-line head to play monaural dual-track recordings.

Stereo tape playback machines now on the market or expected soon include those of Ampex, Concertone, Electronic Teaching Laboratories, EMC, RCA, Telectrosonic, Viking and V-M.

The Ampex stereo "tape phonograph" model 612 uses an in-line head for stereo reproduction and a separate half-track head for conventional dual-track tapes. The 612 is available in either a portable or furniture version at about $395.* It was previously mentioned that Ampex produces companion amplifier–speaker combinations, the model 620, each costing $169.50. The complete system, model 612-SS, in furniture, is priced at $699 in brunette, $729 in blond. A similar ensemble in portable luggage is priced at $734.

Berlant-Concertone's stereo tape phonographs are represented by its models 29 and 39 (the latter $200 higher). Model 29 includes a transport mechanism and two playback preamplifiers at a price of $549.50. Enclosures cost $120 additional, so that the total price is $669.50 (or $870 for the model 39). As previously stated, Concertone manufactures a combination amplifier–speaker system which contains room for the playback preamplifier. The model 29-7 incorporates the model 29 transport in a wood

*Prices given here are highly approximate and are chiefly to show ratios of cost between one piece of equipment and another. Prices vary too greatly with time, geographical location and dealer audiophile policies to make it possible to come very close to the actual price at any given point some months after the article is written.

cabinet (part No. 105244, priced at $75) and two units (part Nos. 10521, priced at $195 each) which contain the power amplifiers and speakers. Total price of this ensemble is $1,015.

While the Berlant-Concertone machines contain a single in-line head, which is also used for playing conventional dual-track tapes, a half-track head can be added for this purpose if the problem of crosstalk arises. Installing the extra head is easy because the machines have provision for up to five heads. An ensemble such as the model 29-7 can be turned on and off from a single point since the transport mechanism and the left-hand channel can be supplied power from outlets in the right-hand preamplifier, controlled by a switch.

The Electro-Dual Monitor, sold by Electronic Teaching Laboratories, principally intended for teaching purposes, is suitable for home stereo playback as well as monaural recordings. It has staggered heads with standard 1.25-inch spacing and is priced at $297. The Monitor's transport is a modified Viking, specially manufactured for Electronic Teaching Laboratories. While the standard model of the Monitor operates at 3.75 ips with a frequency response of 40–7,000 cycles, it can also be had in a 7.5-ips model with a response of 40–13,000 cycles.

EMC Recordings Corp. has recently shown its portable model S, designed exclusively for stereo playback. An in-line head is employed. Model S contains a power amplifier rated at 2.5 watts and a speaker, thus requiring an external power amplifier and speaker for stereo playback. The machine's power amplifier and speaker can be bypassed to feed the corresponding channel into external equipment.

RCA's Stereotape Player is available in both a portable model (8STP1) and a cabinet version (8STP2). In addition to the transport mechanism and preamplifiers, it contains a two-channel power amplifier rated at 2.5 watts per channel, all controls and a three-speaker system which constitutes the left-hand channel. Companion units, models SPK2 and SPK3, contain the right-channel speaker system and also provide tape storage space.

RCA utilizes an in-line head. Half of this head used for playing conventional dual-track tapes inasmuch as—according to RCA—the head is of improved design which reduces crosstalk to a low level. Price of the player and speaker ensemble is about $300 for the portable, $360 for furniture version.

Scheduled for appearance in early 1957 is Telectrosonic's model 220BMP, which will give the purchaser the option of either in-line or staggered heads. At $61.50 for staggered heads, this playback unit, which includes preamplifiers but no power amplifiers, may well be the least expensive on the market. The price will probably be higher for an in-line head. Switching from stereo to monaural playback is provided.

One of the most versatile units is the Viking portable tape playback system, which includes the Viking transport mechanism (model FF75SU) and two playback preamplifiers (model PB60) in a portable case (model D390). Price is $166.50. This "universal" system can play either in-line or staggered stereo tapes as well as monaural dual-track tapes. It includes an in-line as well as a conventional half-track head, spaced the standard 1.25 inches from the in-line head to accommodate staggered tapes.

V-M is currently marketing two units intended not only for stereo playback but also for monaural recording. The 750 is a table model priced at $259.95, the 711 is a portable priced at $219.95. Staggered playback heads are used, one of them also being used for recording monaurally. Both models include a single power amplifier and speaker system. For stereo playback it is necessary to feed one of the outputs to an external power amplifier and speaker. Also, if desired, the player's own amplifier or speaker can be bypassed so that both channels can feed into high-fidelity equipment. All V-M monaural tape recorders are designed to accommodate the company's Stere-o-matic conversion kit consisting of a second playback head and preamplifier, priced at $17.50.

Components

The audiophile who, for reasons of quality, economy or personal taste, prefers to assemble his own system rather than buy a packaged ensemble can also follow his bent with respect to stereo tape. A variety of components such as transport mechanisms, preamplifiers, heads and dual microphone rigs are now available, with more such items soon to appear.

At least two stereo transport units are already on the market. These include heads but no electronic equipment. One is the Fenton Co.'s Brenell Mark IVB which is priced at $114.50 and employs staggered heads. Altogether, there are four heads: two are for recording as well as playback, the other two are for erase—one of each kind for each channel. The Mark IV, although equipped with only one record–playback head and one erase head for monaural use, has provision for four heads and can easily be converted into a stereo transport by adding two heads at $9.50 each. The older Mark II has provision for only two heads but can be adapted to stereophonic playback by replacing the erase head with a playback head. (The same can probably be done with other monaural transports, provided that a spacing of 1.25 inches is maintained between gaps of the staggered heads.)

Another stereo transport now available is the Viking (see photo), which comes with a variety of head combinations to suit virtually any requirement. The FF75SU, previously mentioned in connection with Viking's packaged playback machine, costs $97.65 and has one in-line and one conventional half-track head, both being suitable for recording as well as playback. Thus the FF75SU permits both stereo and monaural recording and playback, with stereo either on staggered or in-line.

However, there is no erase head, so a bulk eraser must be used instead. A bulk eraser insures a quieter tape than most erase heads so this is not altogether a disadvantage. Viking transport model FF75SR, selling at $107.50, contains a half-track erase head in addition to one in-line and one half-track record–playback head. This permits erasure for monaural recording. However, spacing problems prevent the in-line and half-track record–playback heads from being 1.25 inches apart, so it is unsuitable for staggered tapes.

Viking models FF75B and FF75B-LP contain two staggered half-track heads, permitting stereo and monaural recording and playback. Bulk erasure must be used. The only difference between the two models is that the latter, which costs $74.45, includes a pressure pad and a tape lifter that spaces the tape away from the heads during wind and rewind to reduce head wear.

Preamplifiers are available from both Fenton and Viking. Each of these accommodate one channel only, so that two are required for stereo. Fenton's Pro-2, priced at $79.50, is used for recording and playback, is equipped with a VU meter, claims a signal-to-noise ratio of 60 db and provides three equalization curves for operation at 3.75, 7.5 and 15 ips. The NARTB characteristic is followed at all speeds.

Viking's RP61, priced at $74.50, serves the same functions, employs an electron-eye tube as a record level indicator, claims a signal-to-noise ratio of 55 db and uses NARTB equalization which can be varied about ±7 db at 10,000 cycles in playback. For stereo purposes, Viking manufactures a similar model, the RP61S, in which the oscillator is disabled, provision being made to supply bias to both channels from the RP61 preamplifier. As explained before, when using an in-line head it may be necessary to employ a single oscillator to avoid audible beat frequencies due to crosstalk. Viking also makes a preamplifier designed for playback only, the PB60 ($24.50).

At least two in-line stereo heads are now available. One is the Brush model BK-1072, which can be obtained directly from Brush for about $25. The other is the Viking 75-S2, which sells for $33. The latter is made from two conventional Dynamu heads, sliced diagonally and then fitted together for precise alignment of the two gaps. Dynamu manufactures several heads for staggered stereo use. These differ from the conventional half-track models in that they have a wider shield opening on the face of the head. This permits vertical positioning of the heads with respect to the desired channel on the tape. Models 8007 and 8008 are record–

playback heads priced at $27.95 and $17.60, respectively, while model 8009 is an erase head, priced at $9.95.

Bell and Newcomb have designed two-channel power amplifiers for stereo use, respectively priced at $149.95 and $179.50. These are complete amplifiers —they provide for phono equalization, phono preamplification, tone controls, etc., in addition to power amplification. The Bell 3-DT (see photo) is rated at 10 and the Newcomb 3D-12 at 12 watts per channel.

Both provide many of the same essential functions and features: dual inputs for high-level sources such as tape recorders and radio; dual inputs for magnetic pickups; dual outputs for feeding a tape recorder; overall volume, bass and treble controls, which govern both channels simultaneously; a focus or balance control for changing the relative gain between channels; a selector or function switch for choosing between stereo or monaural output to both channels or for reversing channels (placing the left-hand channel on the right and vice versa); a switch for choosing among various input sources.

The two amplifiers also have individual features of interest. The Bell permits feeding the output of playback heads directly into the amplifier and has loudness compensation that may be switched out. The Newcomb provides a variety of phono equalization characteristics, has a switching facility which permits immediate cutting out either channel 1 or 2, permits correction on one channel for the inside track of Cook stereo disc recordings and includes limit controls for adjusting the gain of each amplifier to avoid overload.

Things to come

The foregoing discussion has dealt only with stereo equipment already on the market or engineered to the point where its characteristics are definite and its appearance imminent. In addition, there is a good deal brewing in the way of stereo items that have reached less advanced stages of development. International Radio & Electronics Corp., which makes Crown tape recorders, plans to introduce a two-channel recorder about Nov. 1. Webster Electric anticipates manufacturing stereo recorders "in the near future." Bell Sound Systems is engineering a kit which can be applied to its RT-75 tape recorder to permit playback of stereo recordings. V-M is planning to put on the market a studio 703 model, intended for both stereo and monaural use and consisting essentially of a transport mechanism to which can be added a variety of preamplifier and power amplifier packages. Fenton and Dynamu are working on the development of in-line heads. EMC contemplates production of a matching power amplifier for the second channel of its model S stereo tape player. And there are others no doubt. END

STEREO EQUIPMENT PRESENTLY OR SOON TO BE AVAILABLE*

Type of Equipment	Manufacturer	Model or Part No.	Type of Heads	Speakers	Power Amplifiers	Approx. Price	COMMENTS
Record-Playback Units	1 Ampex	S-5290	In-line	0[a]	0[a]	$950	Price for chassis only. $45 extra for portable case.
		A121[f]	In-line	0[a]	0[a]	$895	Unit consists of recorder and 2 620 amplifier–speakers.
	2 Berlant-Concertone	23, 33	In-line	0[b]	0[b]	$795, $995	Price for chassis only. $120 extra for 2 portable cases.
	3 Educational Labs.	M-6A, M-7	Staggered	0[c]	2	$269, $295	M-6A provides 1 watt per channel; M-7, nearly 5.
	4 Amplifier Corp. of America	Stereo-Magnemite	Staggered	0	0	$395	Price for 7.5-ips model. Portable with spring-wound motor.
Playback Units	5 Ampex	612	In-line	0[a]	0[a]	$395	Auxiliary half-track head for monaural tapes.
	6 Berlant-Concertone	29, 39	In-line	0[b]	0[b]	$550, $750	Price for chassis only. $120 extra for 2 portable cases.
	7 Electronic Teaching Labs.	Electro-Dual Monitor	Staggered	0	0	$297	Permits monaural recording.
	8 EMC Recordings Corp.	S	In-line	1	1	No information	Amplifier and/or speaker can be bypassed to feed hi-fi equipment.
	9 RCA	8STP1, 8STP2	In-line	1[d]	2	$250, $285	2.5 watts per channel. Speaker is 3-unit system for left channel.
	10 Telectrosonic	220-BMP	Staggered	0	0	$62	In-line head optional at probably higher price.
	11 Viking	Portable Playback System	In-line & Staggered	0	0	$167	Plays in-line, staggered and monaural tapes.
	12 V-M	750; 711	Staggered	1	1	$260, $220	Amplifier and/or speaker can be bypassed to feed hi-fi equipment.
Companion Amplifiers and/or Speakers	13 Ampex	620	....	1	1	$170	Amplifier–speaker combination. Portable or cabinet.
	14 Berlant-Concertone	105250, 105251	....	1	1	$150, $195	Amplifier–speaker combinations, respectively, as portable or cabinet. Room for one preamplifier.
	15 Educational Labs.	EL-2S	....	2	0	$48	Two speakers in split case.
	16 RCA	SPK-2[e], SPK-3[e]	....	1	0	$50, $75	3-unit speaker systems, respectively; portable or cabinet. Right channels.
Transports	17 Fenton Co.	Brenell Mark IVB	Staggered	..	..	$115	Contains 2 record–play heads and 2 erase heads.
	18 Viking	FF75SU, other	In-line & Staggered	..	..	$98, other	Contains 2 record–play heads: 1 in-line and 1 half-track; no erase heads. Same transport available with other head combinations.
Preamplifiers	19 Fenton Co.	Pre-2	....	..	..	$80	Record–play, single channel.
	20 Viking	RP61	....	..	..	$75	Record–play, single channel, RP61S for second channel.
	21 Viking	PB60	....	..	..	$25	Play only, single channel.
Heads	22 Brush	BK-1072	In-line	..	..	$25	Record–play.
	23 Viking	75-S2	In-line	..	..	$33	Record–play.
	24 Dynamu	8007, 8008; 8009	Staggered	..	..	$28, $18; $10	8007, 8008 are record–play heads; 8009 an erase head.
Dual Amplifiers	25 Bell	3-DT	....	..	2	$150	10 watts per channel. Tone controls, phono equalization, etc.
	26 Newcomb	3D-12	....	..	2	$180	12 watts per channel. Tone controls, phono equalization, etc.
Stereo Conversion	27 Berlant-Concertone	Various	In-line	0	0	Various	Converts monaural Berlant-Concertone units to stereo.
	28 Fenton Co.	Heads	Staggered	..	..	$10	Additional record–play and erase heads to convert monaural Brenell transports for stereo.
	29 V-M	Stere-o-matic	Staggered	0	0	$18	Converts V-M recorders for staggered stereo playback.

[a] See line 13.
[b] See line 14.
[c] See line 15.
[d] See line 16.
[e] Matching unit for RCA playback.
[f] Companion model, the A122, is same as A121 except it is housed in portable cases.
Model A423 contains the A121 units plus an AM-FM tuner, a 3-speed record changer and a control unit, all in one cabinet at $1,470. A323 is same as A423, without radio tuner and phonograph.

***As of Oct. 1, 1956, approximately. Due to the rapid increase in stereophonic equipment, there should be a number of additions to and modifications in this material before this is printed. List is based on information supplied; since some manufacturers did not supply requested information, list may not be complete.**

DRY CELLS CAN BE Reactivated

By RALPH W. HALLOWS

THAT it is possible to reactivate dry (Leclanché) cells was proven as long ago as 1938. In a paper read that year before the American Electrochemical Society, Kenneth A. Cobb and Robert P. Graham (Department of Chemical Engineering of the University of Washington) showed that No. 6 cells, discharged for short periods at 250 ma, could be kept in good condition almost indefinitely by applying a suitable direct current with a reverse voltage immediately after discharge.

Their experiments were, unfortunately, not very realistic. Using rotary switches they discharged banks of cells at 250 ma for a few seconds and then immediately recharged them with a reverse dc of the same amount for two or three times as long. In this way they obtained many hundreds of ampere-hours (vastly more than the electrochemical equivalent of the zinc in their cans) from No. 6 cells. But no one who uses a dry cell for any ordinary purpose is going to treat it that way. Reactivation cannot be of real value unless it can be applied after a fairly long period of intermittent or continuous discharge.

In a long series of experiments made over the years I found that reactivation by applying reverse dc gave reasonably good, though not startling, results under the following conditions:

1. The cell must be in good condition and not "stale" as the result of long shelf life.
2. It must not be run down to an underload voltage much below 1.
3. Recharging must start very soon after the cell is taken off load.
4. The reverse dc must be tapered down to about 1.7 volts. If this is not done, the open-circuit voltage of a cell may rise to as much as 2.5. The cell may become very hot and actually burst, with horribly messy results.

Even under these conditions the times that any dry cell can be reactivated is very limited. With a high-grade cell 10–15 successful reactivations are possible. But after that the story is always the same: the can punctures and the cell becomes useless.

Things are very different if the reactivating current consists, not of pure dc, but of dc with a certain amount of superimposed ac. A year or two ago a Dutch electrical engineer, Mynheer Beer, produced a reactivating apparatus called the Elektrophoor. Various forms of it are widely used in Holland for reactivating all kinds of dry cells and batteries. The circuit of an Elektrophoor for recharging three 30 x 55-mm cells in series is shown in Fig. 1. The metal rectifier is shunted by a series resistor of 250 ohms. The resulting charging "dc" (Fig. 2) consists of a short-duration positive peak, followed by a shallow negative trough.

The discharge of a dry cell is in two parts: the main chemical reaction is the conversion of zinc as attacked by ammonium chloride into zinc chloride, ammonia and hydrogen. This results in the formation of a mass of neutral hydrogen bubbles around the positive carbon electrode. These clog the cell, raise its internal resistance and decrease its voltage. To counteract this the cell contains a depolarizer of magnesium dioxide. The net result is that the unwanted hydrogen combines with the manganese dioxide to form manganese oxide and water.

But as the cell discharges, the depolarizing process is never quite good enough. Neutral hydrogen bubbles are concentrated around the positive electrode rather faster than the depolarizer can dissipate them. The cell becomes choked by this accumulation of hydrogen and its emf falls off. Even if the cell is rested for a time after discharge, the depolarizing process is never quite complete. There is always some rise in internal resistance and some fall in emf.

Since the discharge of a dry cell is a twofold process, reactivation can be successful only if it also is twofold. It must not only reconstitute the depolarizer but also restore the electrolyte to its original form and redeposit the zinc on the inside of the can. Reverse dc depolarizes a rundown cell *if* (and these are big "ifs") the cell is discharged at a fairly heavy rate and if the reactivating current is applied almost immediately afterward. It also to a large extent reconstitutes the electrolyte. But it does *not* redeposit the zinc as a smooth, evenly distributed coating on the can. This is the big snag. Break open a cell which has been reactivated in this way and you will find that the zinc returned from the electrolyte consists mainly of small, spongy lumps distributed in patches over the inner surface of the can. The inevitable result is that after a few discharges and reactivations thin places develop and the can punctures.

Matters are very different when a small amount of ac is superimposed on the reverse dc. The redeposition of the zinc is closely akin to electroplating, and electroplating experts have found that suitable amounts of superimposed ac work wonders. I don't pretend to be able to explain what takes place, but I imagine that the ac provides some kind of electrochemical shakeup which is absent when dc alone is applied.

The results, anyhow, are far-reaching for the zinc is redeposited smoothly and evenly. With this method reactivation is successful not just with cells which have been heavily discharged for a short period, nor need the mixture of dc and ac be applied immediately after discharge. I have, for example, flashlight cells still in use after more than 18 months of regular service. They are reactivated only when the light becomes dim, and this may be at intervals of 7 to 30 or more days, according to the time of year.

Cells discharged slowly under light loads can also be successfully reactivated, provided their voltage does not fall much below 1. The dry cell can, in fact, be made to behave very much as if it were a secondary cell, the main limiting factor to its useful life being the eventual drying out of the electrolyte.

An interesting new field for experiment is opened now that transistor apparatus is reviving the demand for dry cells. It is more than likely that the value of the resistor in Fig. 1 is not ideal. Still better results might be obtained by increasing the duration of the positive half-cycle of Fig. 2 and reducing that of the negative, or vice versa. It's certainly well worth investigating! END

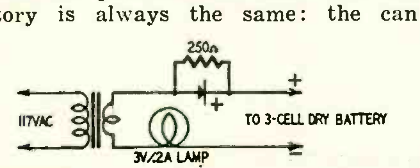

Fig. 1—Schematic of a successful Dutch dry-cell reactivator, the Elektrophoor.

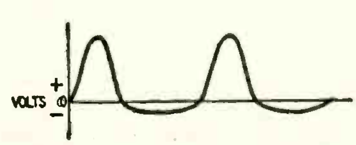

Fig. 2—Waveform of the reactivating voltage applied to the dry cell.

COVER FEATURE

relay moe plays TICK TACK TOE

By EDMUND C. BERKELEY*

ON the front cover of this issue of RADIO-ELECTRONICS appears a picture of an automatic relay machine which can play tick-tack-toe—or tit-tat-toe, as many prefer to call it—with a human opponent. This machine—which we call Relay Moe—is one of the more recent of twenty-odd small robots we have made in the last six years as a part of a scientific program of exploring the behavior of intelligent machines, with the help of part-time college students studying electronics or electrical engineering. (Two of them—"Simon," a miniature automatic digital computer made of relays, and "Squee," an electronic robot "squirrel"—appeared on the front covers of RADIO-ELECTRONICS in October, 1950, and December, 1951, respectively.)

Playing with Relay Moe

You can play tick-tack-toe with Relay Moe, if you want to, in our laboratory in New York City. (But please write us beforehand to request a date.)

If you wish the machine to play first, press the MACHINE-MOVE-FIRST button (see Fig. 1). Then the machine will choose a square and light a red light in it.

If you wish to play first, press the green button under the square that you choose. Then the square right above your button lights with a green light. The machine then starts its program of thinking, turning a plastic cylindrical drum (the timing drum) with associated cams which control the succesive timing of the circuits; decides on its move and turns on a red light in some other square.

Then you can make another move. And so on.

If the machine wins, a red light is turned on in the top row of the board, red again indicating the machine. If the game is a draw, a white light is turned on in the second row at the top of the board. If you win the game against the machine, a green light is turned on in the third row, green again indicating the human player.

If you are disgusted with the way the game is going (or has gone) and want to start a new one, press the NEXT-GAME button at the bottom of the board, which cancels whatever is on the board and leaves the equipment ready to start a new game.

General layout

The general layout of the machine is shown in Fig. 1. It has been made in two sections, the display board and the main chassis (or "brain"). At the top of each one is a long handle, so that it can be moved around. The two sections are connected by two multiwire cables and two large Jones plugs. The main chassis contains at its bottom a transformer and rectifier which convert 117-volt ac into 24-volt dc to operate some 90 relays, a motor, a stepper and other apparatus inside the main chassis.

Two groups, each including 9 of the 90 relays, correspond with the 9 squares of the board. One group records the machine's moves into any particular square of the board: the MM or Machine-Move relays. Another group of 9 relays corresponds with the human player moving into any particular square of the board: the PM or Player-Move relays. In parallel with the coil of each of these relays is a small red or green light, respectively. So, as each square on the display board lights up red or green, light of the same color goes on in the main chassis.

This is a rather striking parallel to results reported by a brain surgeon operating on a rabbit. As various parts of a rabbit's retina were stimulated with light, so various parts of its brain showed electrical excitation, reported in neon tubes, and the pattern of vision was roughly repeated in the neons.

The machine's strategy

Several different kinds of strategy are built into Relay Moe. One is *variable intelligence*. In the back of the main chassis are three horizontal cams, called the Machine Intelligence Cams, affecting three snap-action switches. These cams are plastic discs mounted eccentrically so that from time to time they close their switches and disable certain circuits to give the machine less than perfect intelligence. On such occasions the human player may win.

Some more details are shown in Fig. 2. As the cams revolve, four conditions—known as cases A, B, C or D—may prevail. In case A, which is the condition 52% of the time, the machine plays to win at all times; the human player can only lose or draw. In case B, 16% of the time the player can win every game. In case C the human player has a chance to win every time and in case D he may win under certain situations. Cases C and D each occupy 16% of the playing time.

Also in the main chassis are a set of Board Rotation relays. To make the machine strategy harder for a human player to guess, after every game the machine in its "computing mind" turns the board a random multiple of 90°. Of course, the board does not actually turn, but the machine thinks of it as turned. This prevents a human being from guessing quickly what is the machine's strategy or what sequence of moves it plays, because after each game the machine plays a randomly rotated strategy.

Thus the strategy of the machine is hard to guess and is different from game to game, and sometimes the human player has a chance of winning (see Fig. 2). This makes Relay Moe more fun to play a game with than if it were unvarying and always perfect.

Intelligence control does not affect the offensive and defensive machine moves. Thus the machine when playing defensively will always block a human player having only one set of two squares in a row by occupying an empty third square in the same row, and when playing offensively will always occupy an empty third square in a row if it already has taken two squares in that row. Diminution of intelligence only affects the machine when it has a choice of making a move not involving a decisive offensive or defensive play, *except* that in cases B and C, the machine will never choose to take the center square.

A full rotation of the intelligence control cams takes place once for every 60 games if the Board Rotating relays are switched to act.

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* Berkeley Enterprises, Newtonville, Mass., and New York, N.Y.

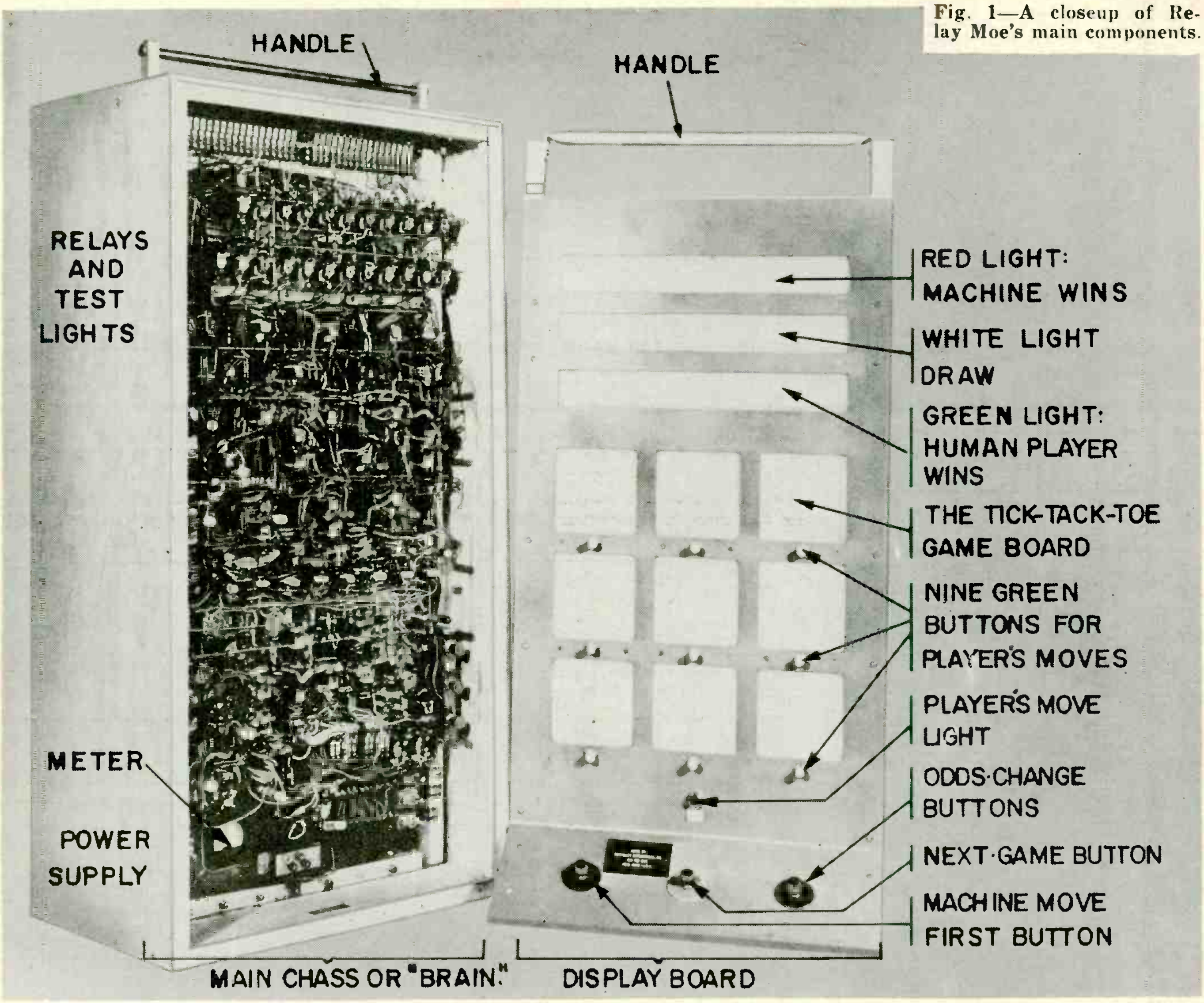


Fig. 1—A closeup of Relay Moe's main components.

The basic organization of the behavior of the machine is controlled by a Timing Drum, a large plastic cylinder with protuberances here and there which act as cams and close snap-action switches so that in a full cycle of the machine about 13 timed sources of current are used. These are identified as times A, B, C, D, E, (two each), and X, Y and Z (one each). Making use of these times, various circuits carry out their functions during every single machine cycle (see Fig. 3). The timing drum and the motor which turns it are located in the middle of the back of the main chassis (not visible in Fig. 1).

For example, the first thing that may happen is that a player may push a button under a square. This will happen at Resting Point time. If a moderately low resistance path from the button to ground exists and if the square selected is unoccupied, a sensitive relay is energized. This energizes another relay which then disconnects the sensitive relay and allows further steps in the operation of the machine to continue. After the player's move, the machine first searches for an offensive (winning) move, using the first set of times A, B, C, D, E of Fig. 3. Failing to win, the machine checks for a defensive (blocking) move, using the

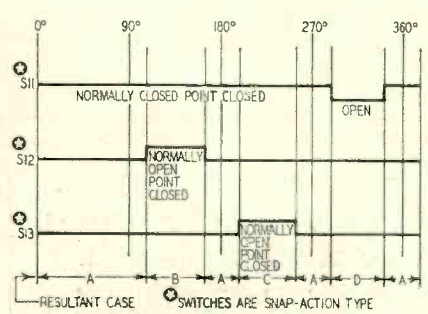


Fig. 2—The intelligence circuits. Rotation of the cams assures the machine's winning half the time; gives the player a chance the other half.

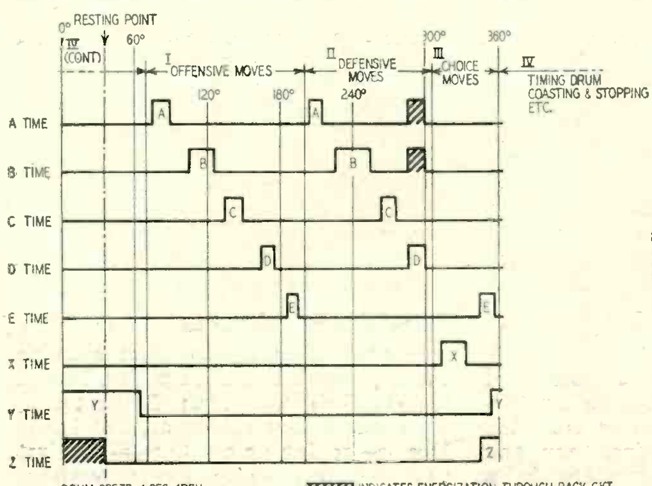


Fig. 3—Timing circuits set sequence of operations. These are controlled by switches on a drum.

second set of times A, B, C, D, E. If none can be made, a decision is made at X time and the machine plays the best move it can make.

Let us continue with the same example. The player having moved and the drum having reached A time, the machine considers effective moves. The first thing it does is to look at the squares which it has already occupied to see if there is any winning unoccupied square (the third square in a row, not occupied by the human player). For example, consider the position:

THE SITUATION

O		O
O	X	
X		X

KEY TO BOARD

1	2	3
4	5	6
7	8	9

In this position the machine (X) has played three times and the human player (O) has also played three times. The machine considers the situation, observing that its possible winning squares are 1, 3 and 8 as shown by the figures on the board at right. (The situation is examined by the Computing Circuit, which we will explain later.)

At A time, the machine considers and then stores in the Intermediate Memory (IM) relays all the winning squares (in this case, 1, 3 and 8). At B time the machine considers occupancy, cancelling out of the IM relays the squares already occupied (1, 3) so that only square 8 remains. At C time the machine selects a line (called the Machine Choice line), corresponding to an uncancelled IM relay, in a succession of choices in numerical sequence. Since there is only one square (8) not cancelled, the machine chooses that square and actuates Machine-Move (MM) relay 8. At D time, the machine checks to see if it has picked up any MM relay at C time. If so, it decides that it has won. Then the rest of the cycle is cancelled and the machine turns on the "Machine Won" light.

If the machine has no winning move, it uses the rest of the cycle defensively, putting the human player's position into the Computing Circuit (see below). The same strategy as above is followed, with the machine putting X's in what would otherwise be winning squares for the human player and making choices in the event of no defensive or offensive answer. These functions make use of the second A, B, C and D times and the E, X, Y and Z times.

Computing circuit

Perhaps the most interesting part of the machine is the Computing Circuit. It receives information from the MM relays and determines, for any two occupied squares together in a line, what third square is needed to make three in a row. If, as indicated above, there is no such move, the E pulse clears the computing circuit. The circuit then receives information during the second A time from the Player-Move (PM) relays and determines for any two player-occupied squares what third square is needed to make three in a row.

How does the circuit operate? Fig. 4 shows:

a The numbers of the squares of the board;

b The eight possible rows of three;

c The third or winning square determined by the other two squares. This is the situation which this circuit of the machine must handle. The circuit which performs this work is shown in Fig. 5. Here the B (branching-network) relays (B1 to B9), for which only contacts are shown, have received the information contained in the MM or PM relays, whichever are being examined. IM relays record the possible winning squares to be played in (or to be blocked) if possible.

Now let us look at Fig. 5 again. How is the position computed by the computing circuit? The machine (X) has played in squares 5, 7 and 9. Therefore this information energizes the B5, B7 and B9 relays and their contacts close. These contacts are marked with an asterisk in Fig. 5. If we trace through the circuit, we can see that the lines marked with the asterisk are "hot." Accordingly, the appropriate IM relays are energized. These are the IM1, IM3 and IM8 relays. Now at B time, as explained above, the IM1 and IM3 relays are concelled because occupied and IM8 remains energized.

Relay Moe's significance

Relay Moe is not the first machine which plays tick-tack-toe with a human player; Bell Telephone Laboratories, for example, has made one. But Relay Moe is—so far as we know—the first such machine which has a variable strategy and which disguises (by board rotation) what strategy it follows. Contrary to the very brief report about Relay Moe given in *Life* magazine (March 19, 1956), the machine can be beaten by a human being, and the percentage of the time he does so on the average can be varied widely by changing the cam settings.

THE EIGHT ROWS OF THREE	WINNING SQUARE	DETERMINED BY
1 2 3	1	2,3;5,9;4,7
1 5 9	2	1,3;5,8
1 4 7	3	1,2;5,7;6,9
2 5 8	4	1,7;5,6
3 5 7	6	3,9;4,5
3 6 9	7	1,4;3,5;8,9
4 5 6	8	2,5;7,9
7 8 9	9	1,5;3,6;7,8

Fig. 4—Information the machine uses in selecting winning moves or blocking the player.

Relay Moe however has a wider significance, as one of our series of small robots (computing, reasoning, puzzle-solving, game-playing machines, etc) of different types and capacities. We plan to make (and are making) many kinds of small machines and robots that display intelligent behavior. They range from the Geniac and Tyniac (two "tiny genius") electric brain construction kits (finished) up to a simple automatic electronic digital computer using transistors called Simplac (not finished).

We think that a good part of the job of learning about the important new development of machines that handle information automatically and reasonably may be accomplished by constructing and operating just such working models as these. END

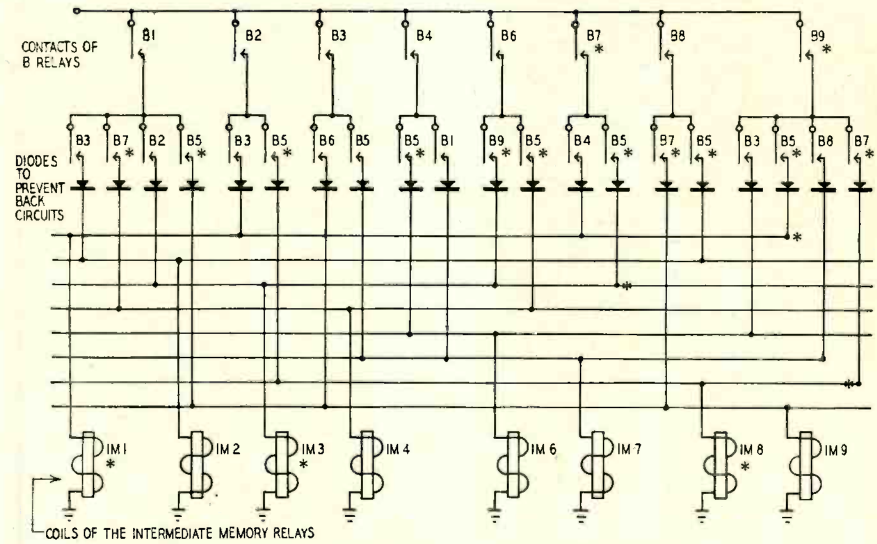


Fig. 5—The computing circuits which actually select the moves.

Electronic Muscle Trainer Aids Arthritics

By ALFRED HAAS

Device uses electric pulses to restore health and vigor to unused muscles

PROBABLY all of us can name at least one way in which electronics is used to cure or alleviate a particular ailment. It can be used to make life easier for an arthritic sufferer.

Arthritis is a very old and common affliction. More than 10 million Americans suffer from some form of arthritis, according to the *Fact Sheet* of the Arthritis & Rheumatism Foundation. That's one out of every 16 men, women and children. Suffering with severe arthritis, I became deeply interested in rheumatic therapy. Let us leave, however, to the physicians use of drugs such as phenylbutazone and cortisone and see what electronics can do to improve the health of the sufferer.

In most cases, the disease is characterized by stiffness of the joints or muscular pain or both. To escape pain, the patient (voluntarily or not) reduces the amplitude of movement of the aching member; lacking their normal functions, the muscles waste away progressively, rendering all motion increasingly difficult. Should the inflammation eventually be stopped, the absence of a well-trained muscular system makes all motive re-education difficult.

Gymnastics may be a way of muscular training. For a very modest working of the muscles there is, however, a risk of aggravating the inflammation of the joints and, in severe cases, physicians don't recommend it. As muscles respond quite well to electricity, it is easy to make them work by electric stimuli.[1] This method is extremely flexible and allows for selective muscular training without any hazard of injury to the diseased joints.

Some basic principles

For most efficient muscular stimulation, the stimulating frequency has to be about 3,000 cps, the so-called "physiological frequency." Connecting yourself to the output posts of an audio-frequency generator and tuning it over the band, you will find that the sensation is strongest at about 3 kc. At that frequency you get the most efficient stimulation with a given energy level, thus minimizing any health hazard.

[1]See "Relaxicisor," RADIO-ELECTRONICS, November, 1952, p 49.

The muscle has a time constant that prevents it from following the exciting frequency. It contracts and stays contracted. To make it work, the exciting wave has to be pulsed at a slow rate. A repetition frequency of 1 cps with a mark and space ratio of about one makes for good contraction followed by full relaxation. The required waveform is shown in Fig. 1.

Some electrical characteristics of the human body make it necessary for the output characteristics of the stimulator to be determined experimentally. It was found that the impedance of the body measured between correctly applied electrodes is 500 to 1,000 ohms, a rather low value. The voltage necessary for full muscular response depends upon the member to which it is applied: 5 volts were found adequate for stimulating the muscles of the forearm and 30 volts were necessary to stimulate fully the muscles of the thighs.

The stimulus generator

The schematic of the stimulus gen-

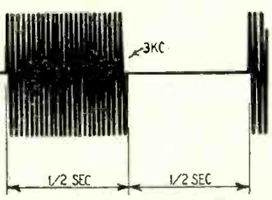
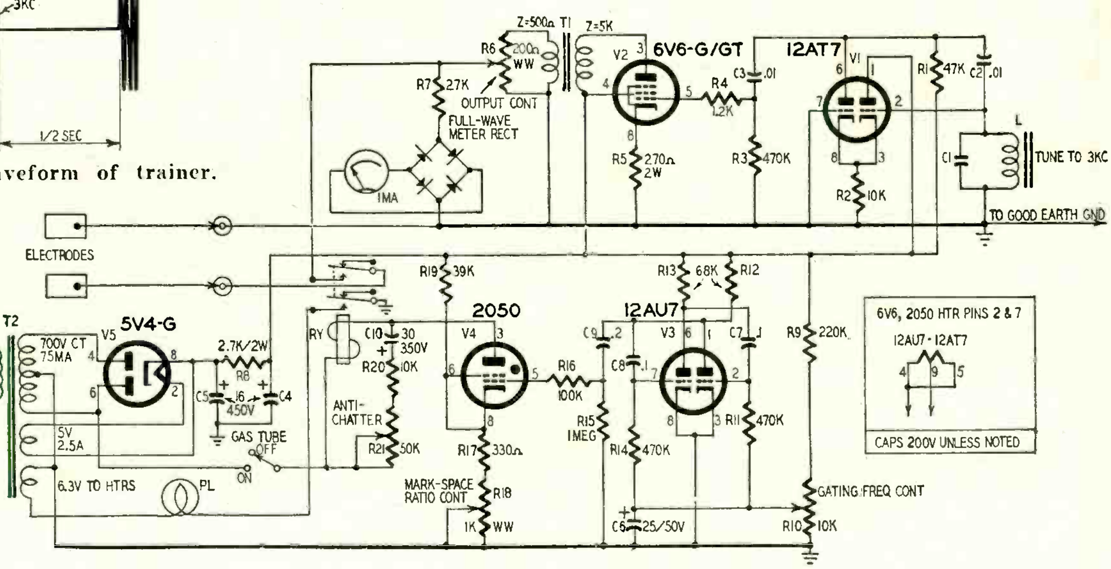
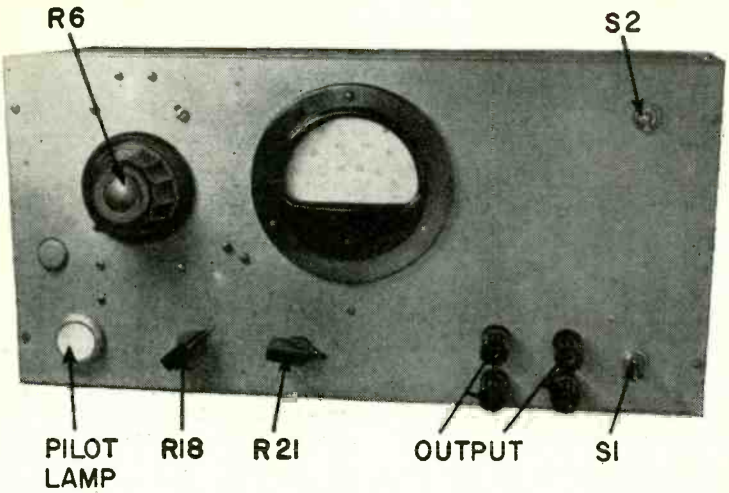


Fig. 1—Output waveform of trainer.



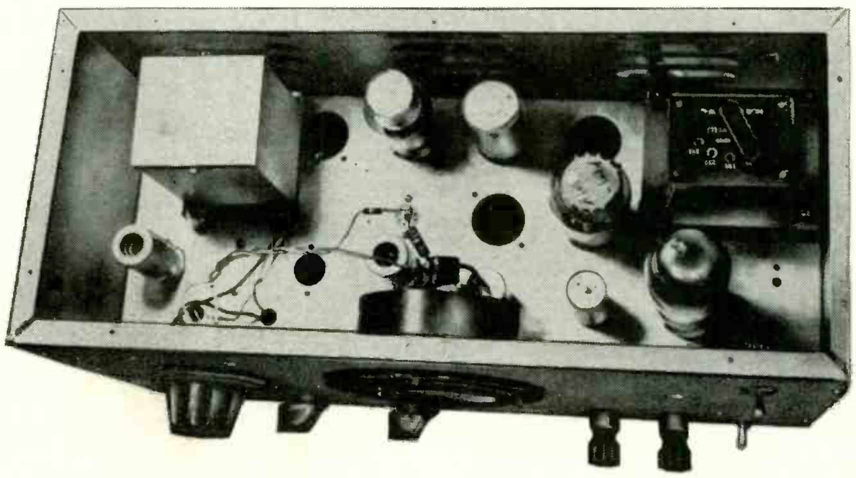
R1—47,000 ohms, 1/2 watt
R2—10,000 ohms, 2 watts
R3, R11, R14—470,000 ohms, 1/2 watt
R4—1,200 ohms, 1/2 watt
R5—270 ohms, 2 watts
R6—200 ohms, wirewound pot
R7—27,000 ohms, 1/2 watt or as needed for full-scale deflection at maximum unloaded output
R8—2,700 ohms, 2 watts
R9—220,000 ohms, 1/2 watt
R10—10,000 ohms, linear pot
R12, R13—68,000 ohms, 1/2 watt
R15—1 megohm, 1/2 watt
R16—100,000 ohms, 1/2 watt
R17—330 ohms, 2 watts
R18—1,000 ohms, wirewound pot
R19—39,000 ohms, 1 watt
R20—50,000 ohms, linear pot
C1—See text
C2, C3—.01 µf, 400 volts, paper
C4, C5—16 µf, 450 volts, electrolytic
C6—25 µf, 50 volts, electrolytic
C7, C8—0.1 µf, 400 volts, paper
C9—0.2 µf, 400 volts, paper
C10—30 µf, 350 volts, electrolytic
L—Small audio or filter choke or a winding of audio transformer tuned to 3 kc with C1
T1—Audio output transformer, 5 watts or more; 5,000-ohm primary, 500-ohm secondary
T2—Power transformer, 700 volts ct @ 75 ma, 5 volts @ 2 amps, 6.3 volts @ 2.5 ma
S1, S2 (gas tube switch)—spst switch
RECT—5-ma full-wave instrument rectifier, Conant series 160 or equivalent
M—1-ma dc meter
RY—10,000-ohm dpst normally open or dpdt relay
V1—12AU7
V2—6V6-GT
V3—12AU7
V4—2050
V5—5V4-G
Octal sockets (3)
9-pin miniature sockets (2)
Pilot lamp and assembly, chassis, knobs, hookup wire, hardware.

Fig. 2—Complete schematic diagram of the stimulus generator. The stimulating frequency of unit is about 3,000 cycles.

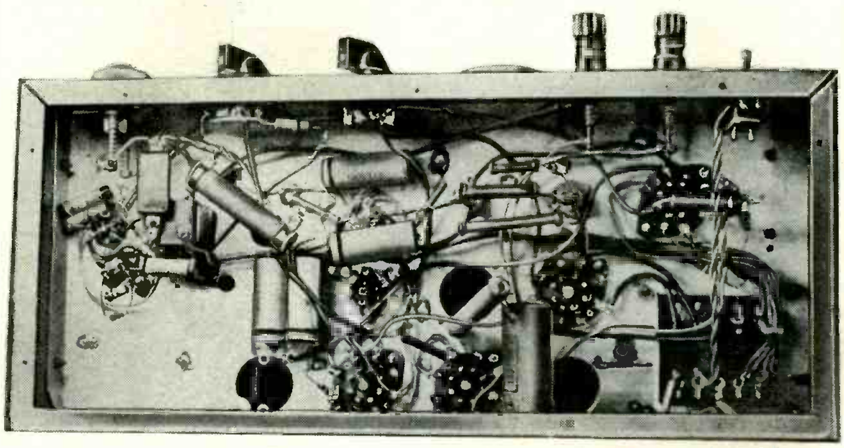


Front view of Electronic stimulator.

Top view shows placement of parts.



Underchassis view. Note Continental type construction of some parts.



erator is shown on Fig. 2. Five tubes are used. V1 is the 3,000-cycle sine-wave oscillator, V2 the output power amplifier, V3 the gating multivibrator, V4 the gating-relay control and V5 the full-wave power supply rectifier for the generator.

Looking for the simplest to build and to calibrate, the cathode-coupled negative-resistance oscillator was chosen. It is rather easy to select audio choke L from the junkbox and to tune it by trial and error to 3,000 cps, using a suitable value for C1. It is not necessary to tune very exactly; any frequency from 2,500 to 3,500 cycles will do. The amplitude of oscillation may be adjusted by varying the common cathode resistor R2, a 10,000-ohm 2-watt unit.

Power amplifier V2 works into an output transformer with a 5,000-ohm primary and 500-ohm secondary. The amplitude control (R6) and gating circuit (relay contacts in series with one electrode) are on the secondary side of the transformer to prevent switching transients.

Gating multivibrator V3 operates at less than 1 cycle per second when the slider of the GATING FREQUENCY control is at the ground end. Moving it toward B plus raises the frequency to several cycles per second. The square-wave output of V3 controls thyratron V4 operated with ac on its plate. The plate circuit of V4 consists of the 10,000-ohm 10-ma relay coil shunted by C10 in series with R20 and R21. R21, the ANTI-CHATTER control, is adjusted for quiet relay operation. R18 controls the firing point of V4 and thus the mark–space ratio.

Relay RY has dpdt contacts, one working contact closing the generator output circuit and the other lighting simultaneously a pilot lamp, thus showing the working cycle of the stimulus. A rectifier type output meter is for checking amplitude of output voltage. As the meter is connected before the gating contact, it is easy to compare the no-load and full-load voltages and see how much the body impedance lowers the output.

Operating the generator

Electronic technicians know a lot about making metallic contacts but little about electrodes on living tissues, consisting chiefly of water and ionized salts. The electrodes generally used are thin metal sheets of about 4 x 5 inches made of a soft corrosion-resistant metal such as tin or very pure aluminum. These electrodes are *never* to contact the skin directly; a synthetic sponge of the household-cleaning type has to be placed between the electrode and the skin. This sponge has to be moistened to conduct. In some cases when generator voltage is ample with regard to the required stimulus, ordinary tap water will do; if the series impedance thus introduced lowers too much the current available, the sponges are to be wetted amply with salted water made by dissolving ordinary kitchen salt in warm tap water up to saturation. Fig. 3 shows how rubber bands are used to fix the sponge–electrode sandwich on the member to be treated.

Make sure that S1 and S2 (gas tube switch) are open (OFF) and connect the chassis to a good earth ground or a cold-water pipe. Set the OUTPUT control

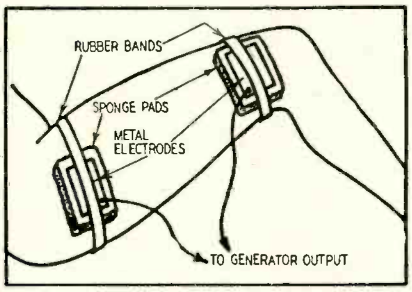


Fig. 3— Construction of the electrodes.

(R6) to MIN. Plug in the generator and attach the pads to the affected member. Close S1 and wait 20 seconds or so for the 2050 to warm up. Close S2. (Applying plate voltage to the thyratron before its heater reaches normal operating temperature shortens its life.)

You will hear the relay begin operating and the pilot lamp will flash. Now adjust R18 so the lamp is on and off for approximately equal periods and set the gating control for a fairly slow rate. Gradually turn up the output control and you will begin to feel electrical shocks. You can then adjust the control for ample stimulating current without pain or discomfort. Touch up the settings of R10 and R18 as desired. The working of the muscular system is very spectacular. The instantaneous swelling and relaxing of the muscles is seen clearly.

A word of caution

To get gear working in a jiffy, a technician may junk parts together without care for safety. *This is not an experimental device, but a therapy unit, and a definite health hazard may result from neglecting elementary safety rules.* A good practice is to connect the ground of the generator to a reliable ground line. The 500-ohm transformer secondary thus being grounded, no dangerous voltage can build up should there be a leakage in one of the transformers. Don't attempt building ac–dc jobs to save a transformer! You may lose your life!

In keeping with the nature of this unit, all wiring should be done with great care. In addition to a reliable ground line, all connections should be double checked. While the ac line is the principal source of danger, also watch all B-circuit wiring in this electronic device.

It has to be emphasized too that the muscular trainer, while being very important for muscular reeducation, *will not cure arthritis;* you always need assistance of a physician for that. A good plan is to talk it over with him. He may advise you on the particular muscles to make work. END

SONAR in ONE HOUR

Simple experimental setup demonstrates radar and sonar theories.

By JAMES H. BOYDEN

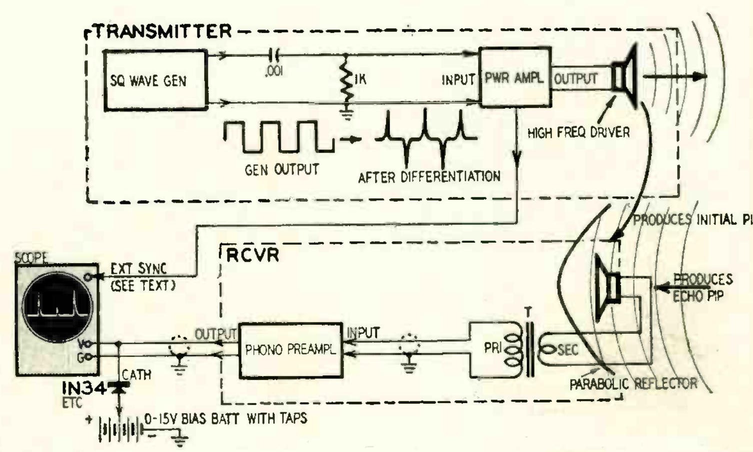
HERE'S an interesting and educational device that can be set up in an hour or less to demonstrate the principles of radar and sonar in a very simple, straightforward manner. The diagram shows the setup. It requires little special equipment except for the high-frequency driver units, which many hi-fi fans have in their speaker systems.

The 20-cycle output of a square-wave generator (I used a Heathkit electronic switch) is differentiated by a 1,000-ohm resistor and .001-μf capacitor, giving sharp recurrent pulses. These pulses are fed into a reasonably hi-fi amplifier of moderate power output, connected to a high-frequency driver unit. This driver squirts out pulses of audio with a large percentage of high-frequency components. This is the sonar "transmitter."

The receiver consists of another driver unit used as a microphone, with an output transformer T connected backward to step up the voltage, fed into a high-gain phono preamp. A standard intercom input transformer

The picture will be more stable if the pulse voltage from one of the stages of the power amplifier is fed into the external sync circuit of the scope. The gain of the receiver can be increased many times by using a parabolic reflector. Though not too many people have these lying around, a good substitute can be made from ordinary posterboard bent into a rough parabolic shape.

Using two drivers from a University 4402 dual tweeter and a small amplifier (12AX7 amplifier–phase inverter and push-pull 6AQ5's), I was able to get return pips from a wall 30 feet away that were actually larger than the initial pips. In this case, range (distance) was limited by pulse frequency and room dimensions. Small objects such as a book or a person's hand could be "seen" easily if they were oriented properly. Experimenting with separation of transmitter and receiver will give optimum results. The transmitted pulses were very weak, being audible only as slight clicks, but the results were excellent.



may be used for T to match the tweeter to the preamplifier input. The output of the preamp is connected to the vertical input of an oscilloscope, with a diode clamper to clip out the speaker hangover hash and extraneous room noises.

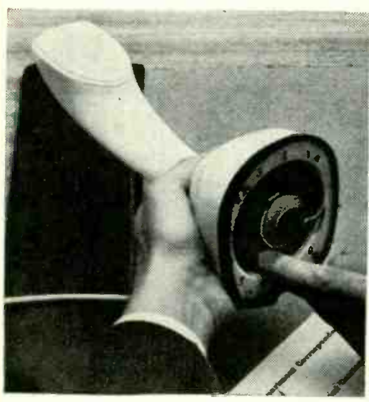
When the transmitter emits a pulse, it is almost immediately picked up by the receiver and a pip appears on the scope. When a reflected echo pulse returns from a wall or person, a second pip appears on the base line, just as in the early radar sets.

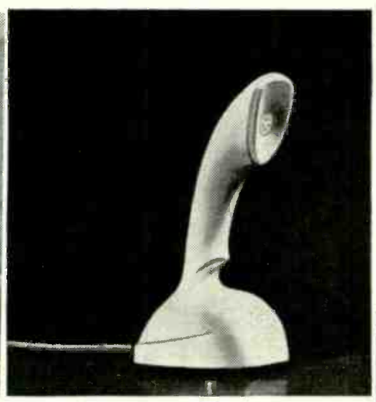
If only one driver unit is available, an ordinary microphone can be used for the receiver with a resulting loss in high-frequency efficiency and increased susceptibility to interference from room noises. Regular speakers could probably also be substituted for the drivers. A simple multivibrator could be used instead of a square-wave generator.

There are many possible modifications of this simple system, such as a rotator and radial sweep with . . . well, you get the idea! There may even be practical uses—who knows? END

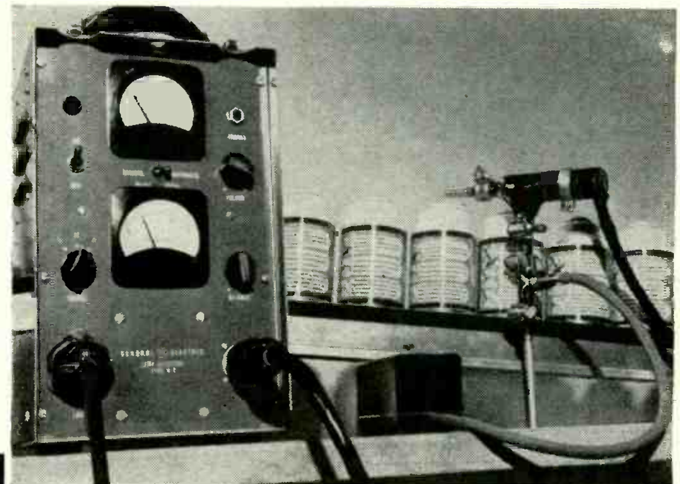
what's new?

NEW DEPARTURE in telephone design and efficiency was introduced at the convention of the Independent Telephone Industry at Chicago recently. Originated by Ericsson (the Telephone Co. of Sweden) the new unit makes a clean break with hand-and-desk-set tradition. The dial in the base is thus in the most convenient position for use when the phone is picked up. The switch is in the center of the base, so the "receiver is hung up" when the set is replaced on the table or desk. Styling combines esthetics with efficiency, and the internal construction is likewise the result of a complete departure from tradition. The number of terminal screws and soldering points, for example, has been reduced by 50%. Even the cord is a new design, part being coiled and the section nearest the phone straight. The instrument is being manufactured in this country by North Electric Co. of Galion, Ohio.

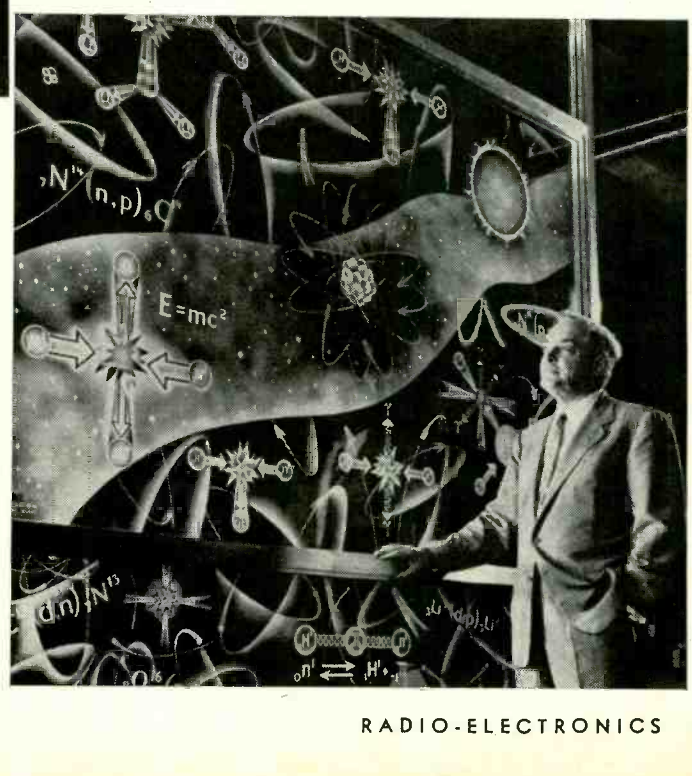




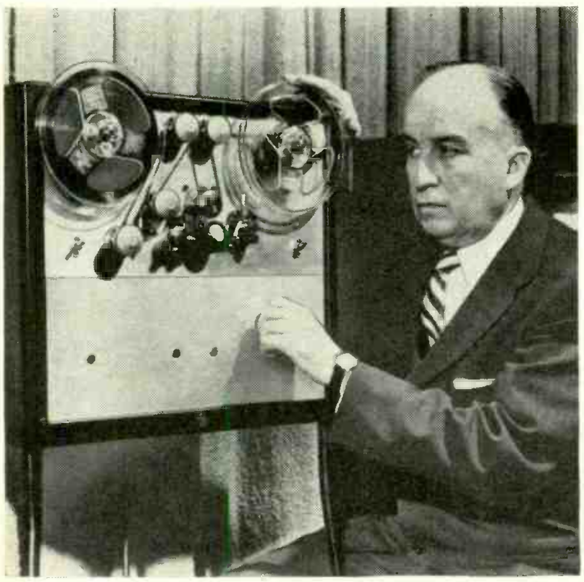
ELECTRONIC SNIFFER, used to detect minute quantities of gasses in the air, (RADIO-CRAFT, July 1948) has graduated from the class of interesting novelties to that of production tools. The gun here is checking for leaks in cans of compressed gasses, such as are now becoming common for insect sprays, varnishes and even as fuels for portable stoves. The sniffer depends on the change in ionization of the air between two of its electrodes, its conduction changing as changes in the composition of the air vary the ionization. The new sniffer is called the H-1 leak detector by its manufacturer, General Electric.



WONDERS OF RADIANT ENERGY are depicted in this huge glass panel that represents the flow of energy from the Sun, storage of energy within the atom and its eventual release for man's use through nuclear reactions. The panel was designed for the Nuclear Energy Products division of American Car & Foundry by Tony D'Attillio in cooperation with ACF scientists and was executed by Harriton Carved Glass in New York. The 8 x 9-foot panel is now on a tour of educational and scientific institutions. On its return it will be set up permanently in the lobby of one of the two plants of the Nuclear Energy division, whose president, Rudolph Furrer, is shown admiring the panel.



TRANSISTOR POWER is great enough to span the Atlantic. This was proven by three Massachusetts hams, who on Sept. 18 worked Denmark on a two-transistor transmitter. The three—Gus Fallgren and Al Hankinson of Raytheon's Missile Systems Laboratory in Bedford and Richard Wright, a student at Worcester Polytechnic Institute—operated from Fallgren's home in Chelmsford, Mass. The transmitter used two Raytheon 2N113/CK761 fusion-alloy transistors. No circuit information has been received to date, but from the photo it is almost obviously a crystal-controlled master-oscillator — power-amplifier setup. Contact was first established on the station's (W1OGU) transmitter, after which the transmitting antenna was switched over to the transistor job. Besides the trans-Atlantic record, contacts include Birmingham, England; the two Carolinas, Ohio, Michigan, Illinois, Puerto Rico and Costa Rica. An Australian ham reported dubious reception of W1OGU/transistorized, though QRM prevented confirmation. The operators' objective now is to work all continents on a transistor.



TELEVISION TAPE PLAYER for home use is forecast by this development, one of the "birthday presents" tendered by the RCA laboratory at Princeton, N. J., to David Sarnoff on the 50th anniversary of the commencement of his radio career. Four connections are made from the tape player to the TV set, and a standard 7-inch reel will play 4 minutes (tape speed 10 feet per second). A double-track tape, playing 8 minutes, is expected in the near future. With the addition of a small amount of additional equipment, the player can also be used as a recorder to store programs from the TV for future playing and could also be used with a TV camera and microphone to make original recordings. Its present size and complexity are about equal to that of an ordinary television receiver. Queried as to its prospective availability, RCA spokesmen would not guess, but left a feeling that it would be marketed not earlier than 2 years or later than 5 years hence.

TELESCOPIC TRACKER, which can hold a rocket fast jet in its sights at a distance of 300 miles and even fast enough to permit its operators to see a fast-moving artillery shell at closer ranges, has been developed by the Army Signal Corps. The object can not only be viewed but photographed automatically. Thus it can be used for study of the action of certain types of missiles as well as for following them. The device is designed to work in conjunction with radar apparatus and will assist in identifying objects which may look much alike on the radar screen but differ in appearance when viewed with the telescope. Telescope powers of 10, 20 and 40 are available and focal lengths of 160, 80, 40, and 20 inches.

surge supply for INTERMITTENTS

By LYMAN E. GREENLEE

TRACKING down intermittents can certainly be classified as the toughest kind of receiver servicing. As an aid in speeding up this work I have developed a surge supply that applies excessive voltages for a short period of time. In a great many cases the higher voltage is sufficient to provide that little extra to break down the intermittent component, making it easier to locate.

Fig. 1 shows a simple power supply which provides a variable source of voltage up to 600 for surge checking and routine voltage overload testing. A conventional half-wave rectifier circuit is used. Voltage regulation is not necessary so a simple circuit can be used; one easily duplicated from junk box parts. The only nonconventional part is the 1,000-volt 1-μf surge capacitor C3.

The 90-ohm 50-watt power rheostat in series with the power transformer serves as a fine voltage control. S2 acts as a low–high voltage switch by connecting either half or all of the transformer high-voltage winding into the circuit as required. The meter has a 500-μa movement; other values would necessitate different voltage multiplier resistors. This meter is a surplus unit with a dual scale reading 0–15 and 0–600 volts. It may be obtained at a low price and is very accurate. The power supply has two voltage ranges, 0–15 and 0–600.

The switching arrangement shifts the meter multiplier along with the voltage divider, but the 0–15 range is brought out to a separate pin to avoid the possibility of unintentionally applying high voltage to some part. This low-voltage range is useful primarily for checking low-voltage electrolytics and may be varied from about 1 to 15 volts as required. Note also the pilot lamps, one of which (PL2) may be used for continuity checking, and the pin jacks which provide an output of 6.3 volts ac for checking transformers, continuity of tube filaments, etc. Since the instrument provides a continuously variable, metered voltage output from about 1 to over 600 volts, capacitors can be checked for breakdown at their maximum voltage rating, electrolytics can be formed, resistors checked under load and surges applied to suspected parts.

The surge-check portion of the equipment consists of a 1-μf 1,000-volt oil-filled capacitor connected to S4. To use, one test lead is the common (ground) wire, the other goes to the pin jack connected to S4. When the test leads are connected across a component on the chassis, flipping S4 alternately charges the 1-μf capacitor to the metered voltage output and then discharges it through the suspected part. Several surges can be applied in a very short time by working the switch back and forth. A surge discharge is most useful in causing intermittent capacitors, resistors, chokes, yokes and transformers to break down completely so that they may be located and removed.

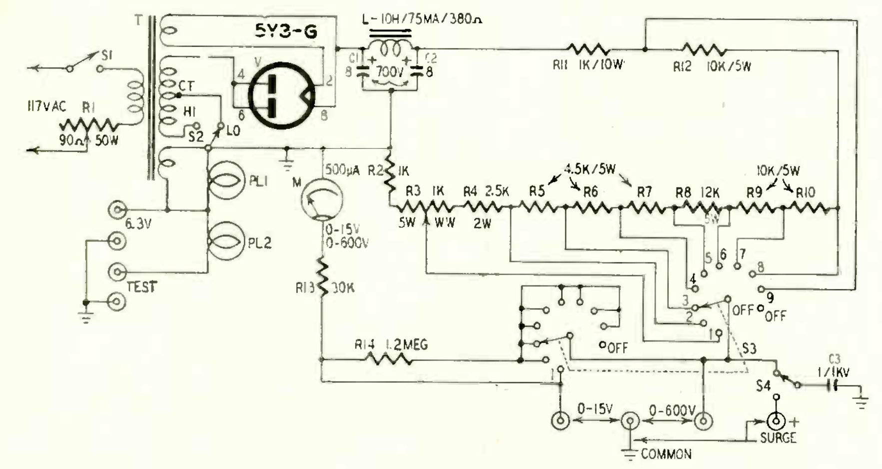
There are a few precautions to observe. Take care to avoid damage to certain critical parts like the filaments of tubes in portables (remove all tubes before applying a surge to any parts), transistors, diodes, low-voltage electrolytics and transformers wound with extremely fine wire. Fuses can also be damaged. Keep away from parts that could be ruined by a voltage surge or adjust the charging voltage to a safe level. If voltages are kept low enough there will be no danger of damage to such parts.

A lot of experimenting has indicated that 1 or 2 μf is about the right capacitance to give an adequate surge for checking and still stay within limits safe for most components. Higher capacitances may be used in special cases.

Be sure to keep the surges through transistors and diodes below their maximum rated operating voltage. Applying surges to suspected diodes or transistors is permissible and is in fact a good method of checking these parts if they are suspected of being intermittent.

Simple surge checking can be done with a few spare capacitors of various values, using a set's power supply as voltage source. However, a separate power supply is more convenient. And when equipped with a meter and some method of varying the output voltage, it becomes more accurate and there is so much less danger of damage to critical parts because the charging voltages can be adjusted to conform to the maximum rating of the parts under test.

Most surge checking can be done with the chassis disconnected from the power line. Actually, the method is specifically applicable to cold checking of a chassis with tubes removed, and this is the way it should be used. Surge checking will show up defective parts



R1—90-ohm 50-watt rheostat
R2—1,000 ohms, 1/2 watt
R3—1,000 ohms, 5 watts, wirewound pot
R4—2,500 ohms, 5 watts
R5, 6, 7—4,500 ohms, 5 watts
R8—12,000 ohms, 5 watts
R9, 10, 12—10,000 ohms, 5 watts
R11—1,000 ohms, 10 watts
R13—30,000 ohms (use 12,000 plus 18,000 ohms), 1/2 watt
R14—1.2 megohms, 1/2 watt
C1, 2—8 μf, 700 volts, electrolytic
C3—1 μf, 1,000 volts, oil filled
L—10 henries @ 75 ma, 380 ohms (see T for current rating)
V—5Y3-G
Octal socket for V
M—0.5 ma (500 μa) meter (see text)
S1—spst switch
S2, 4—spdt switch
S3—2-pole 10-position rotary switch
T—power transformer, approximately 600 volts ct @ 100 ma (use higher-current secondary if unit is to be used as conventional power supply), 5 volts @ 2 amps, 6.3 volts @ 1 amp or more (depending upon use of unit)
PL1, 2—6.3-volt pilot lamps and assemblies
Pin jacks (8)
Chassis
Cabinet

Fig. 1—Schematic diagram of the 600-volt power supply for overload testing.

that might not otherwise break down for days or even weeks of normal routine checking, overloading, heating, pounding, hammering, squeezing and mauling as ordinarily performed by the technician when dealing with an intermittent. Since the surges can be confined to specific parts and locations there is not the same chance of damage to perfectly good components as with the line voltage set at—say—150 volts, for long periods of cooking and overload checking.

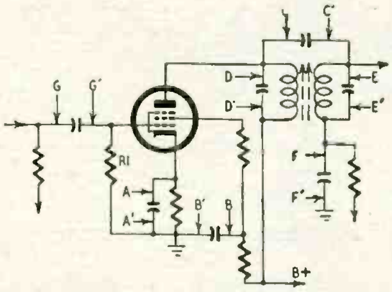
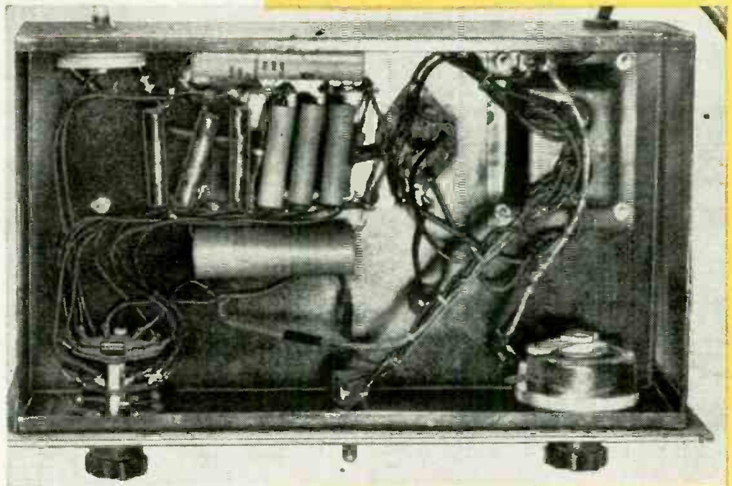


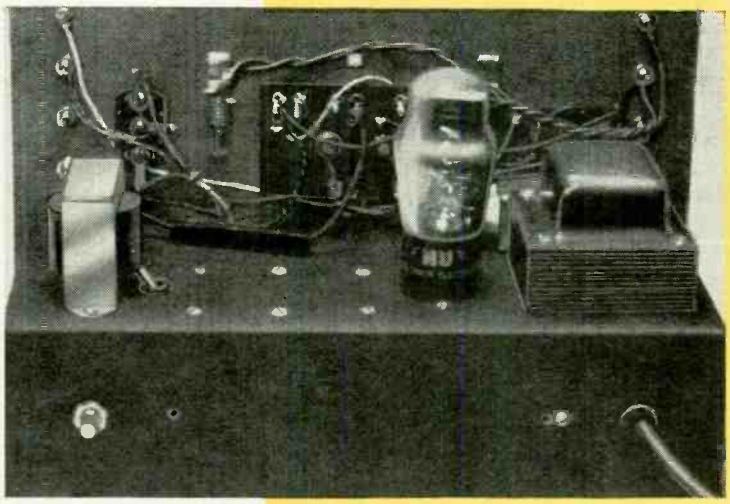
Fig. 2—Typical amplifier circuit with points indicated for surge testing.

Fig. 2 shows a typical amplifier stage and the various points where the surge voltage may be applied. Surge capacitor C3 may be charged to 50 volts and applied across A–A'; charged to 400 volts and placed across B–B', D–D', E–E' and F–F'; charged to 600 volts and discharged across points C–C' and G–G'.

To check resistors, charge the surge capacitor to the required voltage and connect across the suspected resistor. For example, connect between points G' and A' to check grid resistor R1. Good resistors will not be harmed by a surge from a 1-μf capacitor regardless of the voltage used. END



Underchassis wiring of the supply.

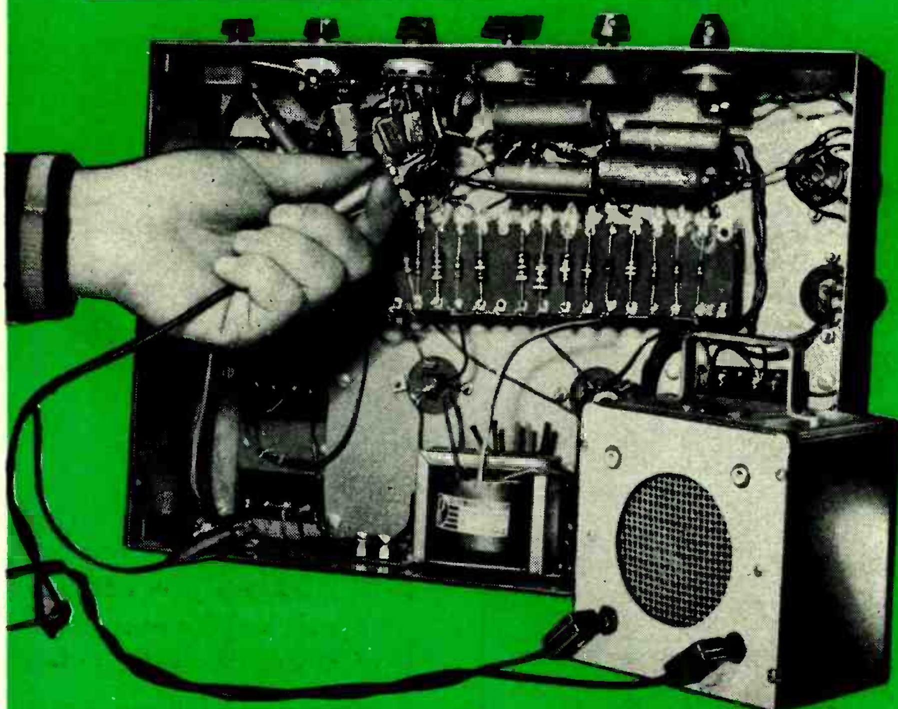


Rear view of unit—surge capacitor is behind the power transformer.

Front panel view of the surge supply.

TRANSISTORIZED

audio amplifier—audio tester



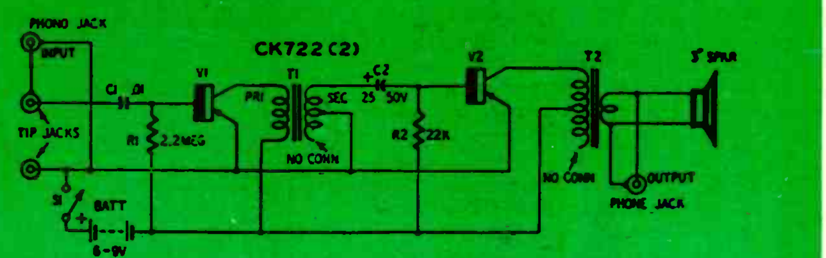
Small transistorized unit is built around 3-inch speaker

By HOMER L. DAVIDSON

THIS transistorized amplifier was built around a small 3-inch PM speaker, chosen because of its availability and compactness. As is, the unit measures 4½ by 4 inches and is 2½ inches deep.

Two Raytheon CK722 transistors were used in cascade. The small amplifier can be used for many things: as an audio amplifier for crystal receivers or small 1- or 2-tube receivers. It is also being used to trace audio signals through radio, television and auto radios. By adding a small rf probe, as described later, rf can be traced through radio receiving equipment.

The circuit (Fig. 1) is easy to follow, only a few components are used. A A .01-μf paper capacitor couples the input signal to the base of V1. Resistor R1 is a 2.2-megohm base return that develops correct bias for the first audio stage. There are two input jacks of different types to inject the input signal. One input consists of two small tip jacks, one black the other red. The other input connection was placed on the amplifier so that phonograph changers could be easily plugged in while working on them. This input is a regular phono jack. The collector terminal of V1 feeds the primary of a push-pull interstage transformer. The secondary is coupled to a 25-μf low-voltage electrolytic. By experiment, a better matching resulted when only one half of this transformer was used. A 22,000-ohm resistor was used as a bias return for V2.

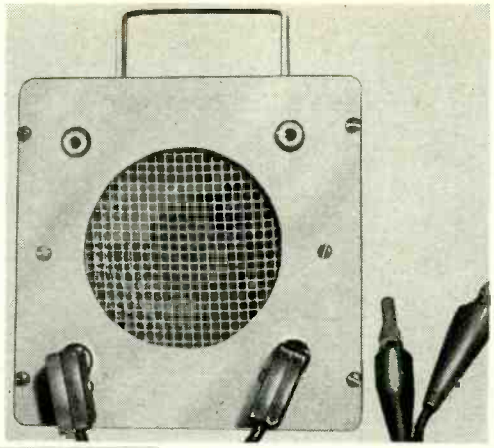


R1—2.2 megohms, ½ watt
R2—22,000 ohms, ½ watt
C1—.01 µf
C2—25 µf
V1, V2—CK722 transistors
S1—spst switch
BATT—9-volt battery (6 penlight cells)
Spkr—3-inch PM loudspeaker
T1—push-pull audio input transformer, primary 7,000 to 15,000 ohms impedance, 1:2 turns ratio. (Stancor A52-C or equivalent, see text)
T2—output transformer, universal type (Merit A-2900 or equivalent)
Phone tip jacks (2)
Phono jacks
Chassis and cabinet (see text)

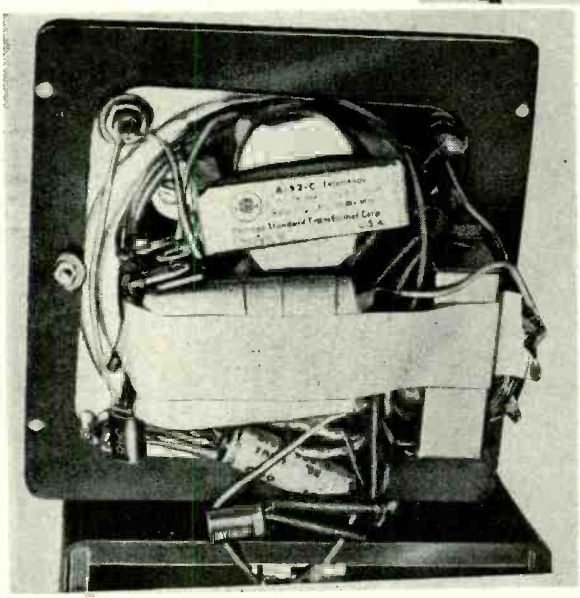
Fig 1—The amplifier-audio tester uses two transistors.

These small transistors should never pull over 5 ma and, by using a variable resistor in the original circuit, these fixed resistors were chosen for correct amplification and current drain. V1 draws only 1.5 ma while the last audio output stage draws 4 ma. To match the output of V2 correctly to the output transformer a small universal type was chosen. Again only one half on the primary was used while the other end was cut off and taped. The secondary of output transformer T2 can be soldered into the circuit. Also in the secondary was placed an output jack, another female phono plug. This was used to check the output of auto receivers that were pulled, with the original speaker left in the car. It can also be used to replace any PM speaker. Both emitter terminals are soldered directly to ground or to a common tie point.

Before mounting the parts the speaker was prepared. The four speaker mounting holes were drilled



Closeup of simple tester.



Parts layout of the amplifier. Speaker forms chassis for entire unit.

and enlarged to ¼ inch in diameter. In the bottom two holes, two small phone jacks were installed. The black jack was tightened directly to the speaker frame and used as a common or grounding point. The red jack was insulated from the metal speaker frame with insulation washers. In the two top holes the phono jacks were mounted. A piece of spaghetti was placed over the center terminal so it would not short against the metal frame. The grounding lugs were soldered directly to the speaker.

The two transformers were mounted on separate metal frames and held into place by the black grounding jack. Then two or three insulated standoff lugs were soldered to the outside edges of each transformer. On these lugs the transistors were soldered and mounted into place. Again insulated spaghetti was placed over the transistor leads so that they would not short. The transistor leads were not cut but soldered directly into the circuit. The base-return resistors were mounted as they were hooked up. The small battery supply was made up of six small penlight cells, 9 volts. They were soldered in series and then taped. A spst sliding type switch was used to turn the small amplifier on and off.

The amplifier was mounted in a homemade wooden cabinet. The sides were cut out of ¼-inch plywood and nailed

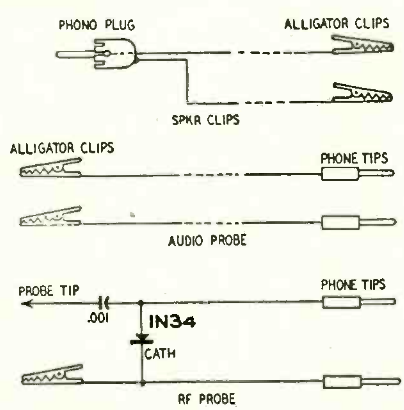


Fig. 2—Leads and probe for use with the amplifier tester.

together with small brads. Both front and bottom panels were sawed from Masonite, cut and drilled, and then screwed to the wood frame. A small handle was added for carrying convenience.

A small rf probe can be constructed, as shown in Fig. 2, to signal-trace through rf and if stages. Another set of leads were made up of pin jacks on one end and alligator clips on the other. For the voice-coil output jack a male phono plug was soldered to two test leads with alligator clips at the other end. END

For Your Convenience

With the growing interest in construction—largely inspired by the transistor—RADIO-ELECTRONICS is including a larger number of construction articles. To make life easier for constructors (though hardly for the editors!), we are increasing the amount of information given in schematics and photographic illustrations.

● SCHEMATICS will generally have all parts coded (R1, C2, etc.), in addition to our long-time practice of having the value noted next to the part.

● CODED PARTS LIST will also be furnished. This should settle such parts list questions as: which of the five 100 K-ohm resistors specified are ½ watt, 1 watt and 2 watt?

● PHOTOGRAPHS will have many more call-outs than in the past, to eliminate difficulties which might result from parts placement different from the original constructor's and to make parts location obvious without need for careful study.

Let us know what you think of these steps, and what others should be taken to help the reader make better use of his magazine.

SCOPE delivers audio test signal

Simple scope modification permits testing amplifier frequency response and stability

By CHARLES F. WOLF

A SAWTOOTH-voltage sweep generator is very useful in amplifier testing. Many circuits for this have appeared. However, if one has an oscilloscope, the sweep generator therein may easily be used when it is calibrated and an output terminal provided.

Fig. 1 is a schematic for modifying a Heath model O-8 oscilloscope to provide a sawtooth output. Here the output is tapped off at the cathode and plate pins of the horizontal phase-splitting tube. A spdt switch (with a center off position) is used to give positive or negative pulses, positive from the plate and negative from the cathode. A 20,000-ohm potentiometer provides a variable output, the maximum being 5 volts, peak to peak.

The sweep generator is calibrated as shown in Fig. 2 by plotting the frequency against the setting of the FREQ. VERNIER control, using semilog graph paper. A scope that has voltage regulation (as the O-8) will have very good sweep-frequency stability. However, without voltage regulation the frequency will be stable enough for most testing purposes.

When this modification is made on another type scope, the value of the potentiometer should be made as low as possible without loading the phase-splitting tube too much. A value that decreases the sawtooth voltage by about a 5% maximum is tolerable.

In Fig. 3 the spdt switch and potentiometer are shown mounted between the HOR. GAIN control and the FREQ. SELECTOR knobs. The output jack is mounted in the lower right-hand corner between the 60 CY. TEST and GROUND jacks.

The 60-cycle test can be used for calibrating the lower-frequency ranges of the sweep generator. This is done in a manner somewhat similar to that of using Lissajous patterns except that we have here a sine wave and a sawtooth wave (not two sine waves, as with Lissajous figures).

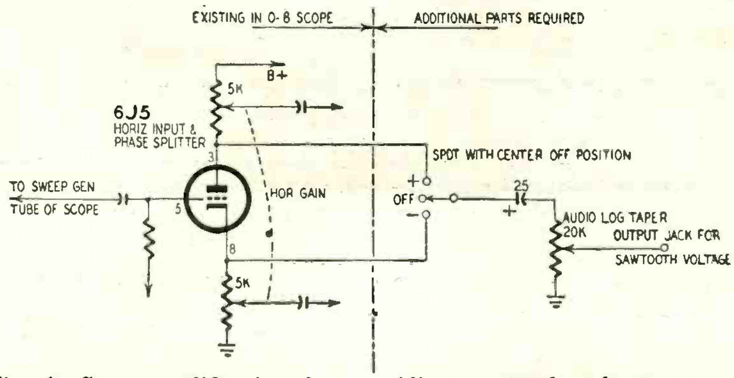


Fig. 1—Scope modification for providing sawtooth voltage output.

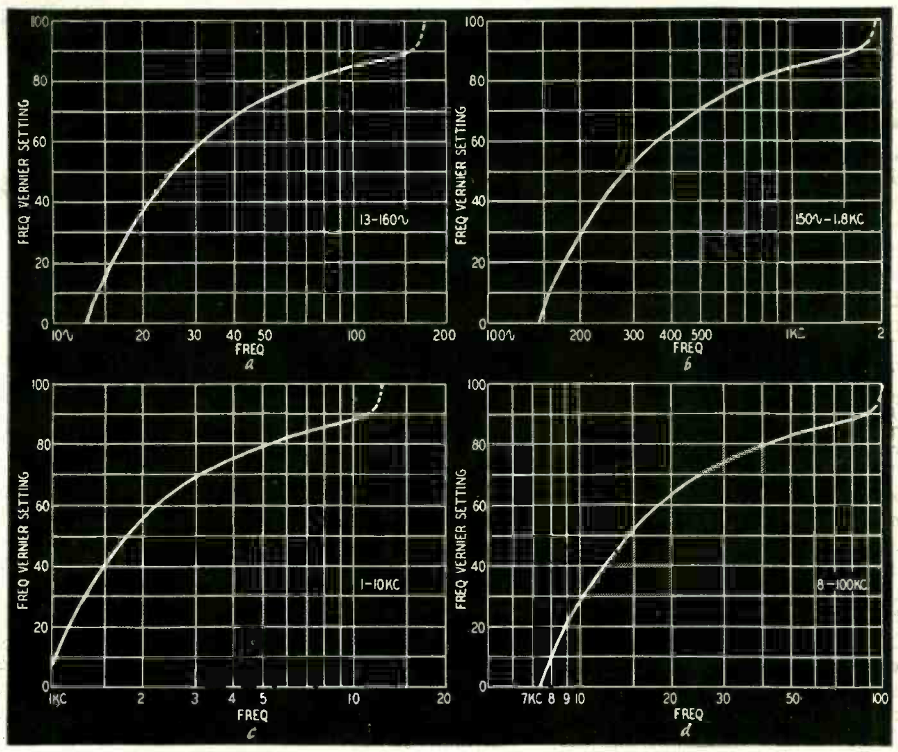


Fig. 2—Charts show generator frequency calibrated against vernier setting.

Oscilloscope patterns

In Fig. 3, the pattern on the scope screen is formed by a sine wave applied to the vertical plates of the scope and a sawtooth wave to the horizontal plates. When the sine wave is 60 cycles, the frequency of the sawtooth wave can be determined by the formula:

$$f = \frac{\text{separate traces} \times 60}{\text{horizontal intersections}}$$

Separate traces means the number of distinctly separate traces that can be counted; three in this case, being easiest to count in a vertical line.

Horizontal intersections means the number of intersections that can be counted in *one* horizontal straight line—four in this case.

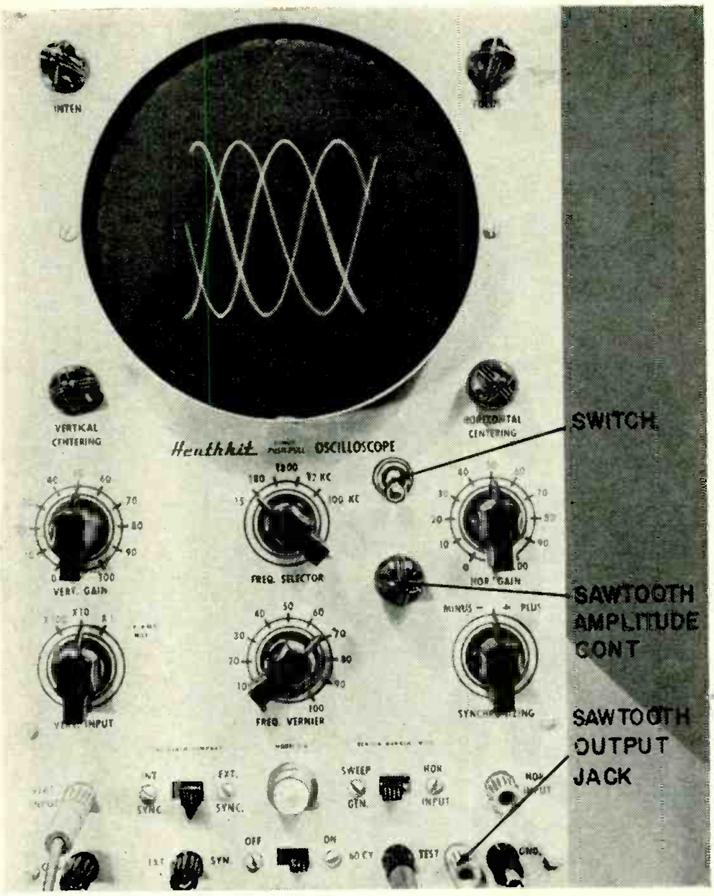


Fig. 3—Oscilloscope panel showing switch, potentiometer and output jack.

Thus in Fig. 3 the frequency of the sawtooth wave is:

$$f = \frac{3 \times 60}{4} = 45 \text{ cycles}$$

Fig. 4 shows the very familiar 120-cycle sawtooth trace, or as expressed according to the formula:

$$f = \frac{2 \times 60}{1} = 120 \text{ cycles}$$

Fig. 5 shows an 80-cycle sawtooth.

This method can also be used for setting exactly and simply the sweep-generator frequency to one of many fractional multiples of the frequency of the sine wave that is applied to the vertical amplifier plates. When 60 cycles is used, the sweep generator can be set to any one of these values, up to about 600 cycles.

A correspondingly higher steady sine-wave source is used to calibrate the higher ranges of the sweep generator. When the calibration of the various ranges has been accurately carried out, the curves for the various ranges will have almost exactly the same shape (see Fig. 3) and form, except that they will be shifted with respect to frequency.

In calibrating a scope sweep generator, the synchronization switch must be turned off as any sync applied to the sweep tube will throw the calibration completely off. With synchronization the sweep generator is able to produce the same frequency for different settings of the frequency vernier control.

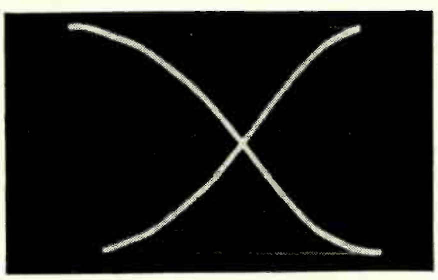


Fig. 4—60 cycles applied to vertical input—sawtooth frequency 120 cycles.

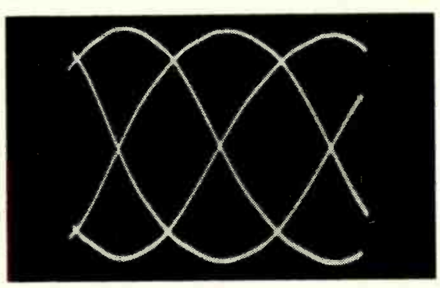


Fig. 5—60 cycles applied to vertical input—sawtooth frequency 80 cycles.

Generator applications

Besides being used to determine the frequencies of waveforms using the above methods, the generator has two important other uses: testing frequency response and amplifier stability.

When checking frequency response, the sawtooth wave is applied to the input of the amplifier or system under test and the output is viewed on the scope, using the vertical input terminals. When used in this way, the sweep generator of the scope performs two functions—a horizontal sweep for the scope pattern and a test signal. If the system being tested reproduces the sawtooth wave perfectly, the resulting pattern on the scope screen will be a straight line slanting up or down from left to right, depending upon the polarity of the sawtooth wave used.

Also, if the sawtooth wave is reproduced perfectly, then the frequency response of the system under test will be flat from approximately 0.1 to 10 times the base frequency of the sawtooth wave being used. For example, an amplifier which reproduces perfectly 100-, 1,000- and 10,000-cycle sawtooth waves is flat from 10 to 100,000 cycles. To get this data using sine-wave signals would take quite a bit of time whereas with sawtooth waves we have to use only three frequencies.

In testing for amplifier stability and transient response the sawtooth wave is a bit better than the square wave because a square wave will fail to show overloading while the top of a sawtooth wave will be clipped off at the point where overloading occurs. Instability or poor transient response is shown on a sawtooth wave by parasitic oscillation on the front part of the waveform. In testing for stability, slowly sweep the sawtooth generator through its entire frequency range a number of times, each time varying the voltage of the sawtooth wave, starting with very low values and working up to the point of amplifier overloading. Sometimes an amplifier will show instability at low levels but not at high, and vice versa. An amplifier that passes this test can be judged extremely stable.

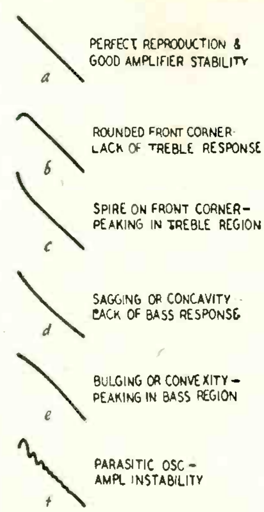


Fig. 6—Oscilloscope waveforms and the amplifier defects they indicate.

Fig. 6 is a list of oscilloscope diagrams of the various symptoms and causes as displayed by the sawtooth wave. Only one period of the wave is shown as this is how it will look when the same sawtooth wave is used as horizontal sweep and test signal. END

References

R. C. Hitchcock, "Testing With White Sound," *Audio Engineering*, October, 1954.

J. C. Arnold, "Check Audio Response With a Neon Glow Tube," RADIO-ELECTRONICS, November, 1952.

New

MODEL O-11
Shpg. Wt.
21 Lbs.

$69.50

* *An improved model of what was already an outstanding instrument.*

* *Performance is unmatched in this price range.*

* *Incorporates the extra features required for color TV servicing.*

HEATHKIT ETCHED CIRCUIT, PUSH-PULL

5″ Oscilloscope Kit

COLOR TV

The previous Heathkit oscilloscope (Model O-10) which was already a most remarkable instrument, has been improved even further with the release of the Heathkit Model O-11. It incorporates all the outstanding features of the preceding model, *plus* improved vertical linearity, better sync stability, especially at low frequencies, and much-improved over-all stability of operation, including less vertical bounce with changes in level. These improvements in the Model O-11 circuit make it even more ideally suited for color TV servicing, and for critical observations in the electronic laboratory. Vertical response extends from 2 CPS to 5 MC without extra switching. Response only down 1½ DB at 3.58 MC. The 11-tube circuit features a 5UP1 cathode-ray tube. Sync circuit functions effectively from 20 CPS to better than 500 kc in five steps. Modern etched circuit boards employed in the oscilloscope circuit cut assembly time almost in half, permit a level of circuit stability never before achieved in an oscilloscope of this type, and insure against errors in assembly. Both vertical and horizontal output amplifiers are push-pull. Built-in peak-to-peak calibrating source — step-attenuated input — plastic molded capacitors and top-quality parts throughout — pre-formed and cabled wiring harness — and numerous other "extra" features. A professional instrument for the serviceshop or laboratory. Compare its specifications with those of scopes selling in much higher price brackets. You can't beat it!

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

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

MODEL OM-2

$42.50

Shpg. Wt. 21 Lbs.

HEATHKIT LOW CAPACITY PROBE KIT

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

No. 342

$3.50

Shpg. Wt. 1 Lb.

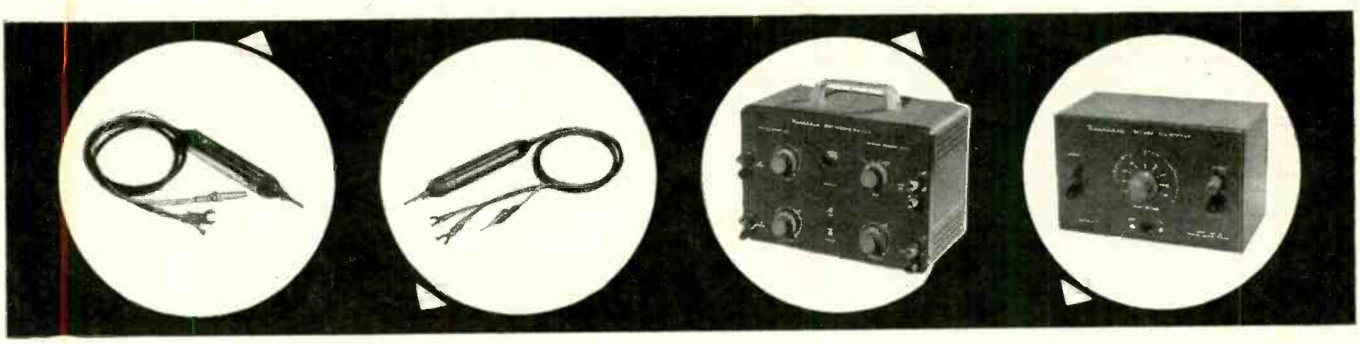
HEATHKIT ELECTRONIC SWITCH KIT

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

MODEL S-3

$21.95

Shpg. Wt. 8 Lbs.



HEATHKIT SCOPE DEMODULATOR PROBE KIT

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

NO. 337-C

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HEATHKIT VOLTAGE CALIBRATOR KIT

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

MODEL VC-3

$12.50

Shpg. Wt. 4 Lbs.

HEATHKIT ETCHED CIRCUIT VACUUM TUBE Voltmeter Kit

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

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

HEATHKIT Etched Circuit RF PROBE KIT

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

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

HEATHKIT 20,000 OHMS/VOLT VOM KIT

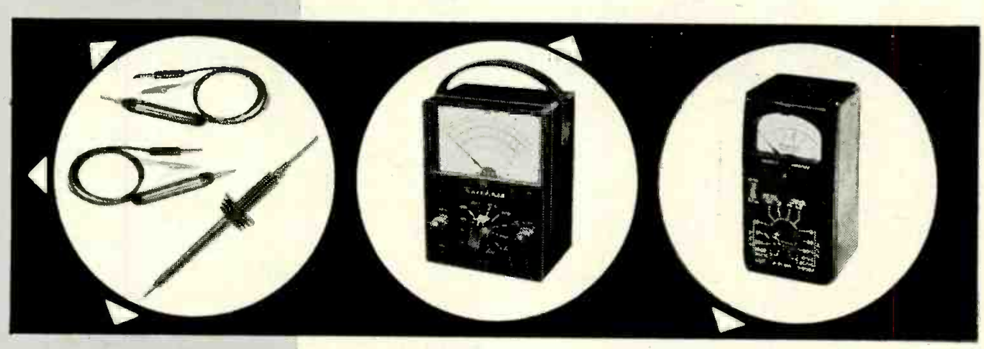
Sensitivity of this instrument is 20,000 ohms-per-volt DC and 5,000 ohms-per-volt AC. Measuring ranges are 0-1.5, 5, 50, 150, 500, 1500, and 5000 volts for both AC and DC. Also measures current in the ranges of 0-150 microamperes, 15 ma, 150 ma, 500 ma, and 15 a. Resistance ranges provide multipliers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

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

HEATHKIT SCOPE DEMODULATOR PROBE KIT

This probe functions like an AM detector to pass only modulation of signal and not signal itself. Permits observation of modulation from RF or IF carriers in TV and radio receivers. Extends usefulness of your oscilloscope. Voltage limits are 30 V. rms, and 500 V. DC. Very valuable in service or laboratory applications.

No. 337-C **$3.50** Shpg. Wt. 1 Lb.



HEATHKIT 30,000 VOLT DC HIGH VOLTAGE PROBE KIT

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

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

HEATHKIT HANDITESTER KIT

The Model M-1 measures AC or DC voltage at 0-10, 30, 300, 1000, and 5000 volts. Direct current ranges are 0-10 ma, and 0-100 ma. Ohmmeter ranges are 0-3000 (30 ohm center scale) and 0-300,000 ohms (3,000 ohms center scale). Uses a 400 microampere meter for sensitivity of 1000 ohms-per-volt. A very popular test device for the home experimeter, electricians, and appliance repairmen, and for use as an "extra" instrument in the service shop. Its small size and rugged construction make it perfect for any portable application. Easily slips into your tool box, glove compartment, coat pocket, or desk drawer. Top quality, precision components employed throughout.

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

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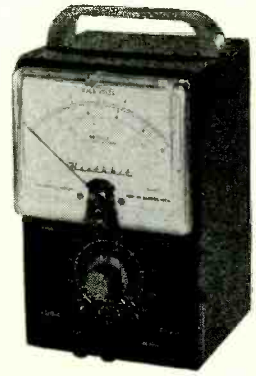
* *Brand new circuit for extended frequency response and added stability.*
* *Ten accurate ranges from 0-.01 to 0-300 volts.*
* *Modern, functional panel styling. "On-off" switch at both extreme ends of range switch.*



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

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

MODEL AV-3

$29.95

Shpg. Wt. 5 Lbs.

HEATHKIT AUDIO WATTMETER KIT

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

MODEL AW-1

$29.50

Shpg. Wt. 6 Lbs.

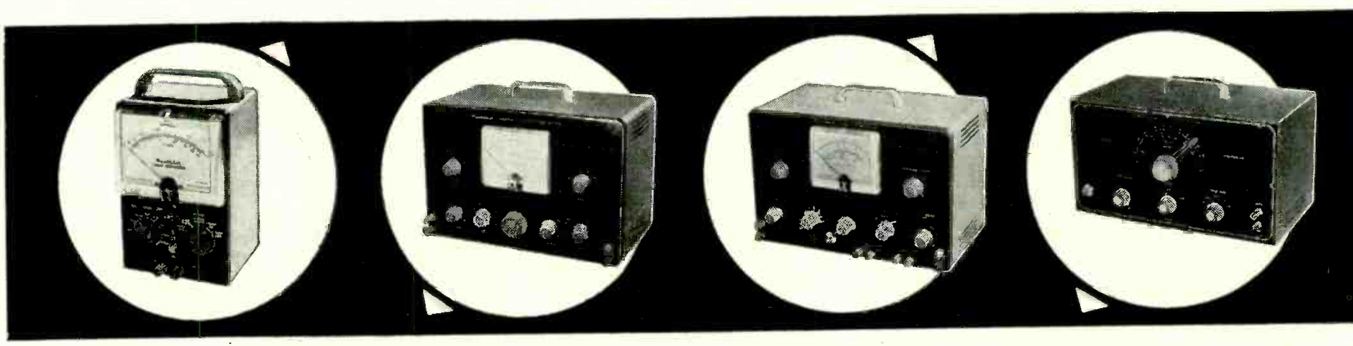
HEATHKIT AUDIO ANALYZER KIT

This multi-function instrument combines an AC VTVM, an audio wattmeter, and an intermodulation analyzer into one case, with combined input and output terminals and built-in high and low frequency oscillators. The VTVM ranges are .01. .03, .1, .3, 1, 3, 10, 30, 100. and 300 volts (RMS). Wattmeter ranges are .15 MW, 1.5 MW, 15 MW, 150 MW, 1.5 W, 15 W, 150 W. IM scales are 1%, 3%, 10%, 30%, and 100%. Provides internal load resistors of 4, 8, 16, or 600 ohms. A valuable instrument for the engineer or serious audiophile.

MODEL AA-1

$49.95

Shpg. Wt. 13 Lbs.



HEATHKIT HARMONIC DISTORTION METER KIT

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

MODEL HD-1

$49.50

Shpg. Wt. 13 Lbs.

HEATHKIT AUDIO OSCILLATOR KIT

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

MODEL AO-1

$24.50

Shpg. Wt. 10 Lbs.

HEATHKIT

Audio Generator Kit

MODEL AG-9

$34.50

Shpg. Wt. 8 Lbs.

* *Less than 0.1% distortion — ideal for hi fi work.*
* *Large 4½" meter indicates output.*
* *Step-type tuning for maximum convenience.*

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

HEATHKIT RESISTANCE SUBSTITUTION BOX KIT

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

MODEL RS-1 — $5.50 — Shpg. Wt. 2 Lbs.

HEATHKIT CONDENSER SUBSTITUTION BOX KIT

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

MODEL CS-1 — $5.50 — Shpg. Wt. 2 Lbs.

HEATHKIT AUDIO GENERATOR KIT

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

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

HEATHKIT DECADE CONDENSER KIT

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

MODEL DC-1 — $16.50 — Shpg. Wt. 3 Lbs.

HEATHKIT DECADE RESISTANCE KIT

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

MODEL DR-1 — $19.50 — Shpg. Wt. 4 Lbs.

HEATHKIT VARIABLE VOLTAGE REGULATED POWER SUPPLY KIT

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

MODEL PS-3 — $35.50 — Shpg. Wt. 17 Lbs.

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

BONUS PERFORMANCE . . .

If a single word had to be selected to describe Heath Company advertising policy, it would be "conservative." By this we mean that the performance specifications and features are not exaggerated, and that the descriptions are accurate. We specify performance on the conservative side so you can be sure of equaling or exceeding our specifications. In almost every instance our kits will do more than we claim. Extra care in construction, and calibration against an accurate standard can extend performance well beyond advertised levels.

HEATHKIT

Signal Generator Kit

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

MODEL SG-8

$19.50 *Shpg. Wt. 8 Lbs.*

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

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

HEATHKIT LABORATORY GENERATOR KIT

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

MODEL LG-1

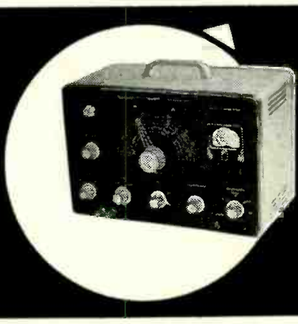
$48.95 *Shpg. Wt. 16 Lbs.*

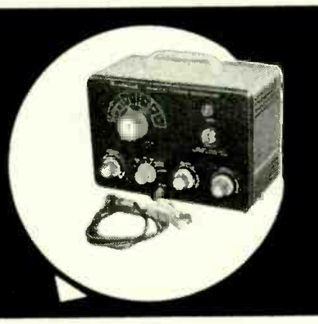
HEATHKIT TV ALIGNMENT GENERATOR KIT

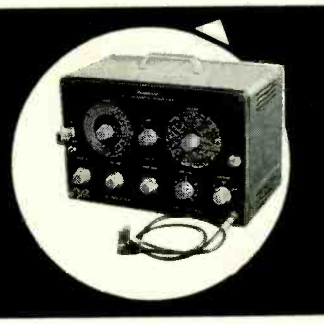
This improved sweep generator model provides essential stability and flexibility for work on FM, monochrome TV, or color TV sets. Covers 3.6 mc to 220 mc in four bands. Provides usable output even on harmonics. Sweep deviation from 0-42 mc, depending on base frequency. All-electronic sweep circuit eliminates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

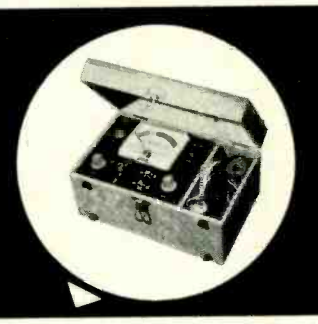
MODEL TS-4A

$49.50 *Shpg. Wt. 16 Lbs.*









HEATHKIT LINEARITY PATTERN GENERATOR KIT

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

MODEL LP-2

$22.50 *Shpg. Wt. 7 Lbs.*

HEATHKIT CATHODE RAY TUBE CHECKER KIT

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

MODEL CC-1

$22.50 *Shpg. Wt. 10 Lbs.*

HEATHKIT

$29.50
Shpg. Wt. 12 Lbs.

MODEL TC-2

Tube Checker Kit

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

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

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

HEATHKIT TV PICTURE TUBE TEST ADAPTER

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

MODEL 355
$4.50
Shpg. Wt. 1 Lb.

HEATHKIT PORTABLE TUBE CHECKER KIT

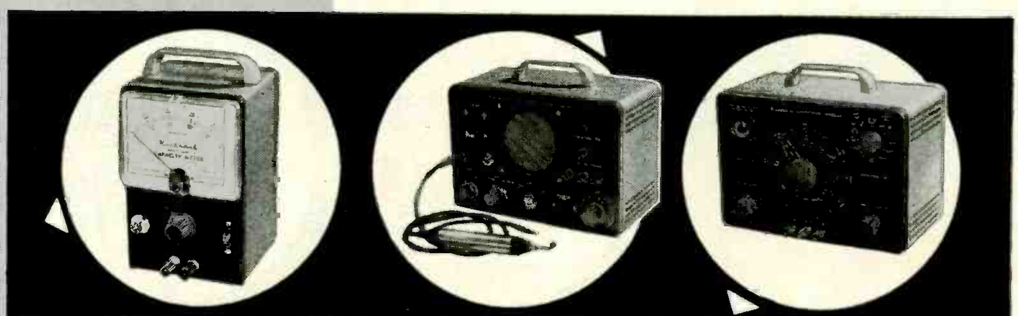
This portable tube checker is identical, electrically, with the Model TC-2. However, it is housed in an attractive and practical carrying case, finished in proxylin impregnated material. The cover is detachable, and the hardware is brass plated. This rugged unit is ideal for home service calls or any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

MODEL TC-2P
$34.50 Shpg. Wt. 15 Lbs.

HEATHKIT VISUAL-AURAL SIGNAL TRACER KIT

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

MODEL T-3
$23.50
Shpg. Wt. 9 Lbs.



HEATHKIT DIRECT READING CAPACITY METER KIT

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

MODEL CM-1
$29.50
Shpg. Wt. 7 Lbs.

HEATHKIT CONDENSER CHECKER KIT

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

MODEL C-3
$19.50
Shpg. Wt. 7 Lbs.

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

PIONEER DESIGN . . .

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

HEATHKIT

Impedance Bridge Kit

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

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

MODEL IB-2

$59.50 *Shpg. Wt. 12 Lbs.*

HEATHKIT "Q" METER KIT

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

MODEL QM-1

$44.50

Shpg. Wt. 14 Lbs.

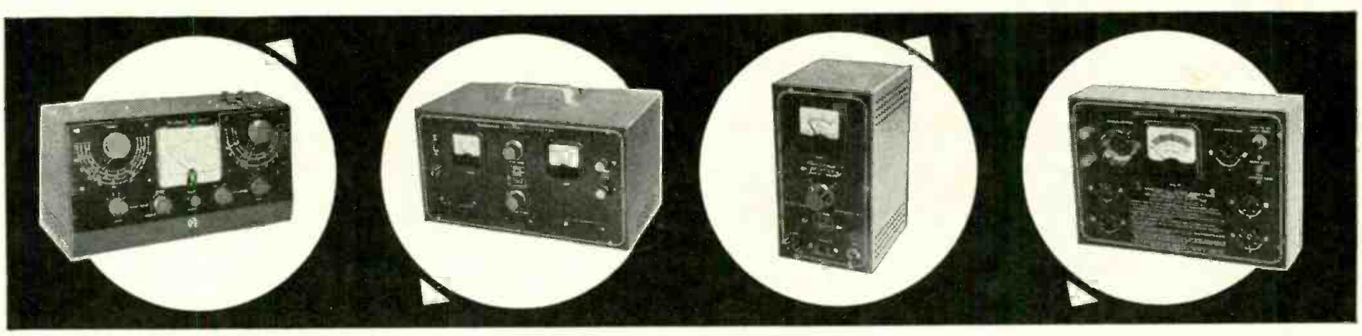
HEATHKIT ISOLATION TRANSFORMER KIT

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

MODEL IT-1

$16.50

Shpg. Wt. 9 Lbs.



HEATHKIT 6-12 VOLT BATTERY ELIMINATOR KIT

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

MODEL BE-4

$31.50

Shpg. Wt. 17 Lbs.

HEATHKIT 6-VOLT VIBRATOR TESTER KIT

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

MODEL VT-1

$14.50

Shpg. Wt. 6 Lbs.

HEATHKIT DX-100 PHONE AND CW

Transmitter Kit

MODEL DX-100

Shpg. Wt. 107 Lbs.

$189.50

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

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

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

HEATHKIT COMMUNICATIONS TYPE ALL BAND RECEIVER KIT

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

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

MODEL AR-3

$30.75

INCLUDING NEW EXCISE TAX‡

(Less Cabinet)

Shpg. Wt. 12 Lbs.

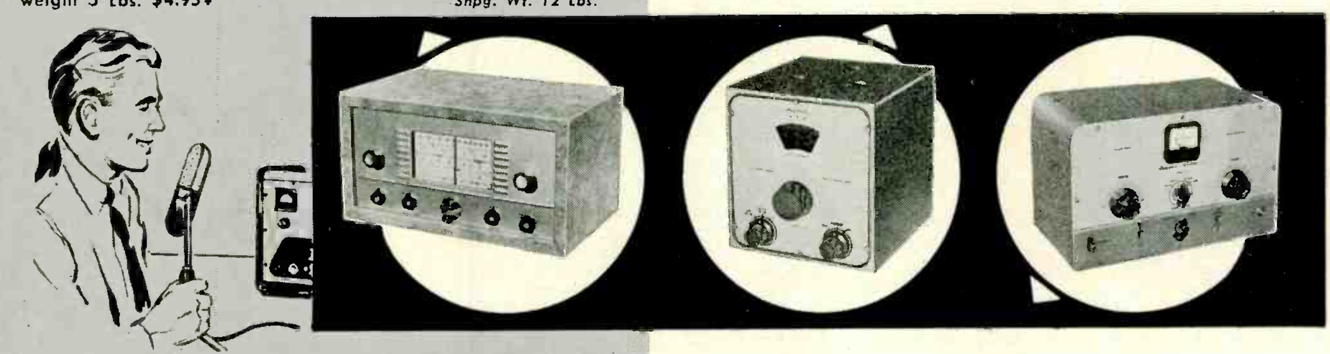
HEATHKIT VFO KIT

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

MODEL VF-1

$19.50

Shpg. Wt. 7 Lbs.



EASY ON THE BUDGET!

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

HEATHKIT CW TRANSMITTER KIT

This is the original low-priced Heathkit CW transmitter. Its reliable performance has been proven time and time again on the CW bands. Designed for crystal control, the Model AT-1 covers 80, 40, 20, 15, 11, and 10 meters. May be excited from external VFO. Plate power input up to 30 watts. Power supply built in. Panel meter indicates grid current or plate current for final. Incorporates pre-wound coils, copper-plated chassis, built-in line filter, profuse shielding, and top-quality parts throughout. Crystal socket and key jack on front panel. Built-in key-click filter, and single-knob bandswitching. 52-ohm coaxial output. Uses 6AG7 oscillator-multiplier, 6L6 power amplifier-doubler, and 5U4G rectifier.

MODEL AT-1

$29.50

Shpg. Wt. 15 Lbs.

HEATH COMPANY

A Subsidiary of Daystrom, Inc.

BENTON HARBOR 20, MICH.

DOLLAR-SAVING ECONOMY . . .

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

HEATHKIT PHONE AND CW

Transmitter Kit

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

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

MODEL DX-35

$56.95 Shpg. Wt. 24 Lbs.

HEATHKIT ANTENNA IMPEDANCE METER KIT

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

MODEL AM-1

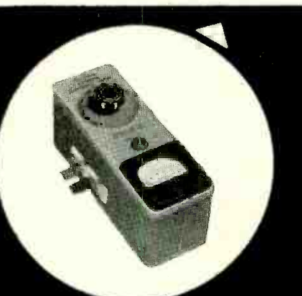
$14.50 *Shpg. Wt. 2 Lbs.*

HEATHKIT "Q" MULTIPLIER KIT

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

MODEL QF-1

$9.95 *Shpg. Wt. 3 Lbs.*



HEATHKIT ANTENNA COUPLER KIT

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

MODEL AC-1

$14.50 *Shpg. Wt. 4 Lbs.*

HEATHKIT GRID DIP METER KIT

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

MODEL GD-1B

$19.95 *Shpg. Wt. 4 Lbs.*

HEATHKIT BROADCAST BAND Receiver Kit

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

$19.25
INCLUDING NEW EXCISE TAX‡

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

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

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

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

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

HEATHKIT PROFESSIONAL RADIATION COUNTER KIT

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

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

HEATHKIT CRYSTAL RECEIVER KIT

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

MODEL CR-1
$8.75
INCLUDING NEW EXCISE TAX‡
Shpg. Wt. 3 Lbs.

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

HEATHKIT ENLARGER TIMER KIT

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

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

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

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

HEATHKIT HIGH FIDELITY

Preamplifier Kit

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

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

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

$19.75

HEATHKIT HIGH FIDELITY FM TUNER KIT

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

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

MODEL FM-3A **$26.95** INCLUDING NEW EXCISE TAX‡ *(With Cabinet) Shpg. Wt. 7 Lbs.*

HEATHKIT BROADBAND AM TUNER KIT

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

MODEL BC-1 **$26.95** INCLUDING NEW EXCISE TAX‡ *(With Cabinet) Shpg. Wt. 8 Lbs.*

HEATHKIT ELECTRONIC CROSS-OVER KIT

This unusual device functions to separate low frequencies and high frequencies so that they may be fed to separate amplifiers and to separate speakers. This eliminates the need for conventional cross-over circuits, since the Model XO-1 does the complete job electronically. Cross-over frequencies of 100, 200, 400, 700, 1,200, 2,000 and 35 00 CPS are selectable with front panel controls on the XO-1, and a separate level control is provided for each channel. Minimizes intermodulation distortion problems. Handles unlimited power, since frequency division is accomplished ahead of the power stage. Attenuation is 12 DB per octave. with sharp "knee" at cut-off frequency.

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

HEATHKIT ADVANCED-DESIGN HIGH FIDELITY

Amplifier Kit

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

MODEL W-5

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

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

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

HEATHKIT DUAL-CHASSIS—WILLIAMSON TYPE HIGH FIDELITY AMPLIFIER KIT

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

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

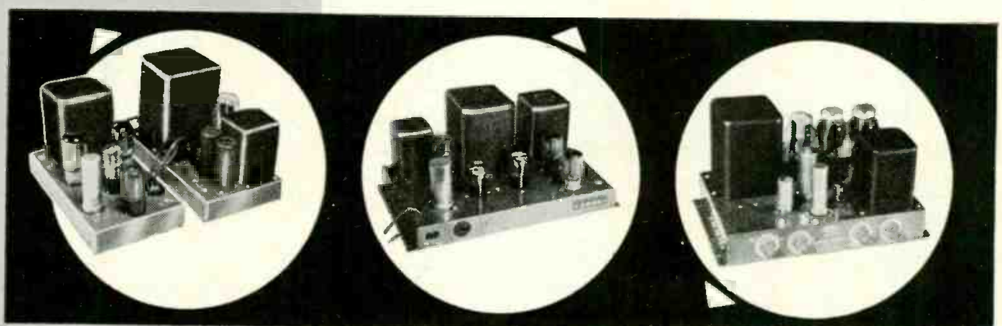
MODEL W-3: Consists of Model W-3M *plus* Model WA-P2 preamplifier. Shpg. Wt. 37 Lbs. Express only.............$69.50

HEATHKIT SINGLE CHASSIS—WILLIAMSON TYPE HIGH FIDELITY AMPLIFIER KIT

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

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

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



HEATHKIT 7-WATT AMPLIFIER KIT

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

MODEL A-7D
$18.65
INCLUDING NEW EXCISE TAX‡

MODEL A-7E: Similar to the A-7D, except that a 12SL7 tube has been added for preamplification. Two inputs, RIAA compensation, and extra gain. $20.35‡

HEATHKIT 20-WATT HIGH FIDELITY AMPLIFIER KIT

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

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

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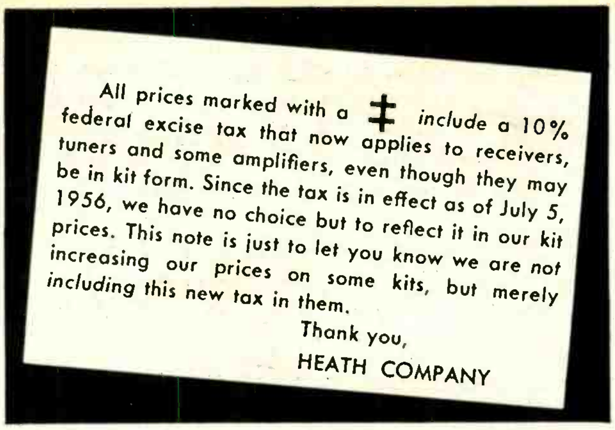
BENTON HARBOR 20, MICH.



All prices marked with a ‡ include a 10% federal excise tax that now applies to receivers, tuners and some amplifiers, even though they may be in kit form. Since the tax is in effect as of July 5, 1956, we have no choice but to reflect it in our kit prices. This note is just to let you know we are not increasing our prices on some kits, but merely including this new tax in them.

Thank you,

HEATH COMPANY

HEATHKIT HIGH FIDELITY

Range Extending

SPEAKER SYSTEM KIT

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

MODEL SS-1B

$99.95 Shpg. Wt. 80 Lbs.

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

HEATHKIT HIGH FIDELITY **SPEAKER SYSTEM KIT**

MODEL SS-1

$39.95 Shpg. Wt. 30 Lbs.

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

This speaker system is a fine reproducer in its own right, covering 50 to 12,000 CPS within ± 5 DB. However, the story does not end there. Should you desire to expand the system later, the SS-1 is designed to work with the SS-1B range extending unit — providing additional frequency coverage at both ends of the spectrum. It can fulfill your present needs, and still provide for the future. The SS-1 uses two Jensen speakers; an 8" midrange-woofer, and a compression-type tweeter. Cross-over frequency is 1,600 CPS, and the system is rated at 25 watts. Nominal impedance is 16 ohms. The cabinet is a ducted-port bass-reflex type. Attractively styled, the Model SS-1 features a broad "picture-frame" molding that will blend with any room decorating scheme. Pre-cut and pre-drilled wood parts are of furniture grade plywood. The kit is easy-to-build, and all component parts are included, along with complete step-by-step instructions for assembly. Can be built in just one evening, and will provide you with many years of listening enjoyment thereafter.

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

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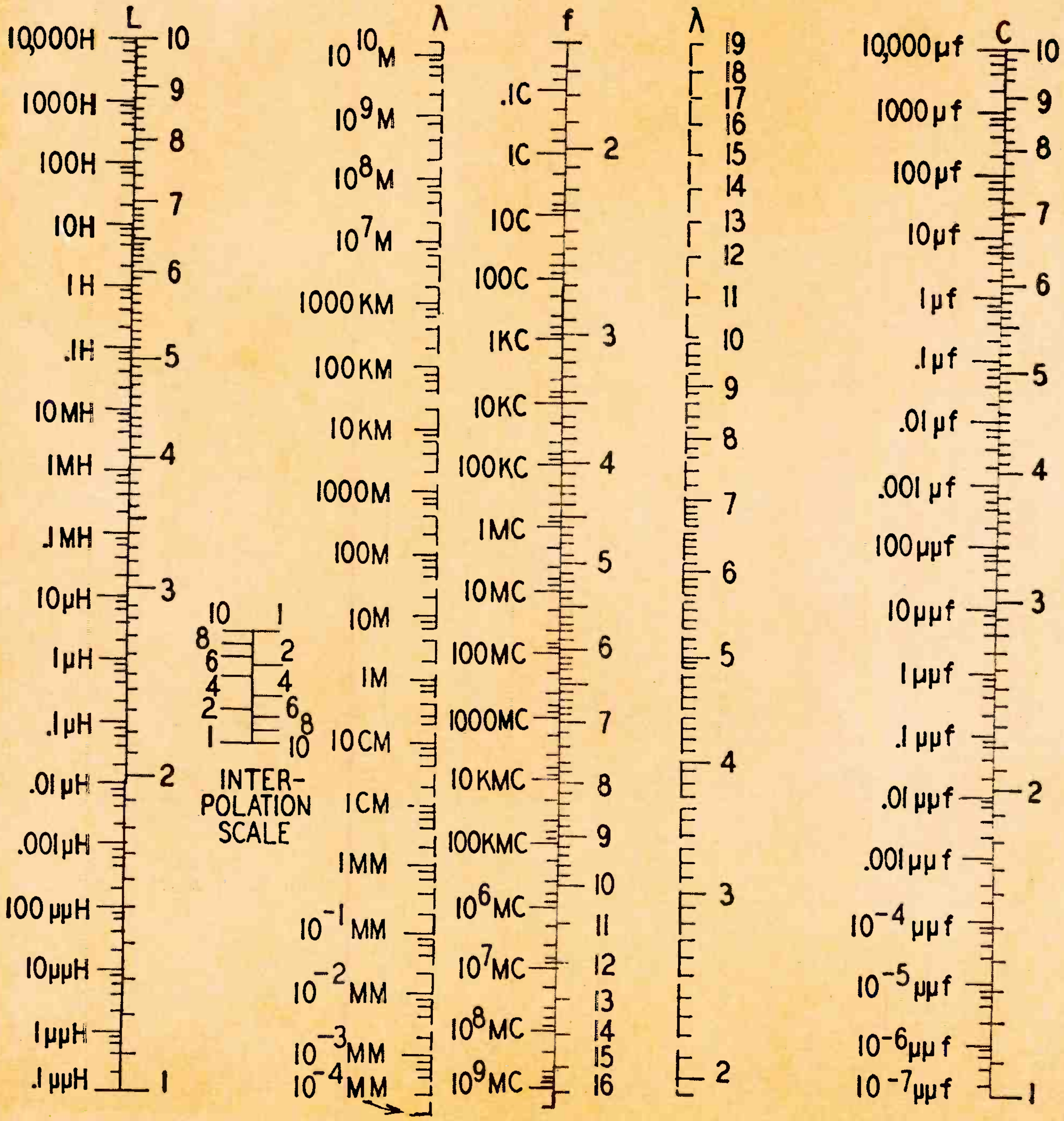
QUANTITY	ITEM	MODEL NO.	PRICE

New resonant-frequency nomo permits greater accuracy

By JOSEPH F. SODARO



Nomograph for calculating L, C or f with the other two functions known, and for frequency-wavelength conversion.

SEVERAL graphical calculators and slide rules have been designed to solve the resonance formula

$$f = 1/(2\pi \sqrt{LC})$$

These have the shortcomings of limited scale ranges or yield only significant figures without reference to units or order of magnitude. Folded scales or multiple charts have been employed to extend scale limits. However, these extensions tend to complicate calculations by presenting discontinuities.

The nomograph shown employs an innovation which solves the resonance formula over extreme ranges of inductance, capacitance and frequency. It is also designed for frequency-to-wavelength conversion throughout the same range. The innovation is that of including an expanded cycle on the right-hand side of the scales for the variable on the left-hand side. Thus, an approximate solution yielding the order of magnitude can be immediately obtained from the left side of the L, C and f scales. Next, an exact solution is obtained by using the right side of these same scales. The wavelength scales designed on the same basis are dashed to indicate conversion use only.

To determine a resonant frequency construct a straight line between the left-side values of L and C. Read the resonant frequency on the left side of the f scale. For a more exact solution construct a second straight line between the right side of the L and C values, using the significant figures of L and C. Read the significant resonant-frequency figures on the right side of f. Decimal location is in accordance with the left-side solution. To convert from frequency to wavelength construct a horizontal straight line through the value of frequency on the left-side f scale. Read wavelength on the left λ scale. Similarly construct a second horizontal straight line through the value of frequency on the right side of the f scale. Read significant figures on the right λ scale. The horizontal condition can be observed in both cases by equal intercepts on the L and C scales.

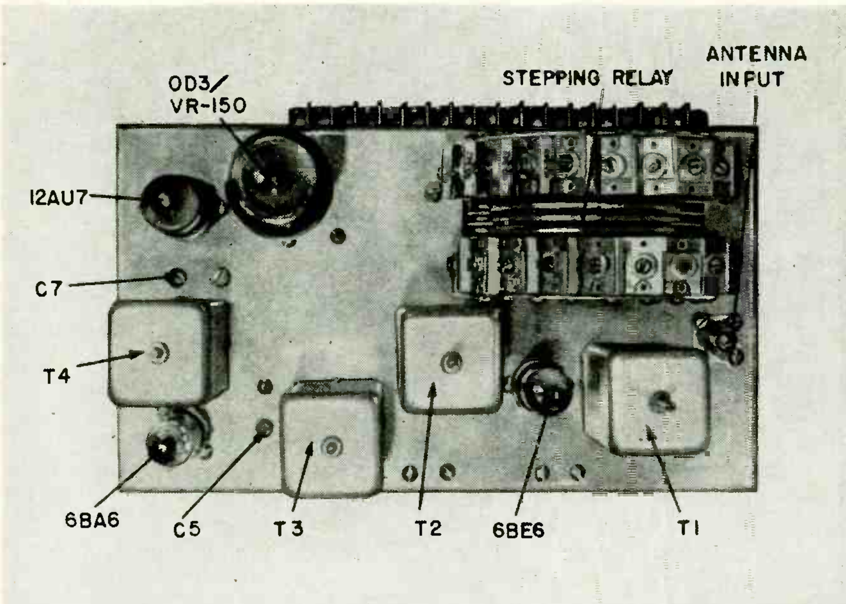
As an example, find the resonant frequency and wavelength of a circuit containing 1-mh inductance and .002-$\mu\mu$f capacitance. Construct a straight line from 1 mh on the left side of the L scale to .002 $\mu\mu$f on the left side of the C scale. Estimate 100 megacycles at the intersection of this line with the left side of the f scale. At this intersection construct a horizontal line. Estimate 3 meters on the left λ scale.

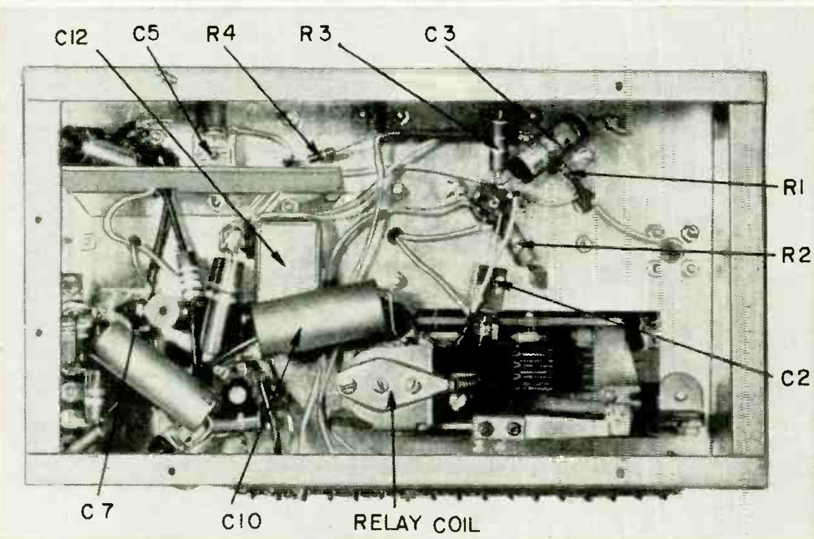
For a more exact solution construct a straight line from the bottom 1 on the right side of the L scale to 2 on the right side of the C scale. Read about 112 mc on the right side of the f scale. (For more exact reading use interpolation scale insert.) Construct a horizontal line through this intersection and read 2.67 meters on the right λ scale. Using the top 1 on the right side of the L scale would obviously be wrong since it would be incompatible with the first solution. END

Unique AM Tuner Improves Audio Quality

Unit provides both high selectivity and high-frequency audio response

By
PETER J. VOGELGESANG

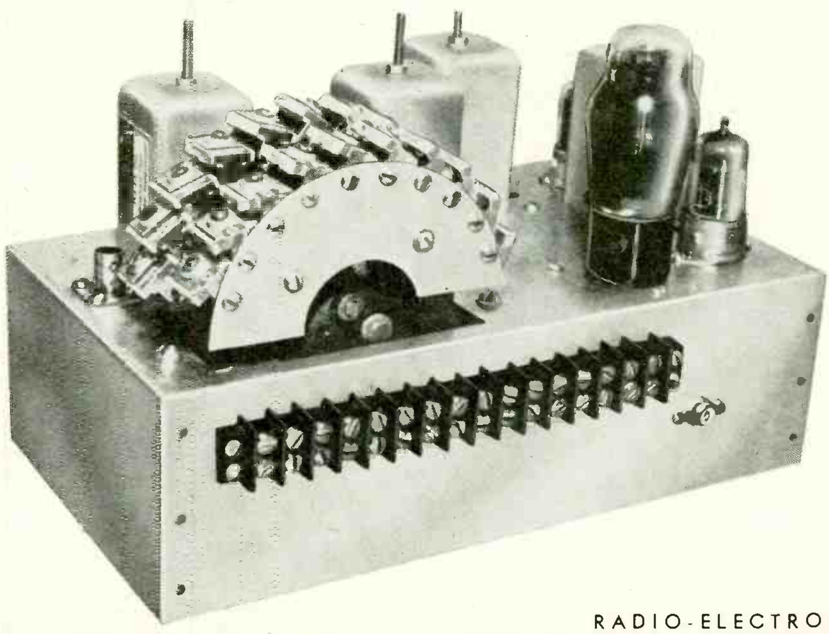




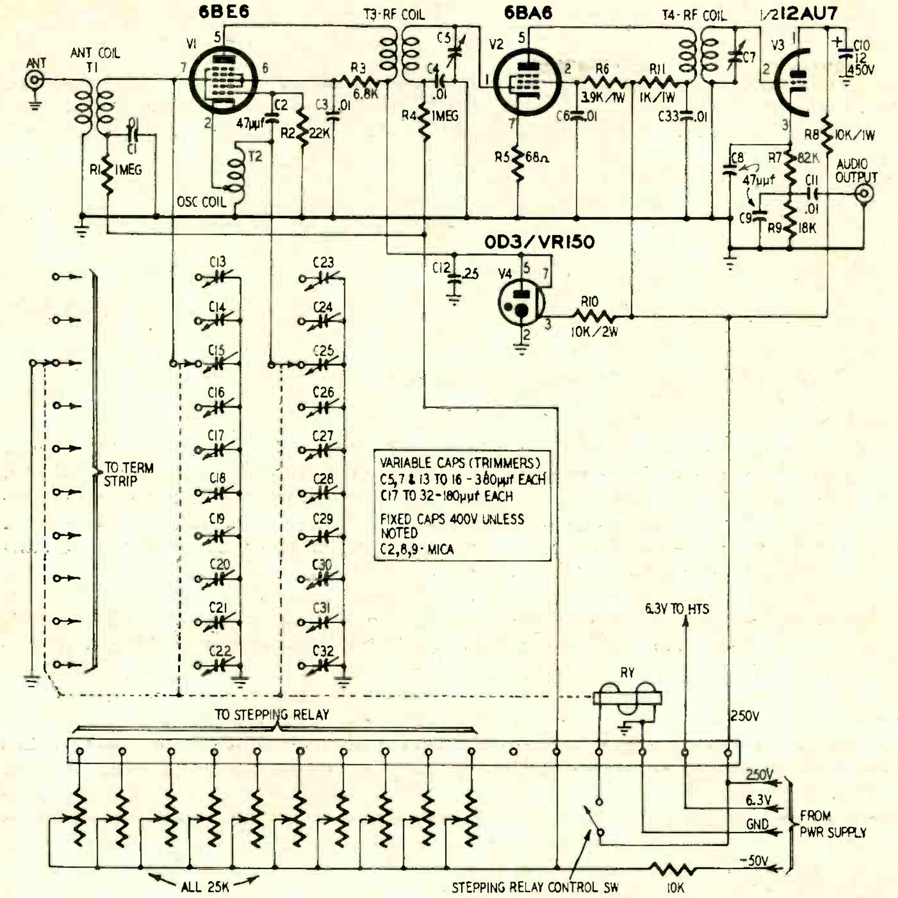
Top—Top view. Lineup of cans give unit appearance of conventional superhet. Bottom—An underchassis view of the tuner.

EVEN though most AM stations do not transmit a range of audio frequencies worthy of the name *high fidelity*, the average tuner is incapable of reproducing the frequencies they do transmit. Most superheterodyne tuners are too selective for high-fidelity sound reproduction. Because of the low intermediate frequency and the multiple tuned circuits of the if transformers, the high-frequency sidebands are attenuated. A slight detuning of the average superheterodyne tuner will produce a very noticable increase in high-frequency audio response, proof that the high frequencies are being clipped when the receiver is properly tuned.

Disregarding expensive bandpass if transformers, one solution to the problem of high-frequency sideband clipping is to use fewer tuned circuits in the tuner. However, this is apt to reduce the selectivity to the point where adjacent stations produce interference—one of the chief objections to the tuned-



The unique AM tuner



R1, R4—1 megohm
R2—22,000 ohms
R3—6,800 ohms
R5—68 ohms
R6—3,900 ohms, 1 watt
R7—82,000 ohms
R8—10,000 ohms, 1 watt
R9—18,000 ohms
R10—10,000 ohms, 2 watts
R11—1,000 ohms, 1 watt
All resistors 1/2 watt unless otherwise noted
C1, C3, C4, C6, C11, C33—.01 μf
C2, C8, C9—47 μμf
C5, C7, C13–C16—380 μμf, trimmers
C10—12 μf, 450 volts, electrolytic
C12—0.25 μf
C17–C32—180 μμf, trimmers
All fixed capacitors 600 volts unless otherwise noted
T1—antenna coil, shielded, frequency range 500–1800 kc (Miller 73-A or equivalent)
T2—oscillator coil, shielded, universal replacement type (Miller 73-OSC or equivalent)
T3, T4—rf coil, shielded, frequency range 500–1800 kc (Miller 73-RF or equivalent)
V1—6BE6
V2—6BA6
V3—12AU7
V4—OD3/VR-150
7-pin miniature sockets (2)
9-pin miniature socket
Octal socket
RY—stepping relay, nonresettable (see text)
Jack, input
Jack, output
Barrier strip, 16 terminals
Chassis, approximately 5 x 10 x 3 inches

The high-fidelity tuner. Power supply and bias resistors are on separate chassis.

radio-frequency receiver. Thus, selectivity seems to have an optimum value somewhere between maximum high-frequency response and maximum station selectivity.

This tuner comes close to this optimum value by tuning each station in the band with separate rf and oscillator tuning capacitors. The effects of an interfering station can be greatly reduced by slightly detuning the rf stage to the side of the desired station that has no interference. The rf input and the oscillator circuits are tuned by pairs of trimmer capacitors mounted on a stepping relay. Stations are changed simply by pulsing the coil of the stepping relay. The rf transformers used instead of if's provide much greater bandpass than standard if transformers and require an intermediate frequency above 600 kc. The higher if also contributes to the greater bandpass. Because each station is tuned individually, the tracking problem is eliminated and stations can be tuned to maximum sharpness. Only the secondaries of the rf transformers are tuned, by 380-μμf trimmers.

An infinite-impedance detector is used for better fidelity and greater sensitivity. Since the infinite-impedance detector provides no avc voltage, a substitute bias voltage is provided. A negative 50 volts is dropped through a separate variable resistor for each position of the stepping relay. The resistors can be adjusted permanently to compensate for the relative signal strengths of stations. While avc is simpler, it is not completely adequate because most receivers require adjustment of the audio gain control when stations are changed. With the system used in this tuner, the output can be adjusted to *exactly* the same level for all stations. An ordinary avc voltage could be provided easily with a crystal diode or by using the unused half of the 12AU7 as a diode with the grid and plate tied together.

The stepping relay used to switch the tuning capacitors is a nonresettable type; that is, it steps in an ordered sequence and cannot return to position 1 until it has stepped through its final position.

The location at which this tuner was installed did not require a station indication system because the individuals using it did not care what station they were listening to as long as the program material suited their tastes. However, others would surely want a station indication system.

The simplest system would be to wire the unused group of stepping relay terminals to a row of 10 indicator lights mounted at the point of remote control. Each light would designate one of the pretuned stations and the lights would glow in order as the stepping-relay control button was pushed.

Stepping relays, while generally expensive, can be purchased from the surplus markets rather reasonably. If a stepping relay with a release coil and spring return can be procured, a telephone dial would provide an excellent method of controlling the tuner with but a single control line.

The trimmer capacitors that tune the oscillator and the rf input circuit are mounted on the stepping relay. One terminal of each capacitor is soldered to a lug of the relay and the other terminal is screwed to a half-circle of sheet aluminum. The whole unit is constructed ruggedly and mounted firmly to the chassis to insure maximum oscillator stability. The oscillator stability is increased even more by supply voltage regulation.

The tuner is constructed on a 5 x 10 x 3-inch chassis. Supply voltages and one group of stepping-relay terminals are brought to a terminal strip on the side of the chassis. The audio output is brought to a separate connector. The variable resistors used to adjust the output amplitude of the tuner are mounted on the power supply instead of the tuner. The 380-μμf trimmers which tune the secondaries of the rf transformers are mounted beneath the chassis and are available for adjustment through holes drilled in its top.

The tuner is aligned the same as any superheterodyne unit. Some unused frequency on the low end of the local broadcast band should be chosen for the intermediate frequency. The higher this frequency the broader the bandpass; the lower the frequency the sharper the bandpass. The rf tuned circuit and local oscillator are tuned for each station independently.

Performance is excellent. It develops just about the maximum in AM fidelity. The announcers' S's sound crisp and clean.

The tuner also presents a remote control feature that will fit ideally into custom radio and sound installations. It could be mounted in the trunk of an automobile and controlled from the dash panel with but a single switch, leaving precious dash-panel space available for other equipment. END

TRANSISTOR RADIOS

Part VII—The Magnavox AM2, Hallicrafters TR-88; receiver repair and alignment

By I. QUEEN
EDITORIAL ASSOCIATE

THIS, the last in this series on transistor radios, describes a few more models and then finishes up with general servicing and alignment procedure. We hope this provides the technician with sufficient data to repair and adjust a transistor receiver. In any case it is recommended that the schematic be on hand to aid whenever one of these radios is serviced.

Magnavox Companion, model AM2

This radio chassis, coded CR 729 AA, is a six-transistor set with class-B output. It measures 3¼ x 5¾ x 1 9/16 inches and is capable of a maximum output of 90 mw; it weighs 20 ounces with battery. The battery delivers 4 volts and lasts about 200 hours. A personal earpiece is provided for; it automatically disconnects the speaker.

The converter stage is conventional. (See Fig. 1.) Feedback between collector and emitter windings provides oscillation. Like the other high-frequency circuits this stage uses an n-p-n transistor.

Both if stages are neutralized by capacitance in series with resistance. The if strip requires either a pair of 2N146 transistors (as shown) or it may use a 2N145 for V2 and a 2N147 for V3. Otherwise, neutralization may be upset and the output lowered. The last if transformer, bifilar-wound, is tapped. One terminal feeds the diode detector; the opposite one provides the out-of-phase voltage for neutralization.

The diode produces a negative voltage across the volume control. After suitable filtering, this becomes the avc signal which is fed to V2.

The audio transistors are Texas Instrument p-n-p types. A common resistor R is in the emitter returns of both V4 and the class-B stage. The drop across R provides the small bias required for the class-B transistors during low-signal periods. Ordinarily this bias is obtained by a voltage divider which results in wasted power. The circuit show here is, therefore, more efficient. The speaker is a 2¾-inch unit with a nominal impedance of 16 ohms.

Hallicrafters El Diablo TR-88

This is a six-transistor set using all p-n-p types. The power supply is 6 volts (four No. 2 flashlight cells). These snap into clips, two at each end of the receiver case. The diagram appears in Fig. 2, with voltages given at each transistor element. The transistors may be as follows: V1, 2N112 or 2N136; V2 and V3, 2N112, 2N135 or 2N139; V4, 2N109, 2N191 or TI310; V5 and V6, 2N109, 2N186 or TI352.

The mixer supplies 455 kc to the if strip. Both if stages are neutralized by trimmer capacitors. Thus each stage may be set to optimum at any time. Each if transformer is tapped, and it is the primary which supplies the out-of-phase neutralization voltage.

The detector produces a positive avc voltage across the volume control, which is then applied to both V2 and V3. The audio stages are transformer-coupled, and the output is class B. This stage receives its bias from a voltage divider. The speaker impedance is 11 ohms.

Receiver maintenance

Transistors are more rugged mechanically than tubes, but electrically and thermally they are more delicate. Therefore the new sets require a different servicing procedure, and special precautions must be observed in handling them.

Transistors often have a maximum storage temperature of 85°C (185°F), and the maximum operating temperature may be 50°C (122°F). The temperature limit varies with the power dissipated in the transistor. *Never* place a transistor radio near a hot radiator or on the rear window shelf of an automobile where a high temperature may exist. *Always* remove transistors from their sockets before soldering near them.

Never remove or plug a transistor into its socket while voltage is applied. *Always* turn off the power first. Transistors should be removed from their sockets before making resistance measurements. This is necessary for two reasons: it prevents erroneous readings (the resistance between transistor elements is relatively low); it eliminates danger to the transistors from excessive current flow from the ohmmeter.

In checking a tube radio many technicians first test the tubes. A different procedure is recommended for a transistor radio. There is little likelihood that a transistor has gone bad under ordinary operation; its life is indefinite and it cannot burn out under normal conditions. A more logical first step is to test the battery. A weak battery can cause instability and regeneration and may result in low sensitivity and volume. Generally a 9-volt battery will give satisfactory service down to even 6

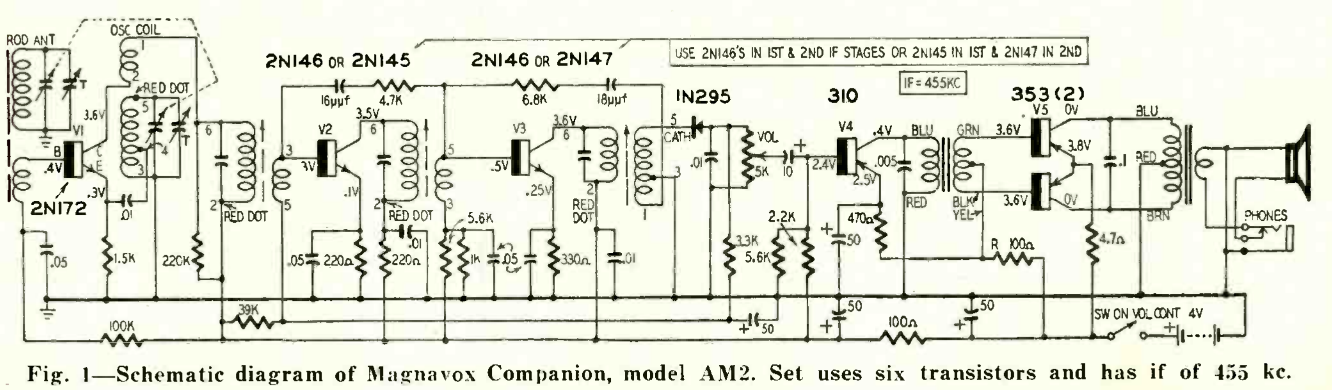
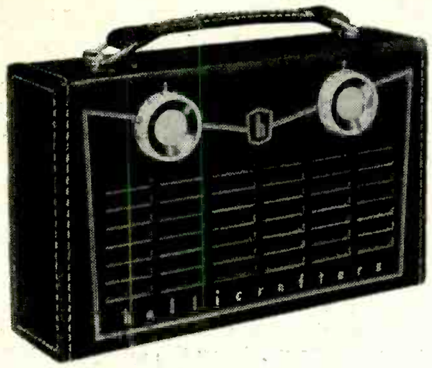
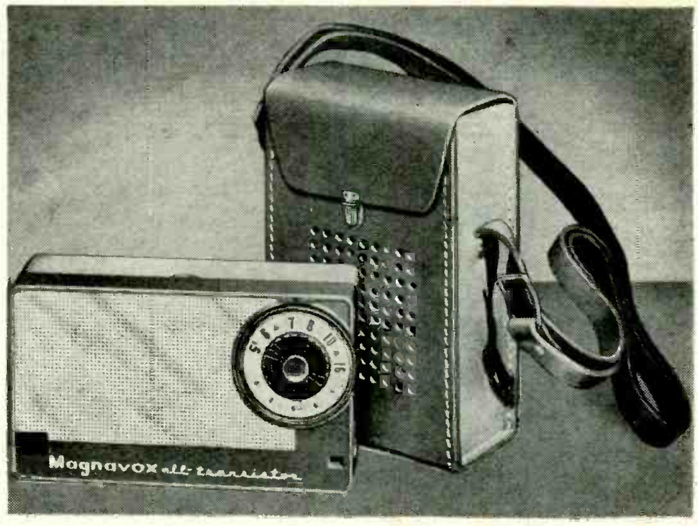


Fig. 1—Schematic diagram of Magnavox Companion, model AM2. Set uses six transistors and has if of 455 kc.



The Hallicrafters El Diablo, TR-88.



The Magnavox Companion AM2 receiver.

volts, but if it falls lower it should be replaced. A worn battery should be removed as soon as possible, before it begins to leak and corrode radio parts or the case. When replacing a battery it is very important to observe polarity. A reversed potential can easily damage the transistors in a very short time.

Transistor tests

If it appears that a transistor is defective, the best check is to replace it with one of the same type known to be OK. If a transistor tester is available, it will indicate the gain and cutoff values. If these are close to the values given by the manufacturer, the transistor is probably good. Some manufacturers of portable radios recommend an ohmmeter test to check transistors; others advise against it. No harm will result provided the ohmmeter does not put more than about 1 ma into the external circuit. Most vtvm type ohmmeters (set to R×10) are safe to use. Shunt type ohmmeters must be avoided—as much as 100 ma may flow out of them, more than enough to burn out a transistor.

To use an ohmmeter, refer to Figs. 3 and 4. For a p-n-p transistor (Fig. 3) the plus terminal of the ohmmeter is connected to the base. The other terminal connects to the collector or emitter. In either case the meter will show a high resistance, ordinarily 50,000 ohms or higher. When the ohmmeter polarity is reversed, it will indicate a low resistance, ordinarily 500 ohms or less when checking each diode of the transistor (emitter to base and collector to base).

For an n-p-n type, simply reverse the ohmmeter leads, as shown in Fig. 4.

If the meter shows a high resistance when a low value is called for, the particular diode is defective. Likewise, a low resistance where a high value is expected shows that the diode has broken down. In either case the transistor is useless.

A simple test for cutoff current is shown in Fig. 5. If the meter reads more than a small current of about 0.75 ma maximum, it indicates a defective unit. Power transistors will show a higher value. Reverse battery and meter connections for n-p-n types, of course.

Since a transistor set is apt to be very compact, special care is required during repair. Often the parts are very close together. Leads should be kept well away from the movable plates of the tuning capacitor. Plate movement against leads can wear away insulation or exert pressure against other parts. On printed-wiring chassis beware of solder blobs which may short out leads. Also, this type of construction calls for care during soldering. A hot iron may ruin a plastic or other base material.

Checking the oscillator

Unfortunately, there is no easy way to check the performance of an oscillator stage. There is nothing to compare with measurement of grid current in a tube oscillator. A transistor passes current at all times through each lead, whether it is oscillating or not. There may be a *slight* change in emitter or collector current when the transistor is oscillating as against the nonoscillating condition. A sensitive rf voltmeter will give a definite indication, but this type of instrument is not commonly available. The meter may

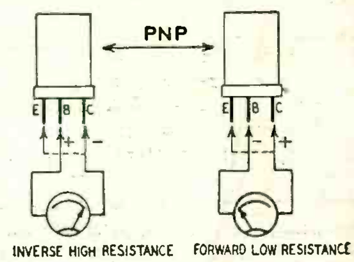


Fig. 3—Resistance check for p-n-p units.

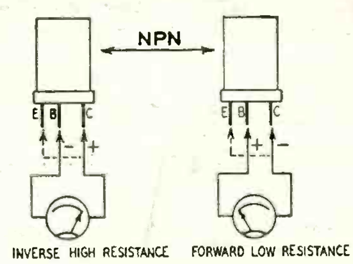


Fig. 4—N-p-n type resistance check.

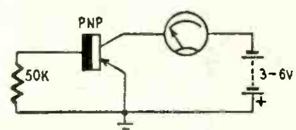


Fig. 5—Testing for cutoff current.

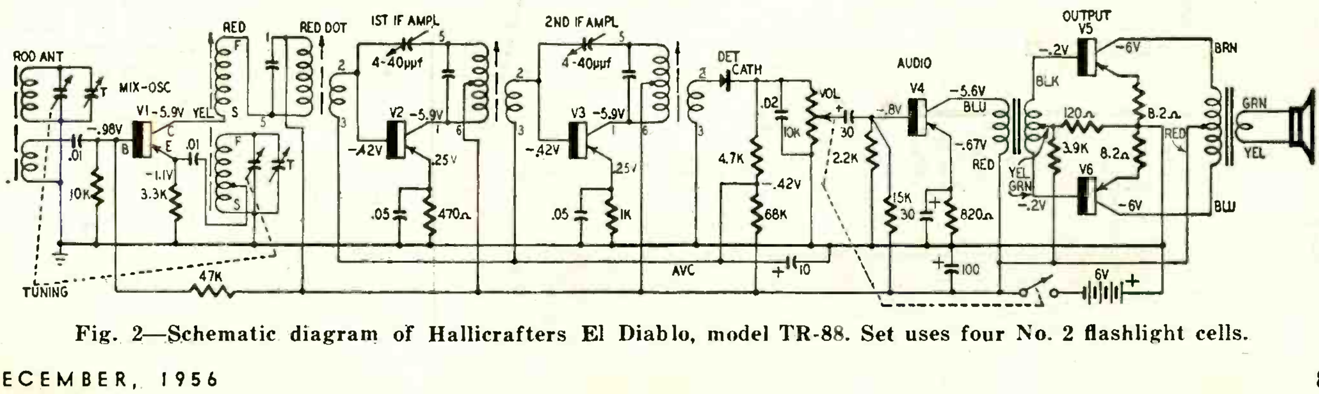


Fig. 2—Schematic diagram of Hallicrafters El Diablo, model TR-88. Set uses four No. 2 flashlight cells.

be connected across the emitter resistor (of the converter stage) to show whether or not any oscillations are present.

In some models (for example, Hallicrafters) the injected rf voltage from the oscillator may be varied. Normally the voltage (as measured by an rf voltmeter) is set to .06 across the emitter resistance (converter stage). It can be adjusted by breaking the wax seal on the oscillation transformer and changing the coupling between windings as required. The windings should be resealed after setting the adjustment. The Hallicrafters portable calls for a voltage of .06 with the tuning gang closed. It should not exceed 0.15 volt with the gang wide open.

The injected voltage may have to be adjusted when the converter transistor is replaced. With too low voltage oscillations may cease, especially at the low-frequency end of the dial and when the batteries are slightly low. Too high a voltage may cause superregenerative action or squegging at the high-frequency end.

Transistor sets use tiny electrolytic or tantalytic capacitors of very high capacitance. When capacitance drops, the result may be oscillation or low gain. The best check is to shunt a good capacitor across the doubtful one. If there is considerable improvement, remove the questionable unit.

Many transistor portables use a push-pull class-B stage to feed the speaker. Normally the two transistors are matched as to gain and cutoff current. If it should become necessary to replace one of the transistors, both should be removed and a matched pair plugged in. Otherwise distortion and lowered output may result.

When a converter or if transistor is replaced, it is best to realign the receiver. This procedure is somewhat similar to that for a tube set—the if strip is first aligned, then the rf circuits. It is important to keep the input signal low to prevent overloading the transistors, especially those in the class-B stage. A class-B transistor passes current in proportion to its output. When overloaded, the output current rises to a dangerous value.

Alignment procedure

Practically all transistor sets have an if of 455 kc, so any conventional modulated if signal generator may be used. A fiber alignment tool is recommended to eliminate hand capacitance and to prevent chipping the ferrite core slots of the transformers.

The first step is to align the if strip.

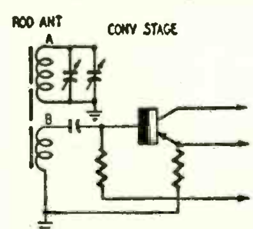


Fig. 6—Generator connecting points.

Couple the if generator loosely to the receiver loop through a .005-μf or larger capacitor. The low side of the generator connects to the chassis, the high side (through the capacitor) either to the primary or secondary of the loop. For example, points A or B of Fig. 6 may be the connecting points. Keeping the if output low, the transformers are aligned in reverse order, that is, starting with the last stage. A vtvm or output meter is connected across the speaker. If the output stage is class B, a meter in series with the battery will make a suitable output indicator. Tune each transformer for maximum output. *Keep the if signal generator output as low as possible.* The if circuits are generally aligned with the tuning capacitor *open* or at least tuned to a quiet spot near 1600 kc.

The rf is best aligned with a radiation loop of about 5 turns, each 2 inches in diameter. This loop is placed a foot or two from the antenna loop of the receiver. Tune the signal generator to 1620 kc, connect the loop across its terminals and tune the receiver to 1620 kc. Now the *oscillator trimmer* is adjusted for maximum output. Next tune the generator and the receiver to about 550 kc. Tune the *oscillator coil slug* for maximum output. This adjustment is often made while the receiver dial is *rocked* back and forth slightly near 550 kc. Next, the generator and receiver are both set to 1400 kc while the *antenna trimmer* is set, again for maximum output. The above steps are repeated until no further improvement is noted.

An *if* signal may be injected directly to the base of the converter. An *rf* signal injected at this point will probably stop oscillator action.

A simpler and more accurate if alignment is recommended by Hallicrafters. However this requires a sweep generator having a center frequency of 455 kc and a sweep of 10 kc. An oscilloscope is connected across the volume control to observe the output waveform of the if strip. It should appear somewhat like that of Fig. 7. Spurious responses or peaks along the curve indicate that neutralization is incomplete. Adjust each if to obtain a smooth curve.

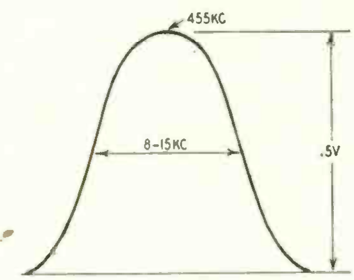


Fig. 7—Hallicrafters if response.

Many schematics given in this series of articles indicated voltage values at each transistor element. These are useful in troubleshooting. Voltages should be measured with a vtvm or with a high resistance non-electronic voltmeter. END

Superior's New Model TC-55

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

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

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

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

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Superior's new Model TV-11

TUBE TESTER

- ★ Tests all tubes including 4, 5, 6, 7, Octal, Lock-in, 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.

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.

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

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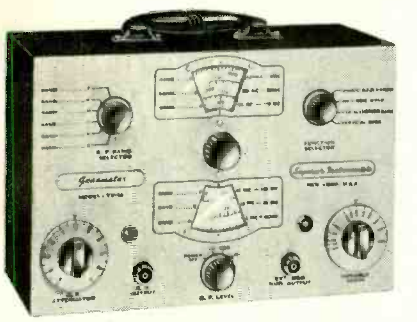

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BAR GENERATOR: The Model TV 50 projects an actual Bar Pattern on any TV Receiver Screen. Pattern will consist of 4 to 16 horizontal bars or 7 to 20 vertical bars.

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

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

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

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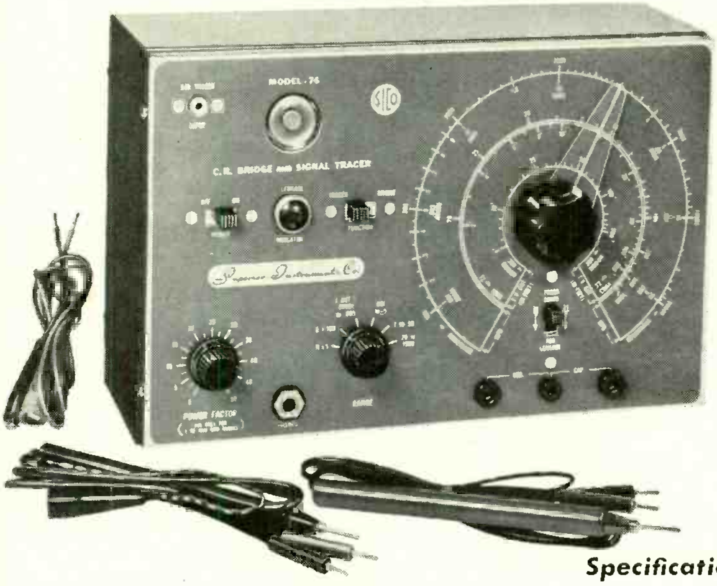

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with a range of 100 ohms to 5 megohms

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

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

Specifications

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

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

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

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portable loop homing antenna

By BEN CRISSES and JAY GNESSIN

Collapsible unit on walkie-talkie permits taking rapid fix on stations; excellent for quick bearing and homing

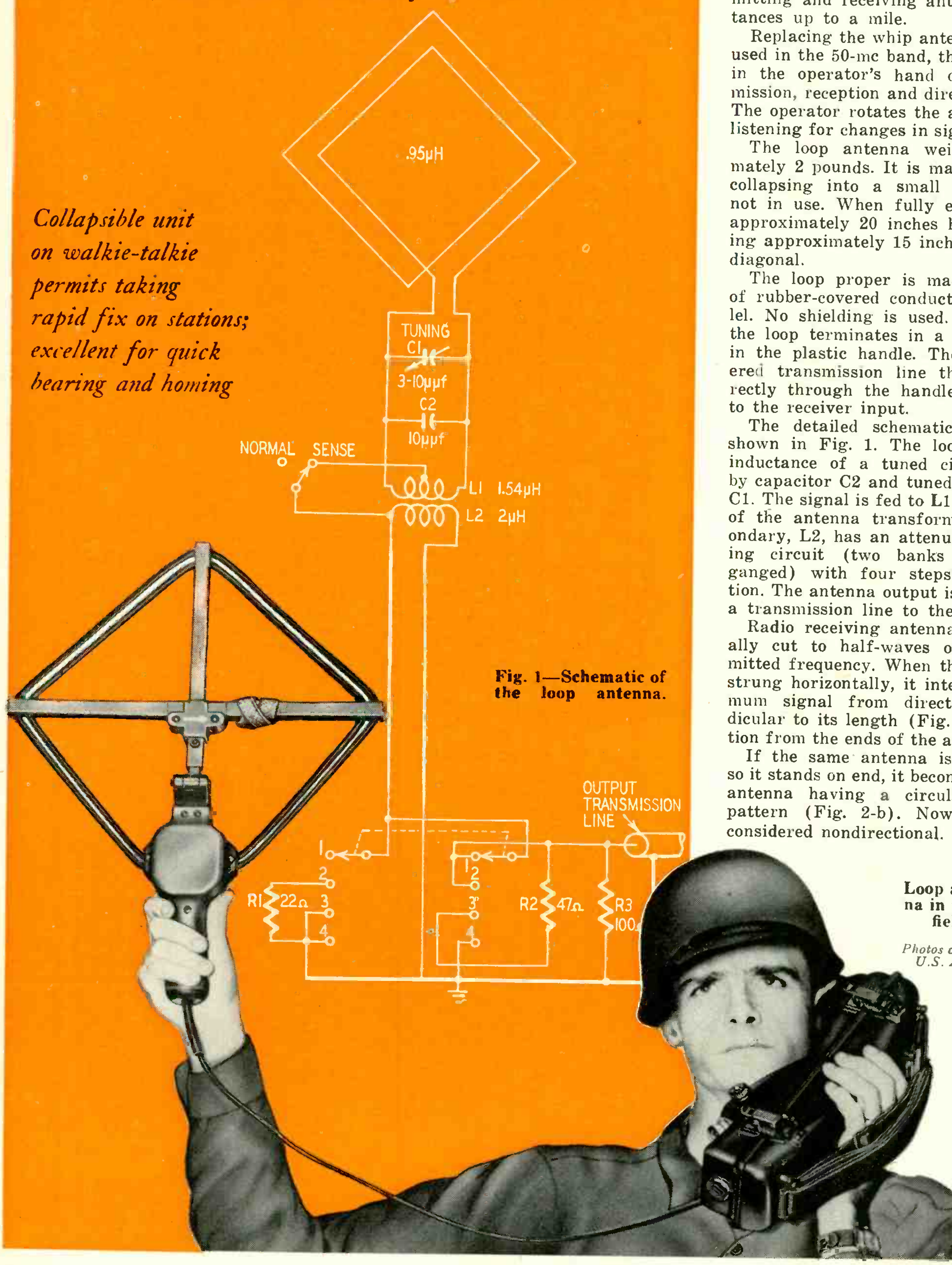


Fig. 1—Schematic of the loop antenna.

Loop antenna in use in field.

Photos courtesy U.S. Army

THE portable-loop homing antenna shown on facing page, attached to a *walktie-talkie* set (the AN/PRC-6), permits an operator to take a quick bearing on a transmitting station, to *home* on that station or take a *fix* on two or more stations. It may also be used as a conventional transmitting and receiving antenna for distances up to a mile.

Replacing the whip antenna normally used in the 50-mc band, the loop is held in the operator's hand during transmission, reception and direction finding. The operator rotates the antenna while listening for changes in signal strength.

The loop antenna weighs approximately 2 pounds. It is made of plastic, collapsing into a small bundle when not in use. When fully extended it is approximately 20 inches high, measuring approximately 15 inches across the diagonal.

The loop proper is made of a pair of rubber-covered conductors in parallel. No shielding is used. The base of the loop terminates in a tuned circuit in the plastic handle. The rubber-covered transmission line then leads directly through the handle of the loop to the receiver input.

The detailed schematic diagram is shown in Fig. 1. The loop forms the inductance of a tuned circuit, loaded by capacitor C2 and tuned by capacitor C1. The signal is fed to L1, the primary of the antenna transformer. The secondary, L2, has an attenuating switching circuit (two banks of switches ganged) with four steps of attenuation. The antenna output is fed through a transmission line to the radio set.

Radio receiving antennas are generally cut to half-waves of the transmitted frequency. When the antenna is strung horizontally, it intercepts maximum signal from directions perpendicular to its length (Fig. 2-a). Reception from the ends of the antenna is nil.

If the same antenna is rotated 90° so it stands on end, it becomes a vertical antenna having a circular reception pattern (Fig. 2-b). Now it may be considered nondirectional.

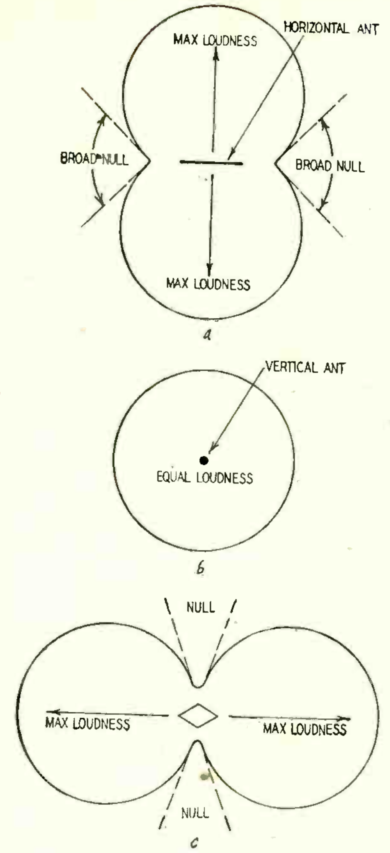
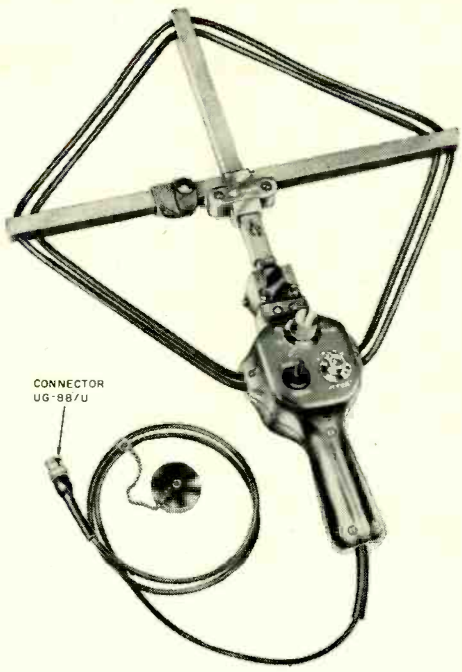


Fig. 2—Antenna reception patterns.



The portable-loop homing antenna. Unit contains tuning, normal–sense and attenuator controls.

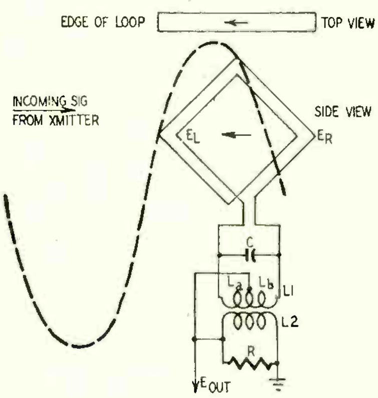


Fig. 3—The loop circuit simplified.

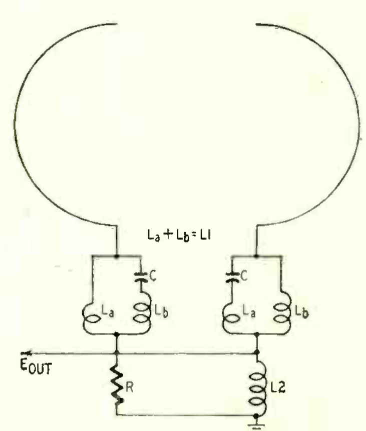


Fig. 4.—Equivalent loop circuitry.

If the receiving antenna is shaped into a loop, placed vertically in space, it will show a pronounced directional pattern in the direction of its front and back edges.

In Fig. 2-c the direction at right angles to the plane of the loop is insensitive to the signal. This is the null; it is always at right angles to the strong signal zone.

The loop circuit is simplified in Fig. 3 and further simplified in Fig. 4. Assume the NORMAL-SENSE switch (Fig. 1) is closed. This switch distinguishes the *to* and *from* directions of the line of signal. The loop defines the line of signal toward and away from the transmitter. *Sense* distinguishes one direction from the other by making the signal directly toward the station stronger than the signal away from the station.

The sense signal is developed as follows: At the operating frequency, L_a, L_b and C form a resonant circuit in series with the parallel combination of R and L2. The impedance of the resonant circuit is so much larger than R and L2 that these two elements may be ignored in the *overall* circuit, which now may be considered as a resistive circuit to ground. In such a circuit, the *sense voltage* is in phase with the signal voltage in free space.

While it is true that in the overall circuit the voltages are in phase, E_{out} is taken across L2. Across this coil E_{out} *leads* the space signal voltage since L2 is an essentially pure inductance. *This is the sense voltage output.*

Note that this is the same effect as if a single vertical wire had been used as an omnidirectional receiving antenna. Other direction-finding systems use a separate vertical sense antenna. However, for portability, the loop itself, switched to the coil–resistor circuit, to ground replaces the vertical wire.

Now consider what happens to the loop action (Fig. 5-a). When a signal arrives, it intercepts sides L and R, inducing voltages in the same direction in each loop side. These would normally buck each other, causing complete cancellation. However, the voltages are not induced simultaneously, since the signal intercepts one side of the loop before the other, causing a phase difference between the sides.

The phase difference produces incomplete cancellation, leaving a small residual voltage. This voltage *leads* or *lags* the space signal voltage, depending on the direction to or from the station. Fig. 5-b shows the loop signal when the loop is reversed.

Thus, breaking down the operation of the loop into its two component voltages, there is the *sense* voltage, which is the same no matter how the loop is held since it is the *omnidirectional* component of the antenna. And there is the *loop* voltage whose output depends directly upon the direction of the loop with reference to the direction of the signal. Both these voltages are developed across L2.

The addition and subtraction of *sense* and *loop* voltages are demonstrated graphically in Fig. 6. The sense voltage is the same, regardless of loop direction.

It is shown at *a* as a circle surrounding the antenna, with all voltages the same around the circle (shown *positive* in all directions around the antenna).

Loop voltage *b* is shown as a figure-8 pattern with resultant positive voltage toward the transmitter (at this instant) and with negative voltage in the opposite direction. Since the two voltages are received simultaneously, they are superimposed as in *c*. Adding the positive voltages will make that lobe larger. At the bottom of the pattern the voltages will oppose, cancelling that lobe completely. The resultant pattern *d* is called *cardioid* (shaped like a heart), with maximum response toward the station.

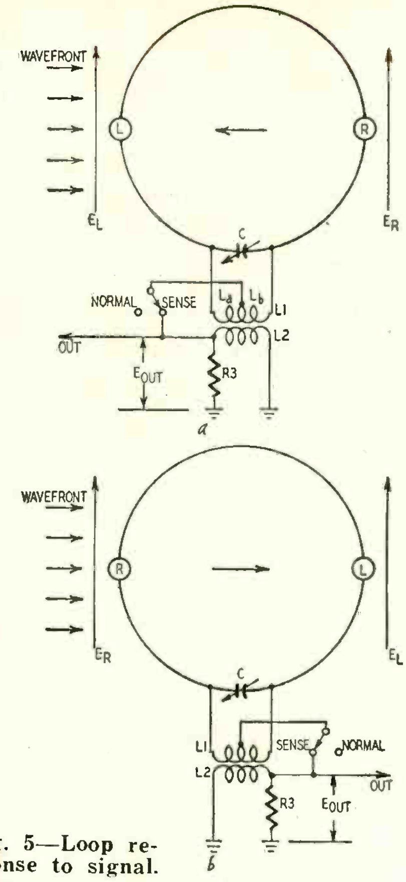


Fig. 5—Loop response to signal.

The loop has an arrow marked on the cross-piece to conform to the balance of the circuit so it points toward the source of the signal when the sensed output is maximum. The operator merely looks at the arrow to determine the direction of the transmitter when he sets the loop in position to give him loudest signal.

The analysis of directon finding was made with the attenuator (Fig. 1) in position 1. Since there are four attenuator positions, it may be useful to study operation in each. Fig. 7 shows the four attenuation positions.

At *a* we find the circuit previously described. Attenuation resistor R is 100 ohms. Series inductance L represents the inductance of connecting leads from coil to switch and transmission line. It combines with the inductance of L2 (making but slight change in position 1), growing in importance at the greater attenuation positions.

At *b* attenuation position 2 introduces a 22-ohm resistor in parallel with the 100-ohm resistor, reducing the amplitude of output fed to the receiver.

At *c* attenuation position 3 introduces a 47-ohm resistance in series with the 100-ohm resistor, making a voltage divider. The output is taken off the 100-ohm section. The high side of the coil is grounded to reduce further the amplitude of output fed to the receiver. Stray inductance is sufficient to prevent completely shorting L2 in position 3 and some energy is passed on to the output terminals.

At *d* position 4 introduces the most extreme attenuation possible. The high side of L2 was grounded to reduce output. Finding that enough signal was coupled to the output to destroy sensing at close quarters, the transmission line was cut open. Now the attenuation was correct. Enough signal was coupled by radiation to the output to permit proper sensing.

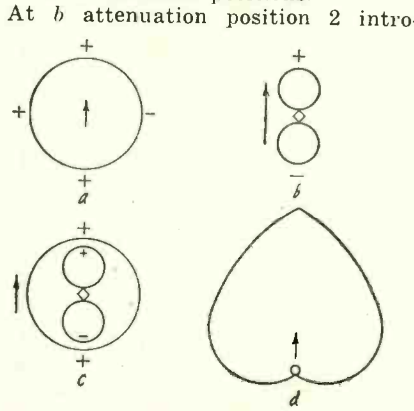


Fig. 6—Resultant response pattern.

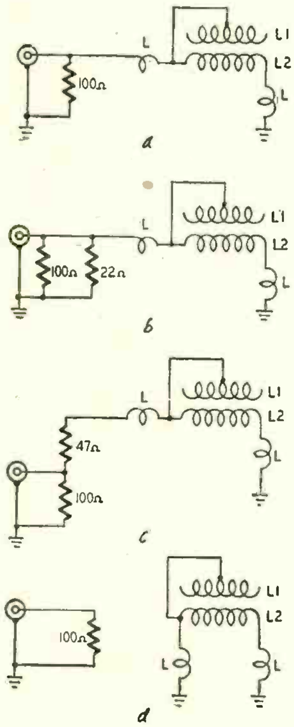


Fig. 7—Operation of the loop antenna in the various attenuator positions.

Remember the inductance of the coil leads to ground and you will avoid confusion in analysis of the circuit of Fig. 1 when you see that the top and bottom of the coil are grounded.

This loop is very popular because of its simplicity and effectiveness in the field. Construction experimenters may duplicate the circuit for ham and other uses by changing the size and number of turns in the loop to suit the frequency desired.

Readers will no doubt recognize this direction-finding system as the one used in the SCR-536 Handie-Talkie made famous during World War II and now being used by some hams and fire, police and emergency forces. The SCR-536 was described in detail in "Inside the Handie-Talkie" in the July, 1946, issue of RADIO-CRAFT. END

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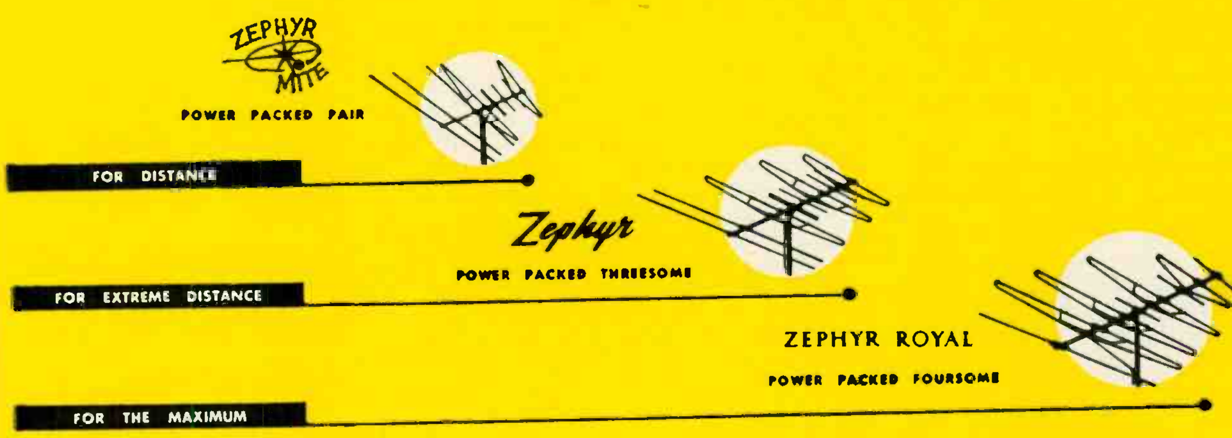

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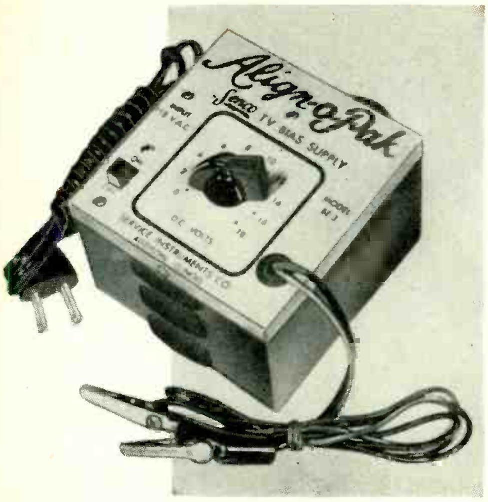

A commercial TV bias supply, made by Senco.

AGC in TV alignment

The effect of agc on receiver performance and during servicing; the bias box

By ROBERT BAUM * and HERB BOWDEN *

WHY is agc required? Manufacturers must build a television receiver with a sensitivity figure great enough to amplify TV signals as low as 5 to 10 microvolts. At this point the front-end noise is as great as the TV signal and it is useless to make the set any more sensitive. The same set must be used in areas where the signal will measure 50,000 microvolts and higher. The result (if receiver gain is left constant) is receiver overloading and sync clipping, causing loss of picture synchronization or no picture at all.

Thus, a circuit is needed to control receiver sensitivity in accordance with input signal strength so that the video amplitude will remain constant regardless of input level. This is the function of the agc circuit.

In early-model TV sets receiver sensitivity was controlled by the viewer with the *contrast* control, which varied the bias on the grids of the rf and first two if amplifiers. This system was satisfactory in strong-signal areas. In areas where signals were weak and signal fading was common, it became apparent that an automatic device was necessary—one that would increase the bias as the signal became stronger and reduce it with weaker signals. This bias, of course, could be obtained from the signal itself by sampling it at some appropriate point in the receiver.

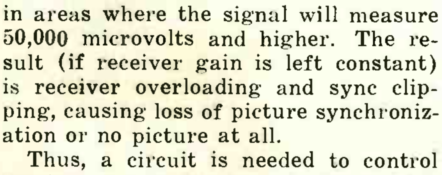

Fig. 1—A simple agc circuit

A simple agc circuit is shown in Fig. 1. It rectifies the incoming intermediate-frequency television signal and develops a negative pulsating dc voltage across resistor R1. Resistor R2 and capacitor C2 filter these pulses to essentially dc. Time constant R1 and C1 is generally 10 or more times the period of the horizontal synchronizing pulses to insure that C1 will stay charged to nearly the peak level of the sync pulse. In this respect the circuit is actually a peak-reading device commonly found in a vtvm that reads peak-to-peak voltages. This simple circuit is employed in many low-cost TV receivers today and works satisfactorily.

A peak-reading agc system is essential in TV receivers since the agc voltage developed must vary directly with signal strength. If the system were an averaging device the agc voltage would vary with the video signal content and as the scenes became darker, the agc voltage would increase. A good example of this would be a man with a big black coat coming on stage. The agc voltage would increase and the video level decrease. The sound output in intercarrier sets would also decrease and the result would be less sound. Therefore, the man with the darkest coat has the weakest voice. Naturally this does not make sense. It becomes apparent that the system used must work from the sync pulse tips as they do not vary with background illumination.

The simple circuit shown in Fig. 1 operates on sync pulse tips but has one serious shortcoming—it will read all noise-pulse peaks as well. In very weak-signal, noisy areas, this results in agc voltage disproportionate to the signal level. The result is even weaker video. The receivers will have low sensitivity and poor sync stability.

To counteract this low sensitivity and instability, some manufacturers have modified the simple circuit shown in Fig. 1 to that shown in Fig. 2. The only difference is that a 10-megohm potentiometer has been added and R1 is lower in value. The 10-megohm control, often called a threshold control or range finder, permits changing the circuit time constant to convert the detector from a peak-reading device to more of an averaging device. This makes the receiver less sensitive to noise pulses.

A superior type of agc circuit is shown in Fig. 3. This is called gated

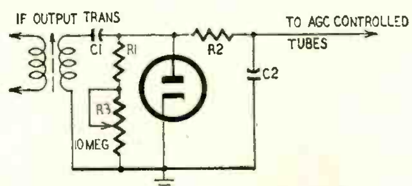

Fig. 2—A modified agc circuit.

or keyed agc. The circuit consists of a 6AU6 coincidence amplifier which conducts only during the presence of plate and grid signals. The plate voltage is supplied by a 300–500-volt (peak-to-peak) flyback pulse from the horizontal output transformer and the grid drive is the amplified video signal. When the televised picture is in sync, the horizontal sync pulses and flyback pulses occur at the same time, causing the tube to conduct. However, conduction occurs only at the sync-pulse level because of the negative bias developed across R1 by the video amplifier plate current.

The principal advantage of this system is that noise pulses occurring between sync pulses will not produce agc voltage as the tube has no plate voltage. Also, since the agc voltage is essentially amplified, it provides a faster-acting system that is less apt to overload.

Alignment and agc

The effect of operating the agc system during alignment is obvious when all facts are considered. Let's examine the average sweep generator used for television alignment. This is an instrument that produces FM in the appropriate ranges for television work. The output of the generator is frequency-

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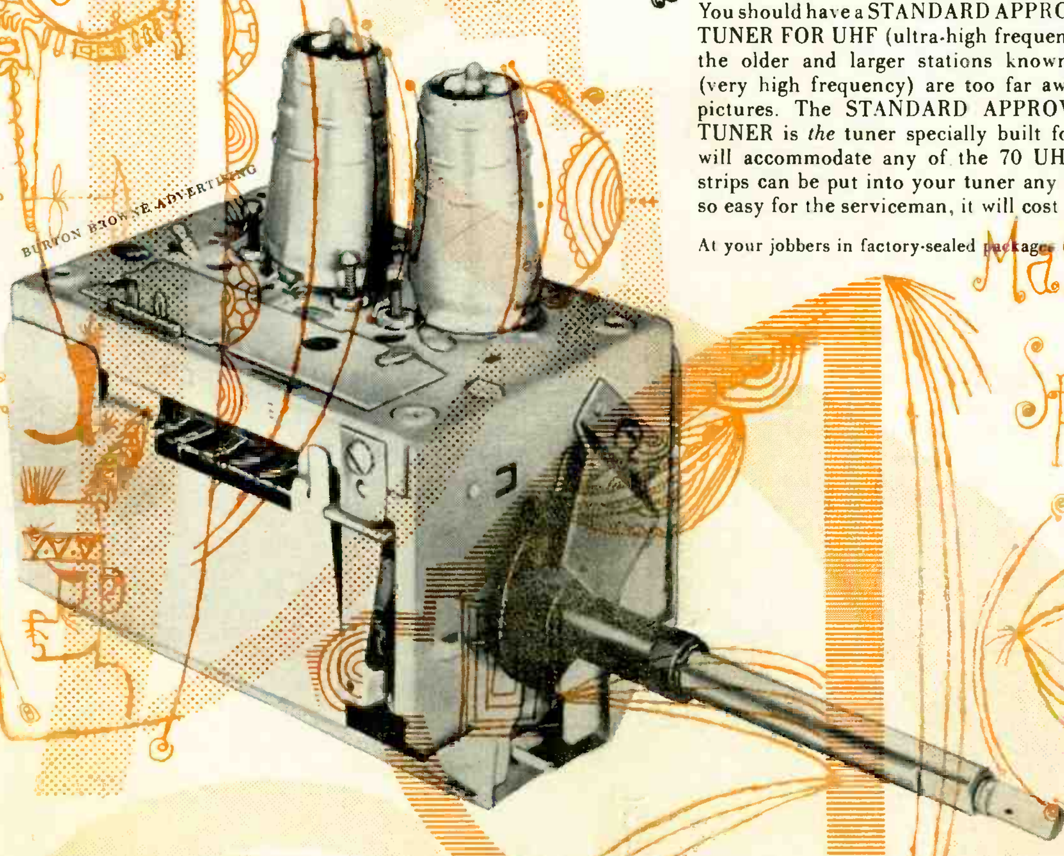

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modulated with a 60-cycle sine wave. This same 60-cycle wave drives the horizontal deflection plates of the oscilloscope to insure perfect synchronization when viewing the response curve of the TV receiver. Since the retrace sweep on the oscilloscope is visible with sine-wave deflection, two superimposed amplifier response curves would appear on the scope. These are not often perfectly superimposed, and for this reason the output of the sweep generator is often blanked out for half of the 60-cycle period to permit indication of only one response curve. However, it is this blanking of the sweep generator output that causes alignment inaccuracies when the agc circuit is permitted to operate.

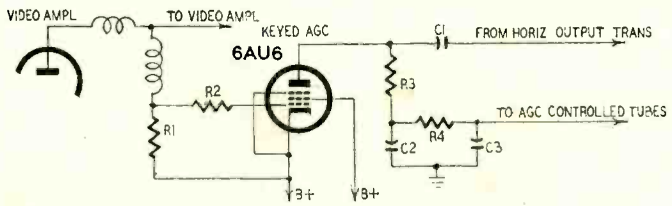

Fig. 3—The basic gated agc circuit.

The filter system of the agc circuit must have an R-C time constant large enough to filter the 15,750-cycle sync pulses to dc but still short enough to follow changes in signal strength within several frames. During alignment, the signal from the sweep generator is present only half of the time. Thus the agc filter will charge and discharge over the 60-cycle period to follow the presence and absence of signal. The result on the agc line is a voltage waveform similar to that shown in Fig. 4.

When this voltage waveform is applied to the grids of the agc-controlled tubes, it biases the amplifiers more on one side of the sweep than on the other and results in a response curve similar to that shown by the dotted lines in Fig. 5. (This effect is greater with a gated agc circuit than with those which are not because of the inherent amplification of the agc voltage in this type circuit.)

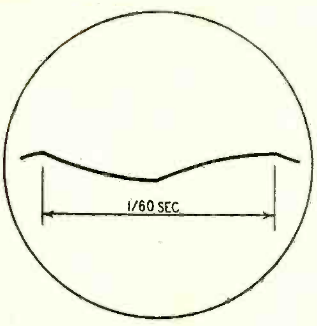

Fig. 4—Voltage waveform on agc line when sweep generator is used.

When the service technician sees the improper curve on the oscilloscope, he naturally thinks that the if amplifier tuning slugs need touching up and often goes ahead, actually misadjusting the receiver. If an external fixed dc bias is applied to the agc line, the curve will appear normal without adjustment.

Thus, a set cannot be aligned accurately when the agc circuit is permitted to operate. Merely disconnecting the agc circuit will not do since the agc voltage developed under actual operating conditions may vary from zero (except for contact potential) to as high as 12 volts. What then should the bias be?

Manufacturers determine an average potential and recommend that this be used for all alignment. For example in late Admiral receivers 4.5 volts is suggested, in Motorola 3 volts, in Zenith 2 volts variable and in Philco 7.5 volts, just to name a few. The importance of using the correct bias can be seen by the fact that the response curve will change considerably in most receivers when the dc bias is varied from 0.5 to 10 volts. As a matter of fact, the response curve becomes a single peak (at low bias setting) in some late-model high-gain receivers. This is due mainly to two things: Miller effect and regeneration. Miller effect is the detuning of circuits caused by changes in tube interelectrode capacitance with applied bias. Regeneration is usually caused by a feedback path from the third if amplifier to the first. Little can be done about either after the set has been

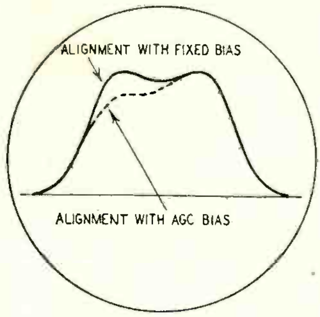

Fig. 5—Variations in if amplifier response with changes in agc bias.

designed and in the field. Most of us have been confronted with sets that seem to be good on strong signal but have poor picture detail on weak signals and vice versa.

If a receiver is to be used in areas with both strong and weak signals, the only answer is to align it with the bias recommended by the manufacturer and then vary the bias from around 1 to about 7 volts to be sure that the curve does not change considerably. If, however, the receiver is to be used only in weak-signal areas, it should be aligned with a potential of around 1 to 2 volts, as this is all that will be developed during operation. For best accuracy, it is a good idea to measure the agc bias with a signal coming in and use that bias. (Or an average of several stations' bias, if all are nearly the same strength.)

Agc troubleshooting

A dc bias can also be used to determine quickly if there is trouble in the agc circuit. If the agc in a television receiver becomes defective, it means that either not enough or too much agc voltage is being developed. These troubles can really be a headache unless it is determined immediately whether the agc line is at fault. To do this, merely connect a dc bias supply to the agc line (without disconnecting any leads in the TV receiver) and slowly vary the bias. If the picture

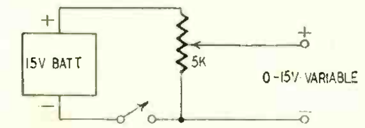

Fig. 6—Simple dc voltage supply.

stabilizes and the picture contrast is correct, the agc circuit is at fault.

Several methods of providing the necessary dc bias are available. The simplest way, of course, is to buy a dry-cell battery. The difficulty that arises here is that TV manufacturers recommend voltages from +2 volts to −12. A simple circuit, shown in Fig. 6, can be constructed to provide these voltages. The output can be calibrated and a steady dc 15-volt supply is available. However, with this circuit the

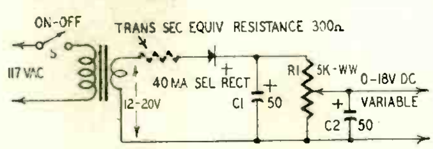

Fig. 7—A commercial bias supply.

batteries eventually have to be replaced and the system would cost about as much as the electronic one of Fig. 6.

This electronic system is a simple isolated power supply with heavy filtering. This is the circuit of the commercially available supply shown in the photo. A wirewound potentiometer is used to obtain linear calibration and to insure calibration accuracy. A 40-ma selenium rectifier is used. If the output leads become shorted, the supply will not become defective. This protection is provided by the 300-ohm internal resistance of the special transformer secondary.

The transformer shown in Fig. 6 could be eliminated and the rectifier hooked onto the 6.3-volt heater supply of the television receiver. However, to say nothing of the time wasted connecting the supply, a number of new receivers do not have the 6.3-volt heater windings, but rather have series heaters. Naturally the supply without the transformer could not be used.

Thus, to avoid alignment inaccuracies, disable the agc circuit by substituting the dc bias recommended by the set manufacturer. In this way the television set can be aligned faster and with much greater accuracy. END

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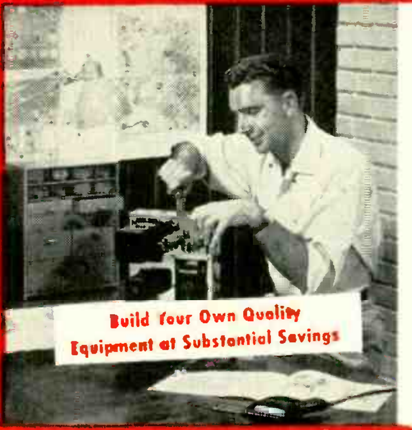

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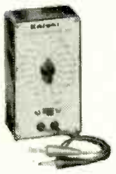

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Outstanding quality and performance at extremely low cost. Features 32 ranges; full vision 4½" meter; accuracy ±2% of full scale; 50 microampere sensitivity for 20,000 ohms/volt input resistance on DC; front panel "zero adjust" Single switch selects function and range. Range: AC, DC and output volts, 0-2.5, 10-50-250-1000-5000; Resistance, 0-2000-200,000 ohms and 0-20 meg.; DC ma, 0-.1-10-100; DC amps, 0-1-10; Decibels, —30 to +63 in 6 ranges. Uses precision 1% multipliers. Moisture-resistant film-type resistors. Complete kit with bakelite case (6¾ x 5¼ x 3¾"), batteries, pre-cut wire, solder and test leads. Shpg. wt., 5 lbs.

Model F-140. 20,000 ohms/volt VOM Kit. Net only **$29.50**

knight-kit VTVM KIT with Printed Circuit Board

Model F-125 $24^{95}

An extremely stable, and highly accurate VTVM. Greatly simplified wiring—entire chassis is a printed circuit board. Maximum convenience in arrangement of scales; 3X AC and DC scale design permits utilization of best portion of each scale for most accurate readings. Also measures peak-to-peak for FM and TV work. Ranges: AC P-P volts, 0-4-14-40-140-400-1400-4000; AC rms volts and DC volts, 0-1.5-5-15-50-150-500-1500; resistance, 0-1000-10K-100K ohms and 0-1-10-100-1000 megohms; db scale, —10 to +5. AC response, 30 cycles to 3 mc. Low-leakage switches and 1% precision resistors. Balanced-bridge circuit. 4½" meter, 200 microamp movement. Polarity reversing switch. Input res., 11 megs. Shpg. wt., 6 lbs.

Model F-125 Printed Circuit VTVM Kit. Net only . **$24.95**

F-126. Hi-Voltage Probe; extends DC to 50,000 Volts **$4.75**

F-127. Hi-Frequency Probe; extends AC to 250 mc. . **$3.45**

PORTABLE MODEL

Model F-143 $29^{75}

knight-kit LOW-COST TUBE TESTER KIT

Offers high accuracy, top versatility and convenience at lowest cost. Tests 4, 5, 6 and 7-pin large, regular and miniature types, octals, loctals, 9-pin miniatures and pilot lamps. *Features test for new 600 ma series string tubes.* Tests for open, short, leakage, heater continuity and quality (by amount of cathode emission). 4½" square meter with clear "GOOD-?-REPLACE" scale. With line-voltage indicator and line-adjust control. Choice of 14 filament voltages from .63 to 117 volts. Blank socket for future type tubes. Universal-type selector switches for any combination of pin connections. *Single-unit, 10-lever function switch.* Entire switch assembly is installed as a single unit—saves time and greatly simplifies construction. Illuminated roll chart lists over 600 tube types. Shpg. wt., 14 lbs.

Model F-143. Counter Model Tube Tester Kit. Net only . . . **$29.75**

Model F-142. Portable Model Tube Tester Kit. Net only **$34.75**

F-141. TV Picture Tube Adapter for above. Net only **$3.75**

knight-kit RESISTOR-CAPACITOR TESTER KIT

Model F-124 $19^{50}

Measures capacitance and resistance by accurate bridge method; checks for opens and shorts in paper, mica and ceramic capacitors; shows power factor of electrolytics. Large dial shows capacitance and resistance at a glance; balanced-bridge circuit with "magic eye" null indicator measures power factor from 0-50%. Tests capacitors with rated voltages applied. 5 test voltages: 50, 150, 250, 350, 450. Capacity ranges: 10 mmf to 1000 mfd in 5 ranges. Resistance ranges: 100 to 50,000 ohms and 10,000 ohms to 5 megs. Accuracy, ±10%. Automatic discharge feature prevents after-test shock. Blue-finished steel case, 5 x 3 x 2". With tubes and all parts. Shpg. wt., 8 lbs.

Model F-124. Resistor-Capacitor Tester Kit. Net only **$19.50**

NEW knight-kit TRANSISTOR & DIODE CHECKER KIT

Model F-149 $8^{50}

Checks leakage-to-gain ratio and noise level of all junction, point contact and barrier transistors. Also checks diodes, forward and reverse current conduction of selenium rectifiers; useful for continuity and short checks. Easy-to-read meter. Features: spring-return leakage gain switch; calibration control; separate sockets for PNP and NPN transistors. Headphones or signal tracer may be used with checker for noise measurements. Case, 5 x 3 x 2". With 22½ volt battery. 2½ lbs.

Model F-149. Transistor Checker Kit. Net **$8.50**

EASY PAYMENT TERMS: If your total KNIGHT-KIT order is over $45, take advantage of our liberal Time Payment Plan —only 10% down. Write for application blank.

ALL PRICES NET F.O.B. CHICAGO

knight-kit LOW-COST "IN-CIRCUIT" CAPACITOR CHECKER KIT

Tests capacitors while they are still wired in the circuit! Saves time and bother; an essential instrument for the service technician. Just press a button and the "magic eye" instantly shows opens and shorts (not leakage). Tests opens and shorts on any capacitor of 20 mmf or greater capacity, even if it is in parallel with a resistance as low as 50 ohms. Tests for shorts may be made on any capacitor even when it is shunted by as low as 20 ohms. Blue-finish steel case, 7¾ x 5¼ x 5". With tubes, all parts, wire and solder. Easy to assemble. Shpg. wt., 5 lbs.

Model F-119. Cap. Checker Kit. . . . **$12.50**

Model F-119 $12^{50}

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"SPACE SPANNER" BAND SWITCHING RECEIVER KIT

Model S-243 **$15.95**

Thrilling Short Wave and Broadcast

Famous 2-band AC-DC receiver in easy-to-build kit form at a very low price. Pulls in thrilling short-wave (6 to 17 mc) and standard broadcast. It's fun listening to amateur, aircraft, police and marine radio. Features highly sensitive regenerative circuit. Bandswitch selects broadcast or short wave. Has 4" PM speaker and beam-power output tube for plenty of volume; headphone connectors for weak signal listening; slide switch cuts out speaker. Uses 12AT7 regenerative detector and audio amplifier, 50C5 power output, 35W4 rectifier. Six controls: Bandspread; Main Tuning; Antenna Trimmer; Bandswitch; Regeneration; Audio Gain. Includes tubes and all parts. 7 x 10½ x 6". Shpg. wt. 4½ lbs.

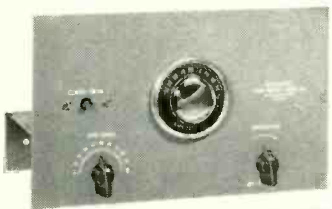
Model S-243. "Space Spanner" Receiver Kit. Net only..... **$15.95**
S-247. Matching Cabinet for above. 2 lbs. Net.............. **$2.90**

Model S-295 **$14.75**

NEW knight-kit TWO-WAY INTERCOM KIT

New low-cost, easy to build intercom system kit. Ideal for use in home or office. Consists of Master unit and Remote unit, each with press-to-talk switch. Remote unit may be left "open" for answering calls from a distance, for "baby-sitting", etc. Remote may also be connected for "private" operation—cannot be "listened-in" on, but it can be called and can originate calls. Master unit includes high-gain 2-stage amplifier; each unit has 4" PM dynamic speaker. Complete with Antique White cabinets (4¾ x 6½ x 4⅜"), all parts, tubes and 50 feet of cable (up to 200 feet of cable can be added). For AC or DC. Shpg. wt., 7 lbs.

Model S-295. Two-Way Intercom Kit. Net only.. **$14.75**



Model S-740 **$11.75**

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"OCEAN HOPPER" RECEIVER KIT

Tops for exciting broadcast, long wave and short wave reception. Highly sensitive regenerative-type circuit. Excellent headphone reception; can be used with 3-4 ohm PM speaker on strong broadcast band stations. Supplied with plug-in coil for standard broadcast; covers long wave and popular short wave bands with coils below. Pulls in thrilling foreign broadcasts, police, amateurs and aircraft. Controls: Main Tuning, Bandspread, Antenna Tuning. Off-On-Regeneration. With all parts and tubes (less extra coils and headset). AC or DC. Shpg. wt., 5 lbs.

Model S-740. "Ocean Hopper" Kit..... **$11.75**

EXTRA PLUG-IN COILS

S-741. Long Wave, 155-470 kc. Net....... 79¢
S-742. Short Wave, 1.65-470 kc.
S-743. Short Wave, 2.9-7.3 mc.
S-745. Short Wave, 7-17.5 mc.
S-744. Short Wave, 15.5-35 mc.
} Net each..... 65¢

Model S-735 **$17.25**

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"RANGER II" SUPERHET RADIO KIT

Thousands have built and enjoyed the "Ranger" Broadcast Band Receiver. Carefully engineered for easy construction and powerful, sensitive performance. Latest Superhet circuit; tunes 540 to 1680 kc; covers entire broadcast band and exciting police calls. Features automatic volume control, built-in preformed loop antenna, ball-bearing tuning condenser. Develops excellent tone quality from Alnico V PM dynamic speaker. Supplied with following tubes: 12SA7GT converter; 12SK7GT IF amp.; 12SQ7GT det.-AVC-audio; 50L6GT audio output; 35Z5GT rect. Complete with handsome brown plastic cabinet (6 x 9 x 5) tubes, speaker, all parts, and instruction manual. AC or DC operation. Shpg. wt., 8 lbs.

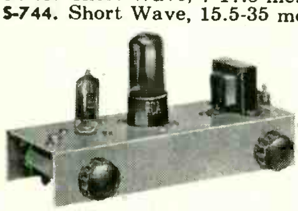
Model S-735. "Ranger II" Superhet Radio Kit. Net only.............. **$17.25**

Model S-730 **$19.95**

knight-kit
3-WAY PORTABLE RADIO KIT

A low-cost portable radio covering the full standard broadcast band from 535 kc to 1650 kc. Delivers excellent reception on AC or DC current or from self-contained batteries. Sensitive Superhet circuit features automatic volume control, economical operation. Includes powerful 5" Alnico PM dynamic speaker, efficient ferrite loop-stick antenna. Supplied with following tubes: 1R5 converter; 1U4 IF amplifier; 1U5 detector-AVC-audio; 3V4 audio output. Complete with attractive portable case (7⅝ x 10 x 5¼"), tubes, speaker, all parts and instruction manual. Shpg. wt., 6 lbs.

Model S-730. 3-Way Portable Radio Kit (less batteries). Net **$19.95**
J-651. Battery Kit for above..... **$2.50**



knight-kit LOW COST PHONO AMPLIFIER KIT

Model S-790 **$8.95**

It's easy to build this fine-performing, low-cost compact phono amplifier. Ideal for use in a portable phonograph—simply add any record player and a 3 to 4-ohm speaker. Amplifier works with crystal or ceramic cartridges. Inverse feedback circuit for rich, clean tone quality. Delivers full 1½-watt output with less than .25 volt input. Includes efficient tone control; has AC outlet, controlled from amplifier switch. Complete with tubes and all parts. Size only 4½ x 7 x 4"—fits into almost any portable phono case. Shpg. wt., 3 lbs.

Model S-790. Phono Amplifier Kit. Net only................ **$8.95**

FAMOUS knight-kit CRYSTAL SET KIT

Model S-261 **$2.15**

Thousands of beginners have started in radio and electronics by building the KNIGHT-KIT crystal set. This feature-packed set delivers loud, clear reception of local broadcast stations. A germanium crystal diode detector assures high sensitivity and simple operation—no crystal adjustment required. "Hi-Q" coil boosts sensitivity. Ball-bearing variable capacitor for easy tuning. With all parts and simple-to-follow instructions. Shpg. wt., 1 lb.

Model S-261. Crystal Set Kit. Net only.................... **$2.15**
S-267. Accessory Kit. 2000-ohm headphones and all parts for outdoor antenna.. **$2.95**

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finest quality electronic equipment in lowest-cost kit form

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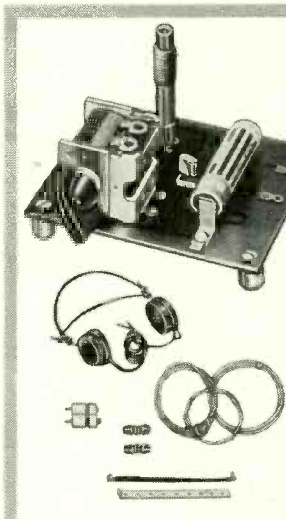
NEW knight-kit ELECTRONIC PHOTOFLASH KIT

Model S-244 **$28.50**

New feature-packed photoflash kit—designed for top quality dependability—available at a money-saving low price. Ideal for black and white or color photography. Xenon-filled reflector-bulb assembly gives over 10,000 flashes at less than ½¢ each! 1/700-second flash freezes the fastest action. Has 50 watt-second output. Provides light approximating daylight in spectral quality; permits the use of outdoor-type film indoors. Film guide number for color (ASA10) is 45. Designed for "X" or "O" shutters only. Requires sync cable (available from any photo supply dealer) and either battery or AC supply listed below. Complete outfit with battery weighs only 3½ lbs. Kit includes all parts, carrying case and easy-to-follow instructions. Shpg. wt., 3 lbs.

Model S-244. Electronic Photoflash Kit. Net.... **$28.50**
S-246. AC Power Supply Kit. Easy to assemble.... **$3.75**
J-626. Battery for above (Burgess U-200)......... **$8.47**



knight-kit TRANSISTOR RADIO KIT

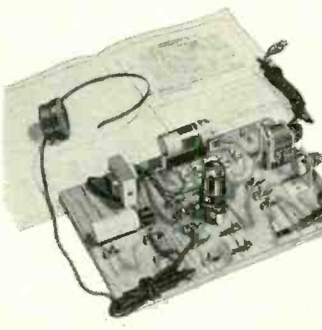
Printed Wiring • Works from Penlight Cell

Model S-765 **$4.35** **Smooth Variable Capacitor Tuning**

Experiment with the marvel of transistors! Printed circuit requires no wiring—just assemble with a few solder connections and enjoy excellent reception over the full AM broadcast band. No tubes to burn out—no crystal. Compact—fits in the palm of your hand—operates for months from a single penlight cell. Transistor provides plenty of power for strong headphone reception. Complete with all parts, transistor and penlight cell. Shpg. wt., 8 oz.

Model S-765. Transistor Radio Kit **$4.35**
S-266. Accessory Kit. 4000-ohm headphones and all parts for outdoor antenna.......................... **$3.15**

FAMOUS knight-kit LAB KITS

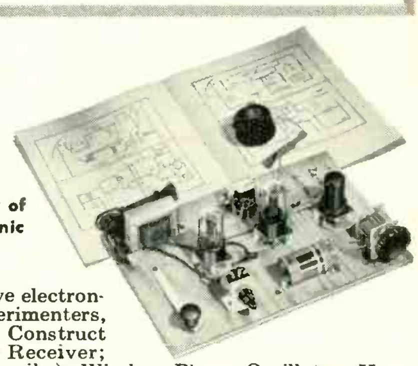


6-IN-1 RADIO LAB KIT

Model S-770 **$7.95** **Build Any of 6 Electronic Projects**

A fascinating and instructive kit. Enables you to build any one of the following projects: Standard Broadcast Receiver; Wireless "Home Broadcaster"; Code Practice Oscillator; Code Practice Broadcaster; Signal Tracer; Sine Wave Generator. Perfect for beginners. Once basic wiring is completed, circuits may be changed without soldering. Safe to build and operate; only tools needed are screwdriver, pliers and soldering iron. The ideal kit for students and beginners in electronics. Kit includes mounting board, tube, all parts and easy-to-follow instruction manual. Less headphone (also serves as mike). Shpg. wt., 6 lbs.

Model S-770. "6-in-1" Lab Kit. Net only................ **$7.95**
J-112. Single 1000-ohm headphone for above............. **$1.05**
C-100. Antenna kit for above........................... **$1.05**



10-IN-1 LAB KIT

Model S-265 **$12.65** **Build Any of 10 Electronic Projects**

A wonderfully instructive electronics kit. Ideal for experimenters, beginners—fun to build. Construct a sensitive Broadcast Receiver; Amplifier (for phono or mike); Wireless Phono Oscillator; Home "Broadcast Station"; Code Practice Oscillator; Capacity-Operated Relay, or any one of *four* other fascinating projects. Low voltages; safe to build and operate. Only tools needed are soldering iron, screwdriver and pliers. Perfect for self-instruction in circuit fundamentals, and packed with practical applications. Kit includes mounting board, tubes, all parts, hardware, microphone, and 12-page builders' manual. Shpg. wt., 10 lbs.

Model S-265. "10-in-1" Lab Kit. Net only.............. **$12.65**
J-112. Single 1000-ohm headphone for above............. **$1.05**
C-100. Antenna Kit for above........................... **$1.05**

knight-kit WIRELESS BROADCASTER KIT

Model S-705 **$9.50**

This fascinating unit makes it possible to "broadcast" witn phonograph or microphone through any standard radio receiver up to 50 feet away—without any connection to the set. May be used with crystal or magnetic cartridge, or with microphone. Broadcasts a clear, full-toned signal. High-gain stage permits using magnetic cartridge without need for external preamp. Complete with all parts, tubes, wire and solder (less microphone). 4½ x 5 x 6". Easy to assemble. Shpg. wt., 3 lbs.

Model S-705. Wireless Broadcaster Kit. Net only...... **$9.50**
S-556. Microphone for above with 5-ft. cable........... **$3.95**

knight-kit PHONO OSCILLATOR KIT

Model S-760 **$5.85**

This low-cost phono oscillator may be used with any crystal phonograph for "broadcasting" recorded music through any standard radio receiver up to 50 feet away. Requires no direct connection to radio set. Operates on any frequency between 600 and 800 kc. Has controls for adjustment of modulation level and selection of clear frequency on radio receiver. Uses 50L6GT tube and 35Z5GT rectifier. Complete with all parts, tubes and instructions. 4¼ x 4¼ x 4½". Shpg. wt., 1 lb.

Model S-760. Phono Oscillator Kit. Net only.......... **$5.85**

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knight-kit CODE PRACTICE OSCILLATOR KIT

Model S-239 **$3.95** **Transistor Circuit—Powered by Penlight Cell**

An ideal code practice oscillator. Uses transistor circuit. Extremely low current consumption—powered by single penlight battery. Provides crisp, clear tone (400 to 600 cps). Has input jack for earphone; screw-type terminal strip for key. In compact bakelite case (2⅜ x 3¾ x 1½") with anodized aluminum panel. Complete with all parts, transistor, battery and easy-to-follow instructions. Shpg. wt., 1 lb.

Model S-239. Code Practice Kit.... **$3.95**

See Next Page for Amateur Kits

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ALLIED'S own knight-kits give you the most for your money

BUILD YOUR OWN QUALITY HI-FI AMPLIFIER!

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BASIC 25-WATT LINEAR-DELUXE HI-FI AMPLIFIER KIT

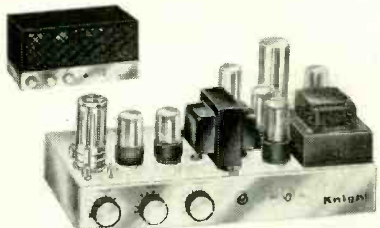
Model S-755

$44.50

Williamson-Type Circuit
Printed Circuit Board
Chrome-Plated Chassis

This super-quality hi-fi basic amplifier is designed to satisfy the most critical listener. Intended for use with tuners incorporating built-in preamp or with separate preamp. Incorporates latest Williamson-type circuit and has potted matched transformers. Delivers maximum output of 45 watts. Frequency response is: ±0.5 db. 10 cps to 120 kc, *measured at 20 watts.* Harmonic distortion is only .15% right up to 30 watts. Intermodulation distortion is only .27% at 10 watts and only .4% at 20 watts, using 60 cps and 7 kc, 1:4 ratio. Hum level is —85 db below full rated output. Output impedance, 4, 8, 16 ohms. Input voltage for 25-watt output is 1.8 volts. Uses two 12AU7's, two 5881's, and a 5V4. Etched circuit is utilized in voltage amplifier and phase inverter stages to speed assembly. Has output tube balancing control, variable damping control, and on-off switch. Handsome chrome-plated chassis, 14 x 9 x 2". Overall height, 7". A deluxe true hi-fi amplifier equal in performance to amplifiers selling at over twice the price. Complete with all parts and tubes. Easy to assemble. Shpg. wt., 27 lbs.

Model S-755. Basic 25 Watt Hi-Fi Amplifier Kit. Net only........................ **$44.50**
S-759. Metal enclosure for above; black finish. 3 lbs. Net.............................. **$4.25**



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10-WATT HI-FI AMPLIFIER KIT

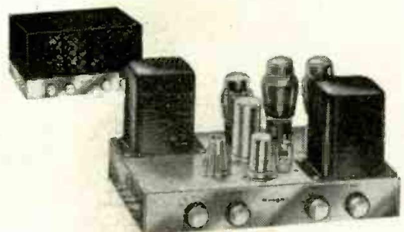
Model S-753

Chrome-Plated Chassis

$23.50

Famous for wide response and smooth reproduction at low cost. Only 0.5 volt drives amplifier to full output. Frequency response: ±1 db, 30-20,000 cps at 10 watts. Harmonic distortion less than 0.5% at 10 watts. Intermod. distortion less than 1.5% at full output. Controls: on-off-volume, bass, treble. Input for crystal phono or tuner. Chromed chassis; punched to accommodate magnetic cartridge preamp. Matches 8 ohm speakers. Shpg. wt., 14 lbs.

Model S-753. Amplifier Kit. Net... **$23.50**
Model S-235. Preamp Kit for above... **$3.10**
S-757. Metal Enclosure. 3 lbs......... **$3.95**



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20-WATT HI-FI AMPLIFIER KIT

Model S-750

Chrome-Plated Chassis

$35.75

True hi-fi for less! Frequency response, ±1 db, 20-20,000 cps at 20 watts. Distortion, 1% at 20 watts. Hum and noise level: tuner input, 90 db below 20 watts; phono 72 db below 20 watts. 4 inputs: magnetic phono, microphone, crystal phono or recorder, and tuner. Controls: Bass, Treble, Volume, Selector. With compensation positions for 78 and LP records. Built-in Preamp. Outputs: 4, 8, 16 and 500 ohms. 23 lbs.

Model S-750. 20-Watt Kit. Net.... **$35.75**
S-758. Metal Enclosure. 3 lbs......... **$4.15**
S-752. Chrome-plated escutcheon for cabinet installation of amplifier. Net..... **$1.40**

LOW-COST TOP QUALITY KITS FOR THE HAM

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50-WATT CW TRANSMITTER KIT

Model S-255

$43.75

Built-in Pi-Type Antenna Coupler

Check the features packed into this new transmitter kit and you'll see why it's one of the greatest Amateur values ever offered. Compact and versatile, it is the perfect low-power rig for the beginning Novice or seasoned veteran. Features: 50 watts input to 807 final; high-efficiency 6AG7 modified-Pierce oscillator takes crystal or VFO without circuit changes; bandswitching coverage of 80, 40, 20, 15, 11-10 meters; pi-section antenna output matches line impedances from 50 to 1200 ohms —permits use with any type of antenna; no separate antenna tuner required. Crisp, clean, cathode keying of oscillator and final. Power take-off plug supplies filament and B-plus voltages for other equipment. Copper-finished chassis and cabinet interior, filtering, shielding, bypassing, and coaxial SO-239 antenna connector provide excellent TVI suppression. Meter reads either plate or grid current of final. Jacks for VFO, crystal and key. Supplied with all parts and tubes. Less crystal and key. 8 3/16 x 11 1/16 x 8 3/4". Shpg. wt., 18 lbs.

Model S-255. 50-Watt Transmitter Kit. Net... **$43.75**

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SELF-POWERED VFO KIT

Model S-725

$28.50

Complete with built-in power supply! Careful design and voltage regulation assure high stability. Excellent oscillator keying characteristics for fast break-in without clicks or chirps. Full TVI suppression. Has plenty of bandspread: separate calibrated scales for 80, 40, 20, 15, 11 and 10 meters; vernier drive mechanism. 2-chassis construction keeps heat from frequency determining circuits. Output cable plugs into crystal socket of transmitter. Output on 80 and 40 meters. With Spot-Off-Transmit switch for "no swish" tuning. Extra switch contacts for operating relays and other equipment. With all parts and tubes. 8 lbs.

Model S-725. Self-Powered VFO Kit. Net..... **$28.50**

NEW knight-kit

AMATEUR RF "Z" BRIDGE KIT

Model S-253

$5.85

Measures standing wave ratio (SWR) and impedance of antenna systems; also for adjusting antenna networks for optimum results. Any VOM may be used for null indicator. High accuracy with 20,000 ohm/v VOM. Correction factor info supplied for other VOM's. With coax input and output connectors. Meters both input and bridge voltage. Calibrated dial gives direct impedance reading; includes 1% precision resistor for precise calibration adjustment. With all parts and handy plasticized SWR chart. 1½ lbs.

Model S-253. "Z" Bridge Kit. Net only **$5.85**

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TV Service CLINIC

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LAST month's TV Clinic confined itself to a discussion of key dc test points as aids to rapid TV troubleshooting. Using an oscilloscope another dimension can be added to this type of quick testing. The scope displays the waveform of a signal and indicates its peak-to-peak value. This provides an interpretation impossible with the vtvm. Observations such as the relative amplitude of horizontal and vertical sync pulses and sweep waveshapes are possible.

Starting at the receiver input, the first—and probably most significant—check point in the set is at the video detector load resistor. By starting at the video detector no demodulator probe is necessary and the signal is strong enough to permit accurate peak-to-peak voltage measurements.

Generally, the strength of an incoming TV signal ahead of the video detector can be checked qualitatively by observing its relative strength as it passes from the tuner through the if amplifier. This method is good enough in checking for a weak or dead stage.

An expensive oscilloscope is not necessary for this type of checking on a black-and-white receiver. A narrow-band scope having a vertical amplifier with uniform response to 0.5 mc will do an excellent job of showing up the rectangular pulse and sawtooth sweep waveforms; the waveshape of the video content is unimportant here.

The signal developed at the video detector load or the grid of the first (and sometimes only) video amplifier stage may be as low as 2 volts peak to peak and as high as 8 volts or so. Observe the signal with the scope synced at half the horizontal and the vertical sweep frequencies. The vertical and horizontal pulse heights should be approximately equal (allowing for scope characteristics which can be checked on normally operating receivers). If there is a significant difference in amplitude, or both pulses are depressed, with possible sync instability and picture smear, check alignment of the tuner and if amplifier. Check carefully the setting of the video carrier on the slope of the if response curve.

The gain of a video amplifier stage is usually between 10 and 25. This can vary, depending upon the number of stages used and the desired signal voltage for driving the picture tube. In typical single-stage video amplifiers such as the Motorola chassis TS-537 about 3.3 volts appears at the video amplifier grid and 85 volts peak to peak at the plate. The G-E model 21T038 has a grid voltage of 8 and a plate voltage of 120. The peak-to-peak plate voltage is not always delivered to the driven element of the picture tube. There may be coupling losses due to contrast control settings or to coupling components. The Du Mont RA-356 and RA-357 has a grid voltage of 3.5 and a peak-to-peak plate voltage of 80.

In typical two-stage video amplifiers the RCA KCS83 chassis produces 2 volts at the grid of the first video amplifier and 41 volts peak to peak at the plate. Through coupling losses, about 15 volts peak to peak appear at the grid of the second video amplifier. This is increased to 120 volts at the plate. In the Du Mont RA-372 and RA-373 chassis (Fig. 1) the grid of the first video amplifier reads 3 volts peak to peak and the plate 50 volts. The grid of the second video amplifier receives a 30-volt peak-to-peak signal with 140 volts at the plate.

The above and following signals are based on receivers in a good signal area and adjusted for a normal picture.

The input to the sync amplifier–clipper circuit is usually taken from the plate circuit of the video amplifier and is generally about 30 volts peak to peak. This can range from as low as 10 to as high as 50 volts, depending upon circuitry. After the horizontal and vertical pulses have been stripped and amplified, the pulses in the plate circuit of the final sync amplifier–clipper, prior to integration and differentiation, are approximately 50 volts peak to peak. Again, this may vary from 30 to 70 volts or so.

In cases of sync instability check these stages for sync compression and for unequal amplitude of horizontal and vertical pulses. Be sure all video information has been removed.

Checking voltages and waveforms in the vertical and horizontal sweep sections is difficult unless the technician is familiar with the various types of oscillator and afc circuits used. However, important universal check points are at the grid and plate of the vertical and horizontal output stages.

The sweep voltage on the grid of the vertical output tube usually has a peak-to-peak value of about 60. Varying with circuitry, this could be as little as 35 volts or so and as high as 80, having the general waveshape as shown in Fig. 2-a. The average peak-to-peak value of the vertical sweep signal at the output tube plate is about 1,000 volts, rarely going much below 700 volts and sometimes going as high as 1,500. The general waveshape is shown in Fig. 2-b. Because of the high voltage in the plate circuit an appropriate capacitance type voltage-divider probe must be used.

In vertical distortion or loss of vertical sweep, the above observations quickly help isolate the trouble to the vertical oscillator, output stage or deflection-coil circuits.

The horizontal output stage provides a similar set of measurements. The waveform at the grid of the horizontal output is an extremely important indication of whether high voltage and raster trouble occur before or after this stage. The grid waveform has the general appearance of Fig. 3, having a peak-to-peak amplitude of approximately 100 volts. Due to drive control settings and circuitry this may vary from as low as 60 to as high as 170 volts (check the grid bias—it should read about one-fourth to one-third the peak-to-peak value).

The plate signal voltage is somewhat difficult to read, being about 5,000 with a variation of perhaps 1 kv. Most technicians prefer to check this test point by drawing an arc. A waveform can be obtained by connecting the scope to a gimmick loosely wrapped around the plate lead. However, the proper thing to do is to use a commercial 100-to-1 capacitance type voltage divider which can be adjusted for a given scope. This gives a safe and accurate voltage check and an indication of oscillation or ringing.

Other scope observations possible are the deflection-coil current waveforms by reading across a 10-ohm resistor placed in series with the coil, and power supply hum. In a conventional full-wave rectifier the 120-cycle component might read about 15 volts at the cathode or filament and 1 volt at the output of the filter.

Most important: know your scope and probe. And the best way to find out about them is to check waveforms on normally operating sets.

Narrow raster

I have a new Westinghouse chassis V-2340 on the bench with insufficient width. The usual checks and adjustments indicated no components at fault.

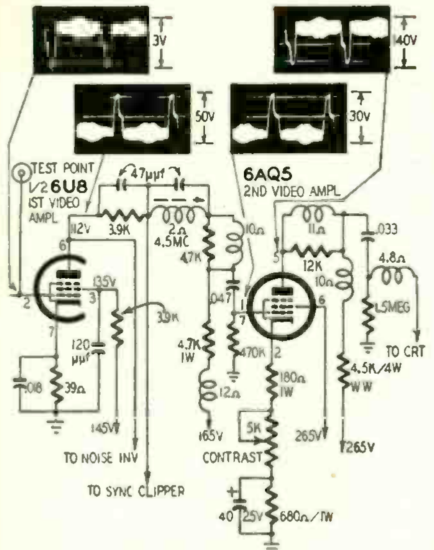


Fig. 1—The two-stage video amplifier in Du Mont RA-372 and RA-373 chassis.

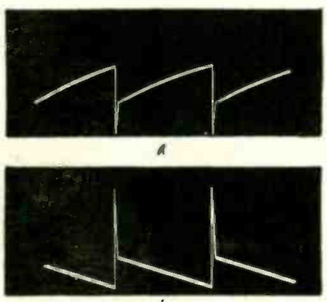


Fig. 2—Normal deflection waveforms at grid (a) and plate (b) of the vertical output tube.

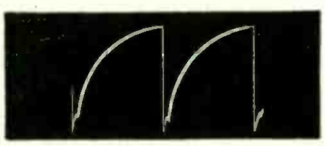


Fig. 3—The sweep waveforms at the grid of the horizontal output tube.

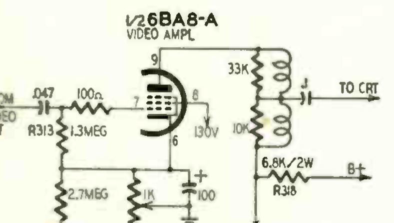


Fig. 4—Video amplifier in Admiral 14YP3B television chassis.

I hesitate to make any circuit modifications because the set was just recently purchased and the trouble is most likely some defective part. I tried placing a capacitor across sections of the flyback and this improved the width very slightly. I would appreciate some method of locating the cause of the reduced width. The picture is fine and the raster is bright and linear.—L. T., Buffalo, N. Y.

Several queries have come in on this symptom on the Westinghouse V-2340. Thus, if you have made a thorough check of the horizontal output and the damper circuits, chances are that the trouble may be in the basic design of the chassis. This is most likely the trouble because later models of this set contain capacitors in the flyback circuit such as you attempted, in addition to reduced resistance values in the horizontal output screen circuit.

Connect a capacitor of about .001–.005 μf across the agc winding. This is terminals 3 and 4 on the flyback transformer. The capacitor should have a rating of approximately 1,500 volts. Also, lower the screen grid resistance, thus increasing the screen voltage. Replace the present 8,200-ohm 4-watt screen resistor with a 6,800-ohm unit or connect a 33,000-ohm ½-watt resistor in parallel with the present unit.

Silvery picture

An Admiral 14YP3B chassis has a negative or silvery picture on strong signals or with the contrast control turned up. I have aligned the set but this did not help. I am sure signal overload is the trouble because an attenuator pad in the antenna circuit clears up the defect. The contrast control has been replaced and all voltages checked to no avail. A careful check of the agc circuit also indicates that everything is operating properly. I would like to know if there is anything I can do about this as I live in a strong signal area.—B. C., Chicago, Ill.

As a double check, see that the local–distant switch is in the local position. This shunts the antenna input with a 470-ohm resistor. Replace the 6BA8-A video amplifier (Fig. 4). The tube may be gassy. Check all components in the video amplifier stage, particularly grid resistor R313 and plate resistor R318. Replace any off value more than 10%.

Of course, it is always possible that the picture tube may be at fault, having low emission or being gassy. If convenient, make this check first.

Improving sound gain

In what is considered a fringe area, I am receiving fairly good programs on my Stromberg-Carlson 621CDM. The picture is fine but the sound is a little weak. I have tried orientation of the antenna and have carefully aligned the set. All tubes in the audio circuits have been checked and all voltages and components tested. I would like to know if Stromberg-Carlson has issued any circuit modifications for improving sound in this set.—J. M., Hancock, N.Y.

The model you have has a rather good sound section and I have not heard of any general complaint or circuit modification. If you have the manufacturer's service notes and are satisfied that the set has been completely aligned and checked, try the following: Turn to one of the weaker stations that you regularly watch and adjust the fine tuning for best picture. Then, without touching any other control, adjust the slug at the top of the ratio-detector transformer for best sound. This will slightly improve overall sound gain.

Tube substitution

This is not the usual type question you receive, but for some time I have used the 6BA6 as a substitute for the 6AU6. It has worked very well but I am told that the set is harmed by doing this. Both tubes are pentodes and fairly similar. Furthermore, I have never heard of any complaint or callback involving this substitution. I would like your opinion on their interchangeability.—G. R., San Diego, Calif.

There are many cases where tubes having widely different characteristics may be substituted in a given circuit. In the substitution of the 6BA6 for the 6AU6 you have tubes whose major differences are in their cutoff characteristics. The 6AU6 is a sharp-cutoff pentode, the 6BA6 a remote-cutoff type. Other than this, in typical operation, their plate resistance, transconductance and plate current are reasonably close. This does not mean that substitution will necessarily work both ways. A remote-cutoff tube on occasion may give slightly inferior but acceptable performance in a circuit requiring a sharp-cutoff tube. However, a sharp-cutoff unit will not usually perform well in a circuit requiring a wide grid-control range.

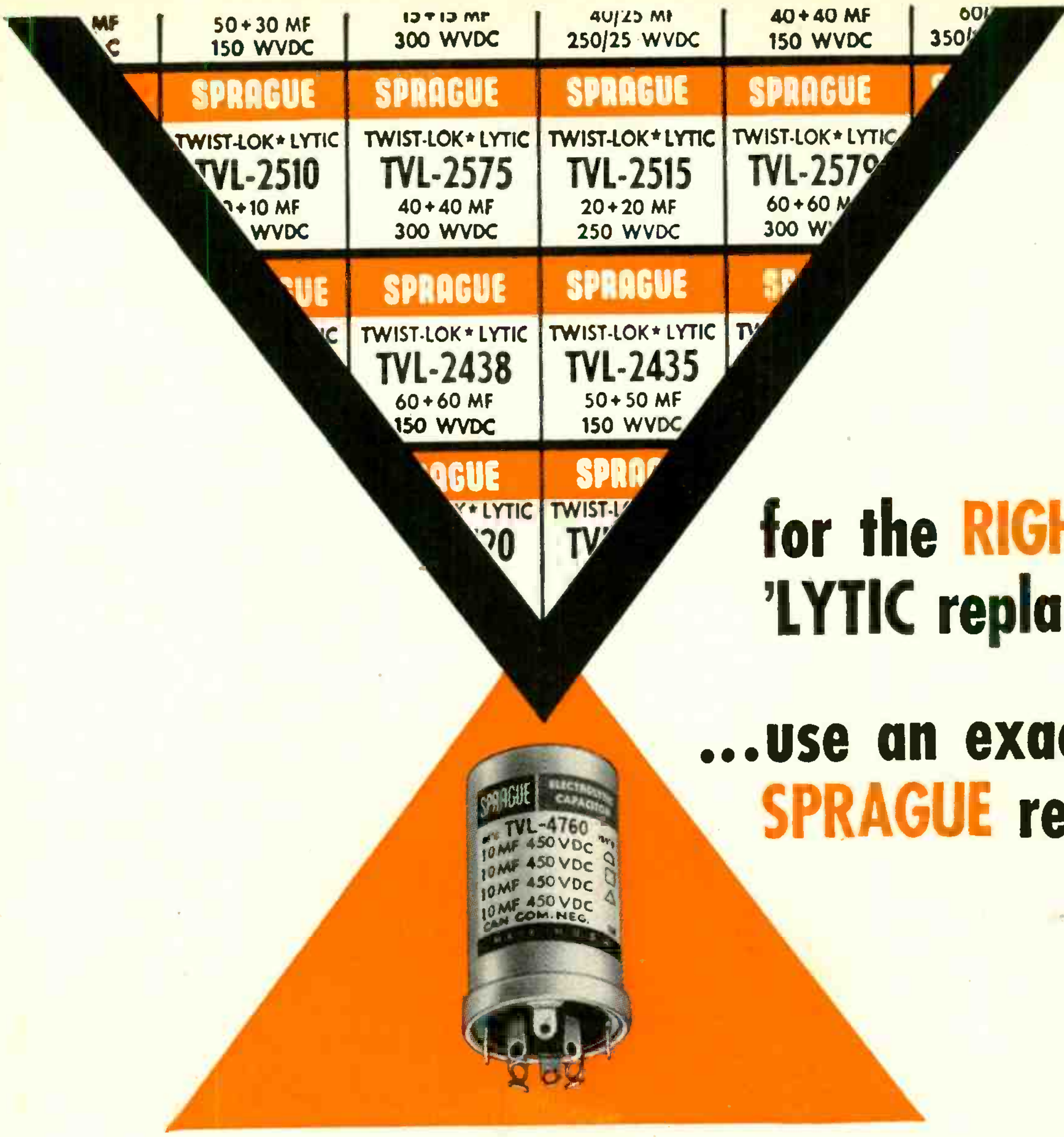
Thus, for optimum performance, try always to use exact tube replacements. Don't make a general rule of a condition that works out satisfactorily in a given case. Your substitution will not harm a set current-wise.

Heater-line resistor

I have made three service calls on a Sylvania chassis 1-527. Each time the trouble was traced to a defective 6AK5. In two cases the tube heater was open but the other tubes were lit because the 6AK5 is shunted with a resistor. When I inserted a new tube, the heater voltage measured normal. The shunt resistor measured about 20 ohms, which is only slightly higher than the schematic calls for. I replaced it with a 2-watt unit but since then I have had another blown 6AK5. Perhaps I am overlooking something very simple and would appreciate your comments.—R. H., Akron, Ohio

In heater strings such as these, an open heater will often damage the shunt resistor. Thus, before replacing the defective tube, carefully check the shunt resistor. In your chassis the resistor is a 15-ohm 5-watt unit. Possibly some other technician had replaced the original resistor with the 2-watt.

Be sure you have the correct resistor—this one is mounted on the chassis near the tuner, not inside. The 6AK5 should not be left out of the chassis for any length of time because the shunt resistor is overloaded and will change value, causing poor receiver operation or possibly damaging the new 6AK5 when it is inserted. END



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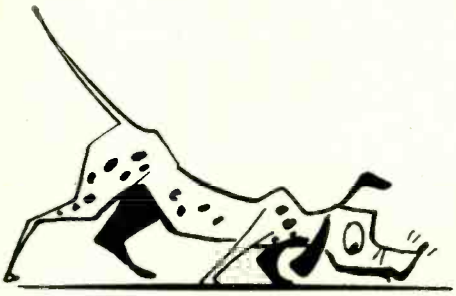
By
ROBERT G. MIDDLETON*



tracking down an intermittent

INTERMITTENT dogs are among the worst; so much time must often be spent waiting for the intermittent to appear. A dog was brought in which had sync pulling, with the picture wavering horizontally in an intermittent manner. The wavering was not well defined and the pulling occurred randomly, sometimes almost to the extent of tearing; at other times with only slight momentary pulling. This uncertain horizontal sync was frequently accompanied by streaks of noise which flashed horizontally through the picture. It looked as though a high-voltage arc might be present except that the pulling and tearing were not always associated with the random noise streaks. Then, when the chassis was pulled from the cabinet, the intermittent suddenly stopped.

New tubes had been tried and most of the capacitors and resistors in the horizontal sync circuit had been replaced. According to the customer the trouble became progressively worse after the receiver was turned on for some time. For this reason, it appeared that there might be some type of thermal intermittent in the sync circuits. However, since the sync circuit had been practically rebuilt, with no change in the symptoms, there were few components which could be suspected. A heat lamp was not available so the technician started work by tapping resistors, capacitors and inductors at random. This approach led nowhere and it was clear that the intermittent was not mechanical.

Variable line voltage no help

In another attempt to make the intermittent start up, a variable line-voltage transformer was connected to the receiver and the voltage run from 90 to 130. The set operated like a normal receiver under the same circumstances. So it began to appear that the initial surmise of a thermal intermittent was correct and the technician sent out for a heat lamp. (There is no excuse for any service shop not to have a heat lamp available!)

Intermittent starts again

Almost as soon as the heat lamp was applied a slight wavering and random pulling appeared in the picture. This condition rapidly became more severe and soon was the same as when the receiver had been operating for some time in the cabinet. However, since the rays from the heat lamp fell on a rather wide area, the next problem was to run down the faulty component.

Discussion arose as to whether the intermittent could really be in the sync circuit since it had been practically rebuilt. The high-voltage circuit was ruled out since the noise streaks occurred at random. However, it was suggested that picture pulling could arise from an intermittent in the agc circuit, causing transients in the video signal. The objection to this theory was that the picture didn't exhibit the usual effects of subnormal agc voltage. There might have been a little change in contrast with the picture pulling, but if so it would be classified as a possibly unrelated symptom.

At any rate, it would be easy to rule out the possibility of agc trouble.

Bias box stabilizes sync

A variable-bias box was obtained and the output applied between the agc bus and chassis ground. Immediately the picture pulling was under control. When the bias was set at —1.5 volts a normal contrast picture was obtained, with little or no pulling. As soon as the bias box was disconnected the random pulling started again.

Since it was now established that the trouble *was* in the agc system, a vtvm was connected to the agc bus. The pointer moved to some extent when the more severe picture pulling occurred. It seemed likely that the intermittent was very rapid, so that change in picture contrast was hardly noticeable for the duration of the intermittent. However, the intermittent did insert noise pulses in the video signal of sufficient intensity to upset the horizontal phase discriminator.

It remained now only to run down the intermittent component in the agc system. Someone suggested at this point that we could mount the bias box in the receiver and leave it connected since there is only one TV station in this section of the country. This cure was not seriously considered although it brought back a recollection of the time that a radio receiver had been brought in for repair.

A nonstandard repair, that one

To digress from the main issue for a moment, this radio was brought in for replacement of filter capacitors. However, a large black box wrapped in friction tape was mounted below the chassis, with two leads coming out. One lead was attached to the plate of a tube, the other returned to some other circuit point. At first we replaced the filter capacitors and turned the set on. It played satisfactorily, and usually we would have let it go at that.

But the black box was a little too much for human curiosity, so we unwrapped it. Great jumping jupiter! It was a volt-ohmmeter wrapped up in the tape. When the volt-ohmmeter lead was disconnected from the circuit, the radio stopped playing. It turned out that there was a nearly open resistor in the circuit, which was "repaired" by applying the input resistance of the meter. How about that?

Finding the intermittent

To get back to the TV receiver, the intermittent component was next sought by holding the tip of a soldering gun near one component after another in the agc system. When a resistor in the agc keying tube was heated in this manner, the sync started to go crazy and we knew we had at least localized the main trouble. Fig. 1 shows the location of this resistor. The triode agc keyer tube in this circuit is uncommon but troubles caused by high-amplitude pulses across

* Chief field engineer, Simpson Electric Co.

resistors are, unfortunately, not rare.

When the resistor was replaced, the horizontal sync instability was cleared

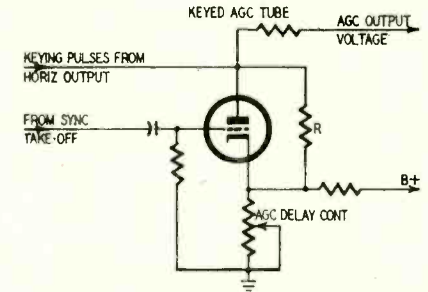


Fig. 1—Bad resistor R between plate and cathode affects sync stability.

up completely. The picture could not be made to pull by further application of the heat lamp. However, another symptom now appeared.

Capacitor is a battery

The picture began to compress vertically with application of the heat lamp, until it looked like the raster was made of rubber. This was obviously vertical trouble which we had overlooked before because of the prominent nature of the horizontal trouble.

Double trouble! Well, it could be localized by the same means as before. The tip of the soldering gun was next held near various of the vertical-sweep components in turn. When it was held near peaking capacitor C (Fig. 2), the

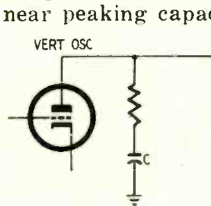


Fig. 2—Peaking capacitor, among other things, affects height of raster.

picture responded enthusiastically, becoming about 4 inches high. This was a .002-μf capacitor which when replaced took care of most of the vertical stretch.

But this capacitor was a puzzler. When placed across the dc voltage terminals of a vtvm, it deflected the pointer ½ volt. If the terminals of the capacitor were reversed, it deflected

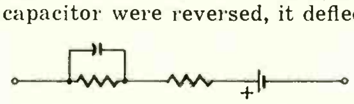


Fig. 3—Equivalent circuit of defective capacitor acting as a weak battery.

the pointer ½ volt in the other direction. The deflection gradually dropped off. But upon giving the capacitor a short rest, it would again generate a voltage and deflect the pointer. It was one of those infrequent cases where electrolysis takes place in a faulty capacitor and causes it to act as a weak battery. (See Fig. 3.)

However, it was not the small voltage generated by the capacitor which was causing the vertical trouble. The capacitor was leaky as well and its leakage resistance was thermally responsive. The battery action of the capacitor was merely a side issue—one of the TV servicing sideshows which makes life more interesting in the back shop. END

tv dx

By ROBERT B. COOPER

THE Perseids meteorite shower occurring during the second week of August provided many dxers with an excellent chance to look into this business of meteor-scatter dxing. Not a few found the results fascinating, while many of the old hands added numbers of stations to their dx totals. Although meteor-scatter dxing (termed MS by those in the know) is supposed to provide bursts only within single-hop sporadic-E range (500–1,500 miles), several alert observers are logging much longer distances. Collin of Buffalo, N. Y., notes verified reception from Billings, Mont., and Salt Lake City, Utah. Lupton of Shelbyville, Ill., notes Las Vegas, Nev., during August. Observer Burch of Hot Springs, Ark., reports that stations were identified via MS on all but two days between July 25 and August 24. Total station identifications were 68. Although the meteorites entering our E-layer are capable of bringing MS reception of some form on any day of the year, definite peaks do occur when meteorite showers really push the burst count up. Such a peak will occur during the period of December 11-14, as an annual shower appears. All dxers should also be alert for high-band (channels 7–13) bursts during this period.

Dxer Rauch, residing in Peoria, Ill., reports two loggings that will undoubtedly bring up an old controversy again. In the past few years, several high-band loggings of rather phenominal distances have been reported to this editor. In the first few instances, we merely assumed them to be a case of mistaken identity. But as more of these loggings turned up, the facts were hard to ignore. As the following information will probably show, we are apparently experiencing an entirely new form of wave propagation that requires a lot of investigation.

In the early morning hours of August 31, Rauch was able to log five minutes of reception from channel 11, KTTV, Los Angeles, Calif. This distance is just over 1,700 miles. As if once wasn't enough, Rauch notes that a repeat performance occurred on the morning of September 19, between 0110 and 0200 CDT. Complete program information was copied, which checks very nicely with the station programming. Rauch also notes that the antenna heading was extremely critical, and that reception did not fade in and out, but rather, "popped" in and out as if someone turned the transmitter on and off. The signal strength was weak, but readable.

Several other loggings in the past few years might be worth some mention at this time. Brown of Barstow, Calif., caught KWWL-7, Waterloo, Iowa, in the same manner in July, 1955. Burch of Hot Springs, Ark., notes KZTV-8, Reno, Nev., in June, 1955, while Seybold of Dunkirk, N. Y., saw not one, but several stations by the same type of propagation on July 26, 1955. Included were WFAA-8, Fort Worth, and KGUL-11, Galveston, Tex., KWTV-9, Oklahoma City, Okla.; KOLN-10, Lincoln, Neb., and KTVH-12, Hutchinson, Kan. In the past years, this column has reported similar reception of KTTV, Los Angeles, Calif., in several spots in Indiana and Wisconsin. And not to be forgotten are the loggings of Rugel, Independence, Kan., who saw WTOP-9, Washington, D.C., and Startzman, Bennington, Kan., who noted WICU-12, Erie., Pa., on the same day that Seybold noted the various Midwest stations.

The interesting part about these loggings is that no other stations than those normally seen were logged when this dx was noted. Ground wave was not noted to be better than average in any of the instances. The periods of reception vary from early morning to late evening, with only one logging noted between 0900 local time and 2000 local time. Reception was never too strong, but always steady. In each case, reception was from June 15–Sept. 30.

As these reception reports seem to involve a new form of wave propagation, not yet known to propagation enthusiasts, RADIO-ELECTRONICS is endeavoring to collect as many similar reports as possible. If you can add to our growing file of reports, please do so.

Special Reports

A special MS report on hand from observer Bedford Brown, Hot Springs, Ark., is of definite interest. During a special early morning dx test put on by station WITN-7, Washington, N. C., for the dxers in the American Ionospheric Propagation Association (AIPA), Bedford noted 13 identifiable bursts in a period of one hour. This is a distance of 905 miles, and at a frequency of 175 megacycles. Bedford was able to draw correctly a test pattern and call slide.

The periods adjacent to July 7 and August 5 produced excellent ground wave (tropo) conditions from the mid-Gulf states to the area along the Great Lakes. Observers on both ends of the circuit report high-band loggings in excess of 700 miles, while the low-band tropos were good for 550-mile loggings. Observer Lupton of Shelbyville, Ill., notes uhf reception to 300 miles during the same period.

Rauch of Peoria, Ill., also notes reception from WOR, WABC and WRCA from New York, N. Y., via tropos on the AM on the 30th of August. This is a distance of 805 miles, and is the farthest west penetration of high-band signals from the Atlantic coast line that we know of.

Forecast for midwinter

For meteor-scatter dxing, the period of December 10–15 promises to be extra interesting. This is the period of an annual meteorite shower which has, in past years, been very productive. The evenings of December 12 and 13 usually produce the best dxing sessions, and observers interested in MS should not overlook the periods from 1100–1400 LST in the first two weeks of January.

F2 skip should have made its appearance, and long since receded for awhile, as you read this. Checking with the records of the past years of high F2 activity, we find that a dip should occur around December 1 and last until March 1, 1957. For all practical purposes, then F2 will be nonexistent for the next four months, at least here in the states. Observers in South America and the Pacific should continue to enjoy reception from 2,200 miles over.

Sporadic-E skip will begin to find its own about the time you read this. The annual upswing in E-sporadic occurrence usually peaks in mid-January, although some openings are expected throughout December. Almost all E's occurring during the next two months will take place between 1600 and 2000 LST (4 pm to 8 pm local standard time). The first openings will be noted in the more southern areas of the country, gradually spreading northward as January appears.

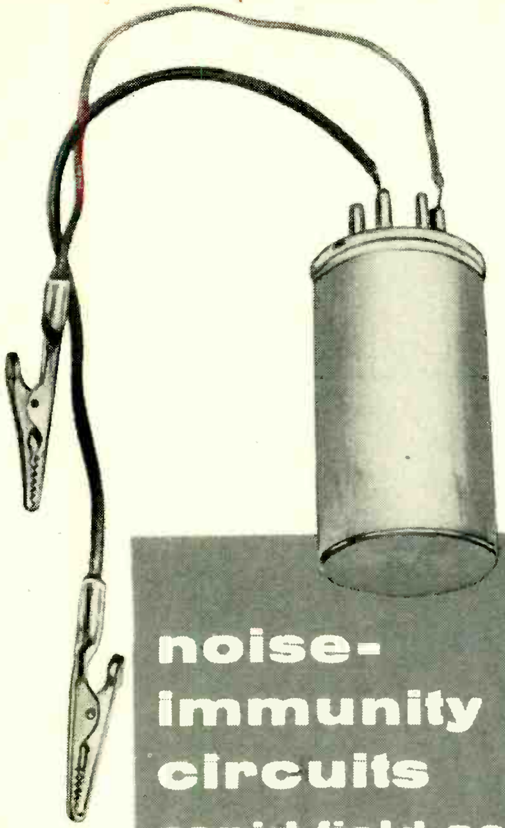
Tropospheric dx is expected to be poor over the whole country during the next three months. Occasional early morning and late evening openings are expected near large bodies of water, as storm fronts approach the receiving location.

Get your forms!

RADIO-ELECTRONICS provides TV dx forms for dxers reporting to this column. These are available free of charge by merely dropping a card with your name and address to TV DX Column, RADIO-ELECTRONICS, 154 West 14th Street, New York 11, N. Y.

The January issue of RADIO-ELECTRONICS is traditionally the Annual TV Issue. In accordance with this, we plan a review of the TV dx highlights of the year, notes on unusual loggings, and a listing of the members of the "Over 50 TV Dx Club."

With our column appearing in the January issue, as well as December, the next regular TV dx report and forecast will appear in March, 1957. END



Rapid tests and adjustments for these critical circuits

noise-immunity circuits

rapid field service methods

Fig. 1—A handy source of noise.

By JAMES A. McROBERTS

NOISE-IMMUNITY circuits are designed to prevent random noise pulses from affecting the sync circuits. Strong noise bursts cause the picture to roll vertically or tear horizontally in the absence of noise-immunity circuitry. These circuits often need minor adjustments and servicing in the field.

Fig. 1 shows a very handy noise source, an old vibrator that still vibrates but is so worn and noisy as to be unsuitable for auto radio use. Two leads are soldered to the base pins, making it a simple buzzer. Or, an ordinary doorbell buzzer may be used. The wire leads terminate in clips that are attached to the hot heater supply and to chassis ground, respectively. In series-string sets use a filament transformer or battery as a voltage source. A tube may be lifted partially from its socket for above-chassis access. I usually pull the picture-tube socket back a trifle to expose the heater base prongs. Or employ any 6-volt source on hand.

Fig. 2 is the schematic of the noise source, a simple buzzer. A lead may be hooked to the hot filament lead and brought near the antenna lead to give greater noise injection if it is necessary.

Adjustment

For adjustments, simply clip the leads to the hot heater and chassis ground. Turn the noise control—whatever it may be called in that set—until the picture does not tear on a reasonably weak but usable signal. Do not use too weak a station signal or there may be poor sync action even in the absence of noise. Too strong a signal produces poor operation on the weaker channels. In some types of sets the noise (from the buzzer or vibrator) will have to be turned on and off while making the adjustments. This simulates random noise bursts. A small variation of the control each time the vibrator is off will soon produce a stable picture when it is running.

Fixed type of control

Noise-immunity circuits fall into two categories:

1. *The cancellation type.* The noise signal is clipped (Fig. 3) from the sync (often the video) signal, inverted and fed back into the system 180° out of phase to cancel the noise, without adversely affecting the sync. The constants of the clipper are rather critical and adjusted at the factory by a cut-and-try procedure if an external control is not provided. This arrangement is used in the Magnavox series 160 and 107 and in other makes and models.

2. *The conduction type.* The path of the sync pulses is cut off (Fig. 4) as by a switch in the presence of noise. The switch is open when noise appears. This circuit, used several years ago by Philco, depends on a very critical state of near cutoff during normal sync. The inertia or flywheel action of the local oscillators (vertical and horizontal) are relied upon to keep the picture in sync when the switch or gate tube is nonconducting, i.e., when the switch of Fig. 4 is open.

3. *Shunt type.* Fig. 5 shows a shunt type noise canceller acting as a shunt switch. The switch conducts in the presence of noise above a level set by voltage divider R1, R2. The entire signal is removed when noise arrives at canceller.

These circuits may depend on rather critical adjustment of the bias or voltage determining the clipping action. Usually this takes the form of a voltage divider (R1, R2) from a B-plus supply bus, as in Fig. 4. Here any slight change of resistance values in the chain of resistors makes the circuit ineffective—it will either remain cut off all the time or not be driven to cutoff by noise. If a voltmeter is connected from the chassis to plate (Figs. 4, 5), or chassis

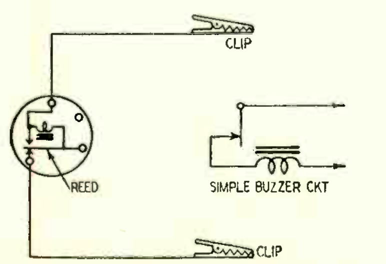


Fig. 2—Diagram of simple buzzer.

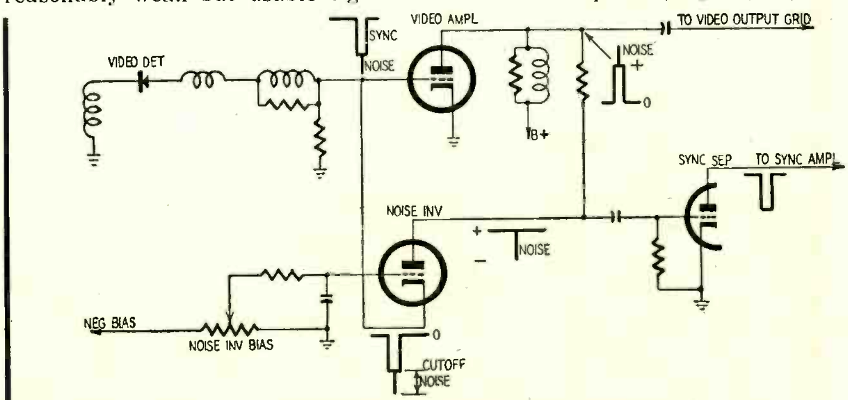


Fig. 3—A cancellation type circuit.

to cathode in some instances, the voltage change will indicate cutoff. That is, when there is no change the tube is in cutoff.

Potentiometers can be put in place of either R1 or R2 and varied until the tube remains cut off (for the nonconduction type) or until the noise clipping (in the cancellation type) just holds the picture stable. The pot is connected as a rheostat and adjusted for a stable picture in the presence of noise. Then the resistance of the potentiometer (rheostat) is measured and a fixed resistor inserted. A potentiometer may be left in the circuit if desired, for control. The same is true of the cancellation circuits.

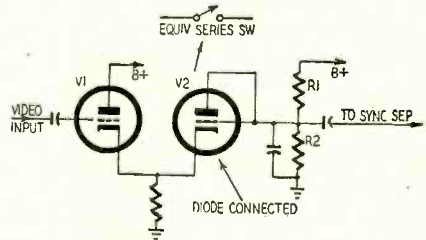


Fig. 4—A conduction type of circuit.

Picture stability is the clue to correct adjustment. In cancellation circuits the noise inverter must invert an approximately equal amount of noise signal to function properly. There is some tolerance; the inverter will operate properly if the clipped inverted signal is about 75–80% of the noise pulse. Therefore cancellation is effective even if not perfect.

A pair of headphones (high-impedance) may be used with a series capacitor to listen to sync pulses in the nonconduction type of circuit. Listen to the sync pulses without the noise source (buzzer, vibrator), then turning on the noise should remove the sync pulses in the headset.

Similarly, an ac voltmeter with a series capacitor to block out the dc may be used. The voltmeter will indicate the sync pulses but is not an accurate indication since the meter is calibrated for rms ac in the common types. However, it will indicate cutoff. It will indicate (for the cancellation type) additional noise voltage (take a reading with source on and then off) and the inverted voltage. Although the readings may be only relative, that is all that is required. END

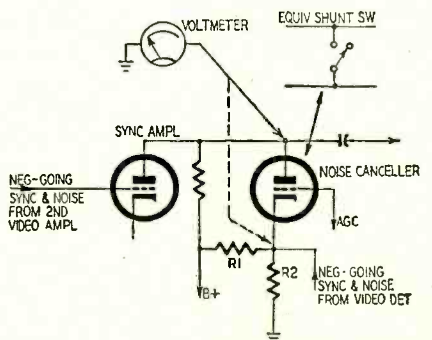


Fig. 5—A shunt type noise canceller.

ABBREVIATIONS and Symbols

By CHARLES S. KIMBALL

(Continued from November, page 81.)

—D—

D	—Electrostatic flux density.
	—Density.
	—Diameter.
	—Layer of the ionosphere 50 to 100 kilometers above the earth.
d	—The prefix deci.
davc	—Delayed avc.
db	—Decibel.
DBB	—Detector balance bias (radar).
dbm	—Decibel, 1-mw reference.
dc	—Direct coupled (amplifier).
	—Direct current.
DC REST	—Direct current restorer.
dcc	—Double cotton covered (wire).
dce	—Double Cotton Enamel (wire).
dd	—Duplex dropout (telephoney).
deci	—1/10 of any given unit.
DEFL	—Deflection.
deka	—10 times any given unit.
Delta (Δ)	Greek letter symbol for:
	—3-phase circuit arrangement in which the circuit configuration is shaped like the Greek letter.
	—Increment or decrement (capital or lower-case letter).
	—An impedance-matching arrangement (Delta match) for feeding a center-fed resonant antenna with a balanced transmission line of lower impedance.
	—Determinant (Capital).
	—Permittivity (Capital).
	—Density.
	—Angles.
DEMOD	—Demodulator.
DET	—Detector.
DEW	—Distant early warning (radar network)
df	—Direction finder (or finding).
DIELECT	—Dielectric.
DISCH	—Discharge.
DISCRIM	—Discriminator.
DME	—Distance measuring equipment.
dpdt	—Double pole double throw (switch or relay).
dpst	—Double pole single throw (switch or relay).
dsc	—Double silk covered (wire).
dx	—Distance (radio reception).
DYN	—Dynamic.

—E—

E	—In radar, an indicator that presents target range and elevation data.
	—Layer of the ionosphere 100 to 175 kilometers above the earth.
	—In waveguide propagation, waves whose magnetic vector (H vector) is always perpendicular to the direction of propagation. Also known as TM waves.
E, e	—Voltage.
e	—Emitter (of transistor).
ec	—Enamel covered (wire).
ECM	—Electric counter measures (radar).
eco	—Electron-coupled oscillator.
ehf	—Extremely high frequency (band).
ELEC	—Electric.
ELECT	—Electrode.
emf	—Electromotive force.
ENAM	—Enameled (wire).
ensi	—Equivalent noise sideband input.
EPI	—Expanded position indicator (radar).
	—Electronic position indicator.
Epsilon (ε)	Greek letter symbol for:
	—Dielectric constant.
	—Permittivity.
	—2.71828 (base of natural logs).
eput	—Events per unit time.
EQUIV	—Equivalent.
ERASE HD	—Erase head.
ERP	—Effective radiated power.
e/s	—Electrostatic shield.
Eta (H, η)	Greek letter symbol for:
	—Intrinsic impedance.
	—Efficiency.
	—Surface charge density.
	—Hysteresis.
	—Coordinates.
ev	—Electron-volt.
EW	—Early warning (radar).
	—Electronic warfare.
EXT	—External or extension.
	In vacuum-tube terminology:
E_b	—Average or quiescent plate voltage.
E_{bb}	—Plate supply voltage.
E_{bo}	—Quiescent (no signal) plate voltage.
E_{bm}	—Maximum plate voltage.
E_c	—Average or quiescent grid voltage.

ABBREVIATIONS *(Continued)*

E_{cc}	—Grid bias supply voltage.
E_{cm}	—Maximum grid voltage.
E_g	—Rms value of varying component of grid voltage.
E_g-I_p	—E_g-I_p curve: Graph of relation between grid voltage and plate current for specific type of vacuum tube.
E_{gm}	—Maximum value of varying component of grid voltage.
E_p	—RMS value of varying component of plate voltage.
E_{pg}	—Plate voltage in respect to grid.
E_{pm}	—Maximum value of varying component of plate voltage.
E_{sg}	—Screen grid voltage.
e_b	—Instantaneous value of varying component of grid voltage.
e_c	—Instantaneous value of total grid voltage.
e_g	—Instantaneous value of varying component of grid voltage.
e_p	—Instantaneous value of varying component of plate voltage.
	In color television:
E_b	—Normal full blue signal.
$E_b - E_y$	—The signal resulting from subtracting E_y from E_b.
E_r	—Normal full red signal.
$E_r - E_y$	—The signal resulting from subtracting E_y from E_r.
	—F—
F	—Farad (f. in combination).
	—Magnetomotive force.
	—Luminous flux.
	—In mathematics, a function.
	—In radar, type of indicator that presents target azimuth error and elevation error.
	—In rf transmitter emissions, frequency or phase modulation.
	—U. S. Navy prefix for shipborne fire-control radar: FC, FD, FH, etc. Later changed to Mark III, Mark IV, Mark VIII, etc.
F_1	—Layer of ionosphere 175 to 250 kilometers above surface of earth.
F_2	—Layer of ionosphere 250 to 400 kilometers above surface of earth.
f	—Frequency.
f_o	—Resonant frequency.
FBRL	—Final Bomb Release Line.
FDM	—Frequency Division Multiplex. (Carrier-Frequency Telephone.)
FIL	—Filament.
FM	—Frequency modulation.
FOLL	—Follower (ing).
FPS	—Feet per second.
	—Foot-pound-second system of units.
FTC	—Fast Time Control (radar).
FREQ (f)	—Frequency.
frmv	—Free-running multivibrator.
	—G—
G, g	—Control grid of vacuum tube.
	—Electrostatic stress.
	—In physics, gravity.
	—In radar, type of indicator that presents (single signal only) target azimuth error and elevation error data.
Gamma (γ)	Greek letter symbol for:
	—Complex propagation constant (cap.).
	—Specific gravity.
	—Electrical conductivity.
	—Propagation constant.
GCA	—Ground-Controlled Approach (radar).
GCI	—Ground-Controlled Interception (radar).
GCL	—Ground-Controlled Landing (radar).
GCR	—Ground-Controlled Radar.
GCT	—Greenwich Civil Time (navigation).
GDM	—Grid dip meter.
GDO	—Grid dip oscillator.
GEN	—Generator.
GEOREF	—World Geographic Reference System (navigation).
GHA	—Greenwich Hour Angle (navigation).
GL	—Gun Laying (radar).
GM	—Guided Missile.
	—Geometric mean.
GND	—Ground.
GPI	—Ground Point of Interception (radar navigation).
GT	—Glass Type—in vacuum tube number designations: as 6SJ7GT.
GTC	—Gain Time Control (radar).
Gyro.	—Gyroscope.
	In vacuum-tube terminology:
g_c	—Conversion conductance.
g_d	—Dynamic conductance.
g_g	—Grid conductance.
g_m	—Mutual conductance or slope.
g_n	—Plate-to-grid transconductance.
g_p	—Plate conductance.
g_1	—Grid No. 1; similarly, g_2, g_3, etc.
	—H—
H	—Magnetizing force.
	—Horizontal component of terrestial magnetism.
	—Type of attenuator network having shape of letter H.
	—In waveguide propagation, waves whose electric vector (E vector) is always perpendicular to direction of propagation. Also called TE waves.

	—In radar, type of indicator which presents target azimuth, range and elevation data. Not in general use.
h	—Henry, the unit of inductance.
HD	—Head.
hf	—High frequency (frequency band).
HI	—Height Indicator (radar).
HIDF	—Horizontal (side) Intermediate Distributing Frame (telephony).
Hi Fi	—High Fidelity (recorded sound).
HIG	—Hermetically sealed integrating Gyro.
Hiran	—High-precision shoran.
HMDF	—Horizontal (side) Main Distributing. Frame (telephony).
HORIZ	—Horizontal.
hp	—Horsepower.
HTR (H)	—Heater.
HV	—High voltage.
	—I—
I	—Effective or rms value of current.
	—In radar, type of indicator used with conical antenna scan. Presentation is circular and displays range and azimuth data. Not in general use.
i	—Instantaneous current.
IA	—Input axis (gyro).
IAGC	—Instantaneous Automatic Gain Control (radar).
IBRL	—Initial Bomb Release Line (radar navigation).
IC	—Internal connection (vacuum-tube base diagrams).
ICAS	—Intermittent Commercial and Amateur Service.
ICBM	—Intercontinental Ballistic Missile.
ICW	—Interrupted continuous wave.
ID	—Inside diameter.
IDF	—Intermediate Distributing Frame (telephony).
if	—Intermediate frequency.
IFF	—Identification of Friend or Foe (radar).
ILAS	—Instrument Landing Approach System.
ILS	—Instrument Landing System.
IM	—Intermodulation.
Imp.	—Impedance.
IN	—Input.
INV	—Inverter.
Iota (ι)	Greek letter symbol for:
	—Unit vector.
IPA	—Intermediate power amplifier.
ips	—Inches per second.
IR	—Product of current (I) and resistance (R). Equal to voltage.
I^2R	—Product of current squared and resistance. Equal to power in watts.
IRBM	—Intermediate Range Ballistic Missile.
ITV	—Industrial Television.
	In vacuum-tube terminology:
I_b	—Average or quiescent plate current.
I_{bm}	—Total peak plate current.
I_{bo}	—Quiescent (no-signal) plate current.
I_c	—Average or quiescent grid current.
I_g	—Rms value of varying component of grid current.
I_p	—Rms value of varying component of plate current.
I_{pm}	—Maximum varying component of plate current.
I_s	—Total electron emission.
i_b	—Instantaneous total base current.
i_c	—Instantaneous total collector current.
i_g	—Instantaneous total varying component of grid current.
i_p	—Instantaneous total varying component of plate current.
	—J—
J	—Symbol for Joule.
	—In mathematics, square root of −1.
	—In vectors, indication for counter clockwise rotation of 90°.
	—Jack.
	—In radar, type of indicator that presents target range data. Time base is circular and targets appear as radial pips.
	—Impedance-matching arrangement often used to match a half-wave resonant antenna to nonresonant transmission line.
JAN	—Joint Army–Navy (specifications).
JANAP	—Joint Army–Navy–Air Force Publications.
	—K—
K	—Dielectric constant.
	—Specific inductive capacity.
	—Thousand.
	—Symbol for constant; often Nagaoka's Constant.
	—Kilo.
	—Kelvin temperature.
	—Band of radar frequencies extending from 11,000 to 33,000 mc.
	—A type of X-ray radiation.
Kappa (K, κ)	Greek letter symbol for:
	—Susceptibility.
	—Coupling coefficient.
kc	—Kilocycle.
Kilo	—Prefix meaning 1,000 times the unit.
kmc	—Thousands of megacycles.
KV	—Kilovolt.
KVA	—Kilovolt ampere.
kw	—Kilowatt.
KWH	—Kilowatt hour.

TO BE CONTINUED

new Records MONITOR

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

HANDEL: ***Suite from the Water Music***
(Arranged by Harty)
Pro Arte Orchestra conducted by Macklin Marrow

CIMAROSA: ***La Cimarosiana***
(Arranged by Malipiere)

ROSSINI: ***Soirées Musicales***
(Arranged by Britten)
Royal Opera House Orchestra conducted by Warwick Braithwaite
MGM E-3333

All of this is interesting music, the Handel far more familiar than the rest. Unfortunately, the Handel is distorted in spots, though the other side is very good and may well be worth the price alone because these works are seldom heard. The Britten rewriting of themes from Rossini is most interesting for its instrumentation. *La Cimarosiana*, a suite based on fragments of Cimarosa's music, is simple, pleasant music. There are some nice high highs in the larghetto and a lovely dull drum in the vivance, which is first-class demonstration material.

BRAHMS: ***Second Symphony***
Schmidt-Isserstedt conducting N. W. German Radio Symphony Orchestra
Capitol P-18000

BEETHOVEN: ***Symphony No. 3 (Eroica)***
Steinberg conducting Pittsburgh Symphony
Capitol P-8334

Two samples of the new opulence in the sound of the standard classics, the movement away from the exaggerated high and low ends toward a better balance and higher presence. I don't know just how well these versions compare in musicianship with others and won't venture any judgments; but those die-hards who have objected to hi-fi on the score that the hi-fi jinks submerged or profaned the music, should be convinced by these that good sound can enhance the musical values.

SURINACH: ***Doppie Concertino for Violin, Piano and Chamber Orch.***

CHAVEZ: ***Sonatina for Violin and Piano***

REVUELTAS: ***Three Pieces for Violin and Piano***
Mare and Anahid Ajemian, soloists
Chamber Orchestra conducted by Surinach
MGM E-3180

Having uncovered pay dirt in previous works of the above Spanish and Spanish-American composers, MGM has wisely continued working the mother lode. This particular set is not for popular consumption but the musically sophisticated will find it an unusually rewarding test recording. The *Concertino* is the most tolerable to the classical ear but not nearly as much so as the previously recorded works of Surinach. It has some really remarkable tonal effects and some very subtle and sophisticated ones. The simplest sample is a passage in which the clarinet and piccolo play in unison to provide a complex so thoroughly united that it will take good definition to recognize the pairing. The others are far more difficult to account for and it will take both a system with highly exceptional definition and a well-trained ear to recognize them and to figure out how they are achieved. The high highs are very individual. There are plenty of percussives. And some passages present a most severe test for wow. The *Sonatina* is modern dissonance of highly advanced degree. If you can tolerate it at all your system is more than acceptably free of distortion. I warn those who demand pleasant sounds to stay away from this. But you who can tolerate dissonance should find this most interesting and valuable as test material.

CARR, Michael: ***Springtime Suite***
MGM E-3296

WEIL, Kurt: ***Favorites***
MGM E-3323
Richard Ellsasser at organ of Hammond Museum

If you don't want to present your system with a severe challenge or if you prefer more popular organ music, either or both of these discs will do. Nothing here to phase any good hi-fi system but lots of good tuneful music in interesting organ-izations. The Weil record has the more familiar music, incuding one of my prime favorites, the *September Song*.

GRIEG: ***Lyric Suit***
Norwegian Dances
Wedding at Troldhaugen
Holberg Suite
Remoortel conducting Bamberg Symphony
Vox PL-9840

Vox is getting some lovely sound, from the Bamberg Symphony and this disc should appeal especially to those who are just entering the world of serious music. Nothing really startling but fine sound, well balanced, with a good bass, lovely flutes, nice liveness and a fine clean sound throughout.

Don Elliott Doubles in Brass
Vanguard VRS-8016 (10-inch MG)

A jazz record with amazing presence. Don Elliott plays his normal vibrophone plus the trumpet and mellophone, with piano, bass and drum accompaniment, in a sort of modernized "swing" style.

Tony Mottola, His Guitar and Orchestra
MGM X-300 (Two 45-r.p.m. extended play)

Tony Mottola is one of the best jazz guitarists in the business and these records provide some lovely sound with plenty of guitar transients and Latin American noise makers besides. It will do no harm whatever to the attractiveness of any system it is played on. Very clean for a pop.

Pop Parade Vol. 5
MGM X-313 (Two 45-r.p.m. extended play)

If you like to keep a running recorded catalog of the pop hits of the times, I can recommend this series highly. The quality is much better than on the original pop releases, with none of the usual overcutting which makes most pops sound so horrible on wide-range systems.

Calypso
Harry Belafonte
RCA Victor LPM-1248

The simplest way to demonstrate naturalness and presence is with a fine voice recording—though few are familiar with the natural sounds of musical instruments, everyone knows what voices sound like. If, in addition to a good natural voice, the recording possessed a fine bass and a few samples of high high tinkling and if the musical content appealed to most people, we would have a most useful recording. Unfortunately most vocal recordings fail in one or more ways to meet these criteria. If the voices are operatic or concert types, they suffer from the artificiality of each style; if they are popular artists, the recordings almost invariably suffer from overcutting with a consequent high distortion which is very annoying on fine hi-fi systems. Here, however, is a recording which avoids the vices and possesses most of the listed virtues.

Belafonte's highly expressive voice is presented with impressive presence, intimacy and naturalness. The accompanying band includes a fine dull bass and a few touches of Latin American high highs. The overall effect should impress with its intimate naturalness and high degree of presence on a fine system, particularly since the Calypso songs have a high appeal even to the more sophisticated musical taste.

The Wayfarers
RCA Victor LPM-1213

This lacks both the deep bass and the high highs, and therefore the all-around demonstration value of the above, but the voices share the same naturalness and presence. Those who like folksongs and do not require that they be sung by "primitive" voices will also like these very smooth but relatively unaffected renditions of 17 folksongs from all over the world, including the American *Birmingham Jail, Old Paint, Wayfaring Stranger* and many from other lands.

Glowing Embers, Liane
Vanguard VRS-7034

While we're speaking of vocals, we must add this latest discing of the cosmopolitan *Liane*, which, like the previous ones, is very clean and with a strikingly intimate presence. This has some 14 continental songs in English, French and German and has the real Viennese *gemutlicht* sentimentality.

Dictograph High-Fidelity Demonstration
EB-2986

Produced by Capitol for the Dictograph Co. to demonstrate their line of hi-fi systems, much of the material is excerpted from Capitol's own demonstration recordings (though there are two or three excerpts from the general catalog) and the quality is about the same, though in some selections the high highs seem more exaggerated here than in the originals. The music is sandwiched between copious slices of hammed-up commentary, aimed apparently at selling customers who are completely innocent of any knowledge of high fidelity, good music and good sound. For any one even the slightest degree more sophisticated I would suggest the original Capitol or other test recordings without commentary—even when selling the Dictograph line. Not for general sale, this recording is distributed by Dictograph to its dealers only.

MOZART: *Haffner Serenade in D Major, KV250*
Woldike conducting Vienna State Opera Orchestra
Vanguard VRS-483

Another seldom-heard work of Mozart, portions of this long and ambitious serenade were later used by him as the basis for the Haffner Symphony. This recording includes the march originally played in advance of the *Serenade* itself and a more ambitious scoring and orchestration than is usually employed. The sound is fully up to the previous Vanguard recordings of this orchestra, though the music does not provide as spectacular material as Straus waltzes, polkas, etc. It is pleasant and should please.

KARL-BIRGER BLOMDAHL: *Chamber Concerto for Winds, Percussion and Piano*
RICHARD DONOVAN: *Soundings for Trumpet, Bassoon and Percussion*
JOHN VERRALL: *Prelude and Allegro for Strings*
Carl Surinach conducting MGM Chamber Orchestra
MGM E-3371

I don't know why MGM is taking the lead in presenting *avante garde* modern music, but I for one welcome it. I believe that this recording will also be welcomed by those interested in the experimental new music and those who would like a little music (even though of very non-conventional style) with their percussion. The Blomdahl and Donovan works are especially recommended for their remarkable blending of highly unusual instrumental tone and orchestral color and the fine sharp definition of percussion. The mid-bass especially gets a nice going over, what with the bassoon and the tympani in their mid and high registers, and the counterpoint of various other percussion instruments including marimba, xylophone, cymbals, blocks, gongs, tambourine, etc., very nicely reproduced. Because the group is rather small the presence in a living room is high and the sound is very real.

POULENC: *Concerto for Organ, Strings and Tympani*
HANSON: *Concerto for Organ, Strings and Harp*
Richard Elsasser, organist
Arthur Winograd conducting Philharmonia Orchestra of Hamburg
MGM E-3361

MGM offers also this similarly novel and extraordinary coupling of instruments. The Poulenc concerto has some especially notable effects, particularly the unison coupling of drums and organ pedal, and Poulenc's music is both less *avante garde* and more listenable for the music itself. The Hanson concerto, though it is not as piquant musically and—without the tympani—does not produce as novel a sound, is also highly palatable.

These two discs, incidentally, are the first with the new MGM treatment against static. Just what treatment is used, MGM sayeth not, but its effectiveness is evident in the very first playing. Ordinarily the first playing of a new record—without some treatment—results in the pickup needle getting thoroughly fouled before halfway across the disc. On these, it remained clean—and the music, in consequence, unusually clean and sharp—throughout the first and subsequent playings. All hail to MGM not only for its boldness in music but for this exciting precedent.

Amparo Iturbi Plays
RCA Victor LM-1075

Amparo Iturbi, sister of the more famous Jose, plays a very nice piano indeed and this recording of Ravel's *Valses Noble and Sentimental*, Chabrier's *Scherzo-Valse, Idylle* and *Bourree Fantastique*, under her delicate and expressive hands produces a very pleasant sound and offers a good example of good modern piano.

Mexico
Pablo Flores, pianist
MGM E-3312

This is MGM's entry into the tea room and high-check restaurant mood piano-player sweepstakes. Every label has at least one and you can say for Flores that he doesn't do the obvious: some of his renderings will steal your attention from the olive in the bottom of the glass. Pretty good piano and pleasant, mildly different "concert" versions of favorite Mexican tunes, including the *Hat Dance, La Paloma.* END

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

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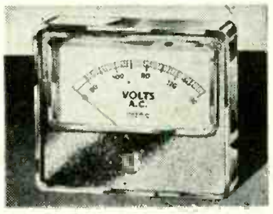


Wide variety ranges and case styles.—**Phaostron Instrument & Electronics Co.**, 151 Pasadena Ave., S. Pasadena, Calif.

MOISTURE METER, *Moisturometer.* Transistorized. 0-100-μa microammeter. Accuracy 5% at 70°F for materials for which it has been calibrated. 0–100

empirical scale for adaptation to special materials. 6¼ x 3¾ x 2¾ inches. 1½ pounds.—**Henry Francis Parks Lab.**, 104 S. E. 57th Ave., Portland 15, Ore.

MULTIPURPOSE FLYBACKER, *model 382.* In-circuit horizontal system analyzer and capacitor checker. Checks entire TV horizontal deflection system. Measures capacitances from 10 μμf to 0.1 μf. Can be used as continuity meter and compares flyback transformers and deflection yokes for relative Q. 4½-

inch microammeter with 60-microamp full-scale sensitivity. 7¼ x 8 x 11⅜ inches. 8¼ pounds. Special test cable included.—**Simpson Electric Co.**, 5200 W. Kinzie St., Chicago 44, Ill.

MULTITESTER, *Redi-Tester,*

model 540. Multirange ac/dc voltmeter, ammeter, ohmmeter, wattmeter and leakage checker. 3½-inch meter. Voltage ranges 0–7.5, 15, 150, 300. Current range 0–15 amps. Direct-reading scale 0–1,000 ohms. Neon lamp ac leakage test circuit. Panel outlet meters current drawn by appliance.—**EICO**, 84 Withers St., Brooklyn 11, N. Y.

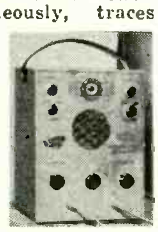
OSCILLOSCOPE KIT. *Model O-11.* For color TV. Built-in peak-to-peak calibrating source, step-attenuated input. Modern etched-circuit boards cut assembly time, prevent errors and stabilize circuit. Push-pull vertical

and horizontal output amplifiers. Response down 1½ db at 3.58 mc. 5UP1 C-R tube in 11-tube circuit. 20 cycles to above 500 kc in 5 steps.—**Heath Co.**, Benton Harbor 20, Mich.

TEST EQUIPMENT. *LSG-10 signal generator.* Frequency range of 120 kc to 260 mc, to 130 mc on fundamentals. *LC-4 C.R. Tester* with 4 direct-reading scales from .00001 to 1,000 μf. 2 resistance ranges from 100 ohms to 5 megohms. *LC-15 Capacitance–Resistance Checker* for opens, shorts, leakage and

intermittents. Ranges from .00001 to 1,000 μf and from 100 ohms to 5 megohms.—**Lafayette Radio**, 100 6th Ave., New York 13, N. Y.

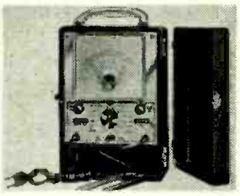
TROUBLE FINDER, *Monitron.* Kit form or completely assembled. Monitors two circuits simultaneously, traces signal



paths and makes point-to-point gain measurements without operator's attention.—**Seco Mfg.**

Co., 5015 Penn Ave. S., Minneapolis, Minn.

VACUUM-TUBE VOLTMETER, *Anchor V 500-VTVM.* 3-volt ac, zero centering for TV and FM alignment and 30-cycle to 100-megacycle range. Polarity reverse switch, db scale. With test

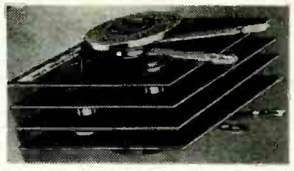


leads and isolation probe. — **Anchor Prods. Co.,** 2712 W. Montrose Ave., Chicago 18, Ill.

TRANSISTOR RADIO KIT. Uses 2 penlight cells. Printed circuit, matched transistors, diode, loopstick, unbreakable gray plastic

case and 16-page instruction book. — **Superex Electronics Corp.,** 4 Radford Pl., Yonkers, N. Y.

SILICON RECTIFIER STACKS. 600 volts. For power applications requiring high ambient

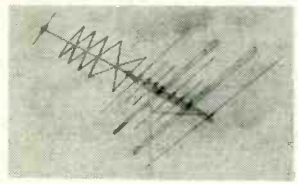


temperature and miniaturization. In all circuit types with rms inverse voltage ratings of 70, 105, 140, 210, 280, 350 and 420 volts, with dc output currents up to 4.5 amps at 75°C ambient temperature. Can be arranged in series and parallel. Hermetically sealed.—**International Rectifier Corp.,** El Segundo, Calif.

VARIABLE VOLTAGE TRANSFORMER. 120 volts input, 1.25 amps maximum output current. *PA-1* for 0–132 volts output and 165-va load rating; *PA-1L* 0–120 output and 150-va load rating.

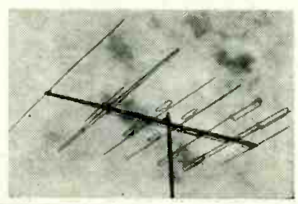
3⅞ x 3⅞ x 3½ inches. — **Standard Electrical Prods. Co.,** 2240 E. 3rd St., Dayton, Ohio.

ANTENNA, *Wonder-Helix Colortenna.* Two 600-ohm double-driven folded dipoles phased for maximum signal addition. In-line Yagi type construction. Maximum back rejection. Front-to-back ratio more than 10 to 1 on all low-band channels, up to 14 to 1 on high band. All-



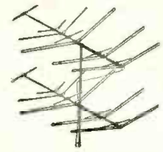
aluminum, boom-braced with 1-inch tubing.—**JFD Mfg. Co., Inc.,** 6101 16th Ave., Brooklyn 4, N. Y.

ANTENNAS, *Topliner series.* Color and black-and-white transmission. Built around new antenna-connecting delay line network that maintains optimum impedance match to transmission line and single-lobe pattern throughout vhf band. *Topliner '40 (Cat. 2540)* with 3 working elements on low band and 9 on high for metropolitan and suburban installations. *Topliner '50 (Cat. 2550)* with 5 working elements on low band and 10 on high for suburban and near-fringe areas where lower-gain antennas are usually



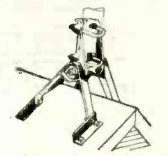
stacked. *Topliner '60 (Cat. 2560)* for fringe installations with 6 working elements on low band and 13 on high. *Topliner '70 (Cat. 2570)* with 8 working elements on low band and 19 on high for extreme-fringe installations. — **Technical Appliance Corp.,** Sherburne, N. Y.

ANTENNAS, *K series.* Molded insulators, snaplock, aluminum. *K9,* small, in-line 9-element, manufactured in 2 models, *K9-1*



and *K9-2* (illustrated). High level gain through vhf band. *K3 Metropolitan* series made in K3-1 and K3-2.—**Kay-Townes Antenna Co.,** Rome, Ga.

ROOF MOUNT. Installed by one man in seconds. Snaps into place when upright. Locks with



tightening of hinge bolt.—**Rohn Mfg. Co.,** 116 Limestone, Bellevue, Peoria, Ill.

INTERCOM KIT *Knight-Kit, No. 83 Y 295.* Two-way system—Master and remote stations plus 50-foot connecting cable. Only

JERROLD Introduces TRAP-EASE*

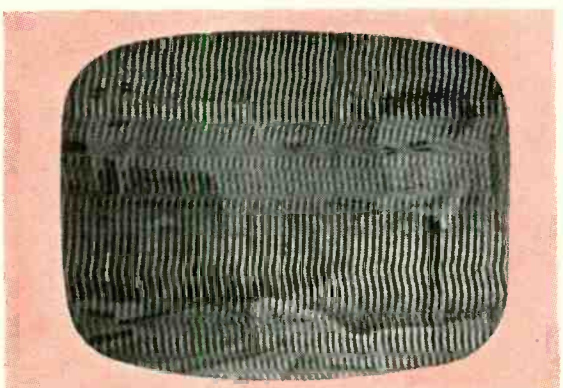
Revolutionary New TV Filter Knocks Out Adjacent Channel Interference . . . Opens New Sales Market For The Television Trade!

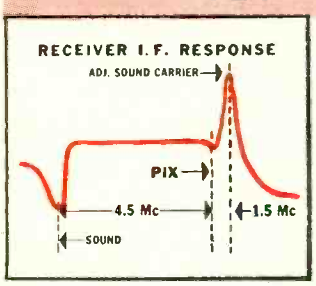
This tunable "deep notch" antenna trap (greater than 50 db) permits TV viewers to remove "beat" or "herring-bone" patterns caused by strong adjacent channel sound or video carriers. Permits clear reception of even weak distant stations.

Works with any TV receiver and any 300 ohm antenna that would normally bring in pictures from the distant stations if the interfering adjacent channel was not on the air. Does not affect reception of regularly viewed channels.

BRINGS IN PICTURES FROM OUT OF NOWHERE!

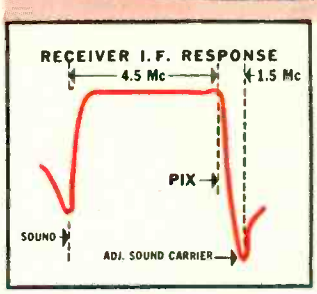
Before TRAP-EASE is Installed





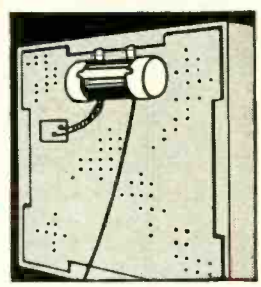
In case shown Receiver AGC is held down by a strong adjacent channel sound carrier. This lowers receiver gain and prevents proper reception of the desired channel. "Beat" or "Herringbone" pattern is predominant on the screen.

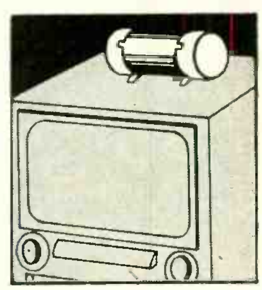
After TRAP-EASE is Installed



The adjacent sound carrier has been suppressed by some 50 db, which: (1) Enables the signal level of the desired channel to control the AGC action of the receiver. (2) Completely removes the "beat", leaving a clear, strong picture.

TRAP-EASE EASILY INSTALLED ON ANY TV SET!





Simply connect the Trap-Ease in series with the antenna lead-in and mount on rear or top of TV receiver. Handsome contemporary design and soft color tones of the unit harmonize with today's modern or traditional cabinet decor.

TRAP-EASE SELLS ITSELF

Let the amazing performance of the Jerrold Trap-Ease do its own selling. One demonstration and the Trap-Ease sells itself with the greatest of ease. Simple to demonstrate either in your store—or in the customer's home.

MONEY BACK GUARANTEE

Never before a TV accessory that achieves such startling results. Contact your Jerrold distributor today for details on the complete sales promotion package available to you.

TWO MODELS AVAILABLE

Low Trap-Ease (Model HQ-91) covers Channels 2 to 6.
High Trap-Ease (Model HQ-92) covers Channels 7 to 13.

JERROLD ELECTRONICS CORPORATION
2220 Chestnut Street • Philadelphia 3, Penna.

*®*Jerrold Electronics Deep Notch Adjacent Channel Trap*

RCA'S MISSILE TEST PROJECT

MTP

is attracting Creative Engineers and Scientists who are bound toward success

MTP... the Missile Test Project of the RCA Service Company, Inc. . . . at the Air Force Long Range Missile Test Center . . . is the largest missile-testing range and laboratory in the world! The responsibility for providing precision instrumentation for advanced stage missiles with a vast range of performance characteristics means new engineering and planning organizations and—real opportunity for rapid individual growth.

Here you will encounter instrumentation problems that challenge the state of the art and stimulate your creative ability in Aero, Ballistic and Space techniques.

Specific fields include:

TELEMETRY
RADAR
TIMING
COMMUNICATIONS
DATA PROCESSING
OPTICS

Your rewards will include all the fascination, excitement and satisfaction of achievement in new frontiers of scientific knowledge . . . plus top salary.

What's more, you'll enjoy the pleasant climate and ideal living on Florida's central east coast, where Patrick Air Force Base, site of the MTP, is located.

RCA offers many additional advantages: Complete facilities . . . Planned advancement program . . . Professional recognition . . . Liberal program of company-paid benefits . . . Relocation assistance. You should have a Bachelor's or advanced degree in EE, ME, Physics or Mathematics and two or more years' experience.

Request Your Interview **NOW...**
RCA Engineering management will arrange an interview at the time and place you find most convenient. Please send complete resume of education and experience to:

Mr. H. N. Ashby, Technical Employment
Missile Test Project, Dept. N-15M
RCA Service Company, Inc., P.O. Box 1226
Melbourne, Florida

RCA

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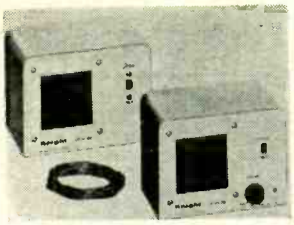
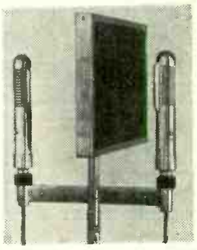
RADIO CORPORATION of AMERICA



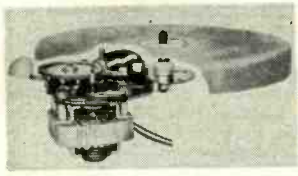
master connected to power source. Remote station has press-to-talk switch that can be left in talk position for continuous listening-in by master. Complete with all tubes, cable, solder, wire, all parts and instructions.—**Allied Radio Corp.**, 100 N. Western Ave., Chicago 80, Ill.

MICROPHONE AND RIG. *B&O 53 Microphone* with ball swivel and finger-operated 3-position voice, music and off switch in cast-iron body. Multitapped output transformer has output impedances of 50, 250 and 40,000



ohms. 20-foot cable, female microphone connector, snap-on bayonet adapter to 5/8x27-inch stand. *Binor Rig* for use with two *B&O 53* or *50* microphones obtains same results as wide microphone placement with acoustical separator between the two. **Fenton Co.**, 15 Moore St., N. Y. 4, N. Y.

PHONOMOTOR. For portable or small phonographs. 3 speeds. Metal or plastic 8-inch turntable. Rubber tire with upper and lower edges vulcanized to each other fixed to outer rim of idler wheel for balanced friction drive. Shock-mounted.—



Power Equipment Dept., Federal Telephone & Radio Co., 35 Central Ave., E. Newark, N. J.

SPEAKER ENCLOSURE KITS. Finished in either Korina (blonde mahogany) or mahogany. *Model PFK-610* modified corner horn for 12-inch speaker. *Model PFK-630* modified corner horn for 15-inch speaker. *Model*

PFK-120 version of Klipsch Rebel KR4-12 corner horn. Accommodates a 12-inch speaker, tweeter and mid-range horn. *Model PFK-150* duplicates Klipsch Rebel KR4-15 corner horn and holds 15-inch woofer, tweeter and mid-range horn. *Model PFK-300* resembles Klipsch Rebel KR-3. *Model PFK-500* for any 8- or 12-inch speaker.—**G & H Wood Prods. Co., Inc.,** 99 No. 11th St., Brooklyn, N. Y.

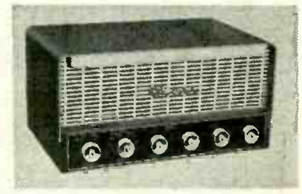
IN-LINE MAGNETIC HEAD, *Model TLD.* For new equipment design, replacement and sterophonic conversion of existing

tape recorders. Can be compensated for flat response between 30 and 10,000 cycles at 7.5 ips.—**Nortronics Co.,** 1015 S. 6th St., Minneapolis 4, Minn.

SELECTORS. *Hi-3 Speaker Selector Model No. DS77* with 3-position switch. Used with any audio output for switching to

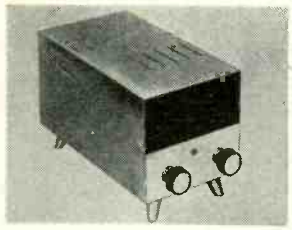
as many as 3 speakers at remote points when making temporary or permanent speaker coupling and comparison checks. *3-way Antenna Selector model DA88* with rotary 3-position selector switch. Where more than one to three individual antennas are to be coupled to one receiver. Up to three lead-in wires can be connected to selector (either 300 or 75 ohms) and 1 set of leads from selector to TV, FM, short-wave or multiband receiver. —**Dynamic Electronics,** 73-39 Woodhaven Blvd., Forest Hills, N. Y.

STEREOPHONIC SOUND SYSTEMS. *Two-channel amplifier, model 3-DTG* (illustrated) for



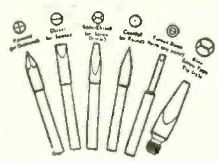
complete preamplification and power amplification for stereo signals from any source. Dual outputs, 10 watts each channel. One chassis. Tape recorder, *BT-76*, with stereophonic playback provided by a second head and preamplifiers. Staggered stereo heads feed separate equalizing preamplifier with these signals channeled from No. 1 head into recorder's self-contained power amplifier and speaker; from No. 2 head (by furnished cable) to any radio, TV or other amplifier with phone input. Console cabinet, *BT-76*, contains high-fidelity amplifier and pull-out speaker enclosure for optional remote use.—**Bell Sound Systems, Inc.,** Columbus, Ohio.

TUNERS AND AMPLIFIERS. Hi-fi line of 8 tuners and 8 amplifiers. 4 tuners basic; 2 have



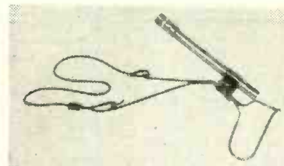
preamplifiers, 2 have preamps and amplifiers. 8 amplifiers range in power from 10 to 70 watts. Variety of transcription and record players and model ST10 stereophonic tape playback unit (see photo) designed for high-fidelity systems.—**David Bogen Co.**, 29 9th Ave., N. Y. 14, N. Y.

SOLDERING TIPS. Heavy coating of iron alloy over copper



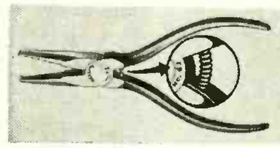
base on exposed surfaces for wear. Thin coating on inserted part for heat transference. 40 sizes and shapes.—**Hexacon Electric Co.**, 186 W. Clay Ave., Roselle Park, N. J.

MICROPHONE CHEST SUPPORT, *Model NS-1 "Chesty"*. 3-way adjustment. Can be placed



on speaker's chest, in his hand or any flat surface. 6 ounces.—**Atlas Sound Corp.**, 1451 39th St., Brooklyn 18, N. Y.

PLIERS, *No. 62* for flush cutoff in miniature and subminiature circuits. Small coil return spring



set into the body of the plier near leverage axis. For use in extremely small spaces. Cutting can be done by thumb and finger only. — **Xcelite, Inc.**, Orchard Park, N. Y.

All specifications given on these pages are from manufacturers' data.

STATEMENT OF THE OWNERSHIP, MANAGEMENT, AND CIRCULATION REQUIRED BY THE ACT OF CONGRESS OF AUGUST 24, 1912, AS AMENDED BY THE ACTS OF MARCH 3, 1933, AND JULY 2, 1946 (Title 39, United States Code, Section 233) of RADIO-ELECTRONICS published monthly at Mt. Morris, Illinois, for October 1, 1956.

1. The names and addresses of the publisher, editor, managing editor, and business managers are: Publisher, Gernsback Publications, Inc., 154 W. 14 St., New York 11, N. Y.; Editor, Hugo Gernsback, 154 W. 14 St., New York 11, N. Y.; Managing Editor, Fred Shunaman, 154 W. 14 St., New York 11, N. Y. Business Manager, none.

2. The owner is: Gernsback Publications, Inc., 154 W 14 St., New York 11, N. Y.; H. Gernsback, 154 W. 14 St., New York 11, N. Y.; M. Harvey Gernsback, 154 W. 14 St., New York 11, N. Y.

3. The known bondholders, mortgagees, and other security holders owning or holding 1 percent or more of total amount of bonds, mortgages, or other securities are: None.

4. Paragraphs 2 and 3 include, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting; the affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner.

H. GERNSBACK, Publisher

Sworn to and subscribed before me this 16th day of September, 1956.

[Seal] Irving Abramson, Notary Public

(My commission expires March 30, 1957)

why the Collaro RC-456 is today's outstanding HIGH FIDELITY RECORD CHANGER

Minimum Noise and Distortion
Balanced, heavy 4-pole motor . . . balanced pulley and coupler reduce rumble to an inaudible minimum. Automatic muting switch and R/C network eliminate 'clicks.'

Accurate Speed & Pitch
Collaro quality control limits for the RC-456 are .25% wow and flutter . . . unmatched by any other record changer.

Jam-Proof
Collaro safety-clutch prevents damage even if tone-arm is held or moved during change cycle.

Four Speeds
Plays all 78, 45 and 33⅓ rpm records . . . plus new types designed for 16⅔ rpm speed.

Automatic Intermix
Plays 7, 10 and 12-inch records stacked in any order — automatically.

Manual Operation
For playing records individually or for selecting and playing specific bands and parts of a record.

Simple Installation
Prewired power and audio connections eliminate soldering. Pre-cut mounting board available.

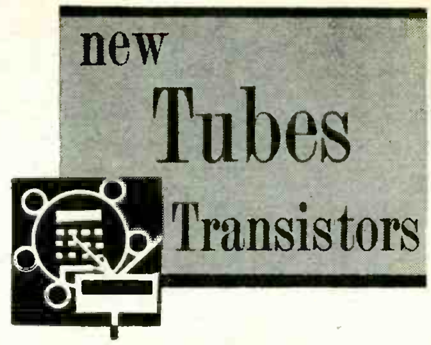
. . . Plus

★ Rapid change cycle independent of record speed.
★ Automatic 'shut-off' after last record.
★ Simple, one-knob speed selection.
★ Gentle, straight-spindle record handling.
★ Interchangeable, plug-in cartridge shells.
★ Heavy, rim-weighted turntable for flywheel action.
★ Automatic idler-disengage prevents idler flats.

At leading sound dealers, or write Dept. WM-16

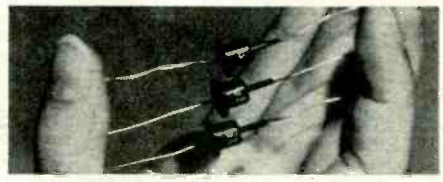
ROCKBAR CORPORATION • 650 Halstead Avenue, Mamaroneck, N. Y.

MEMBER INSTITUTE OF HIGH FIDELITY MANUFACTURERS, INC.



1N536, 1N539, 1N540

Expansion of its line of 165°C low-current silicon rectifiers has been announced by G-E. The new types (see photo) are the 1N536, 1N539 and 1N540 for use in aircraft and other airborne computers, guided missiles, magnetic amplifiers and electronic and electrical equipment operating at high temperatures.



The 1N536, 1N539 and 1N540 are rated, respectively, at maximum peak inverse voltages of 50, 300 and 400. Maximum allowable rms voltages are 35, 210 and 280, respectively. These rectifiers supplement the previously announced 1N537 and 1N538 (New Tubes, September, 1956).

Maximum rated output current for the series is 750 ma at an ambient temperature of 50°C and of 250 ma at 150°C. The full-load forward voltage drop is a maximum of 0.5 volt at 150°C. All in this series have axial leads.

2N247, 2N267

Drift transistors of the germanium p-n-p type, the 2N247 and 2N267 are intended primarily for use as rf amplifiers in military and commercial equipment and in entertainment type receivers covering the AM broadcast band and up into the shortwave bands. They are also useful as if amplifiers or as mixer–oscillators (converters).

These RCA-announced transistors have a base region in which the impurity distribution is very carefully controlled to produce a built-in accelerating field, not available in conventional transistor designs, which propels the charge carriers from emitter to collector. Base resistance and collector-to-base capacitance are substantially reduced. The low values of these parameters permit the design of rf amplifier circuits having high input-circuit efficiency, excellent operating stability, good agc capabilities over a wide range of input signal levels and good signal-to-noise ratio.

The 2N247 has four flexible leads and is hermetically sealed in an insulated metal case having a length of 0.375 inch and a maximum diameter of 0.360 inch. Shielding minimizes interlead capacitance between collector and base leads and also coupling to adjacent circuit components. This feature contributes to the usefulness of the 2N247 in high-frequency circuits particularly in military and commercial applications where very low feedback capacitance is an important consideration. The shielding is provided by a fourth lead situated between the collector and base leads and internally connected to the insulated metal envelope.

The 2N247 features a collector dissipation of 35 mw maximum. In a common-emitter circuit with base input this transistor can provide a power gain as high as 45 db at 1.5 mc and 24 db at 10.7 mc. The very low collector transition capacitance (1.7 $\mu\mu f$) makes possible satisfactory gains in the AM broadcast band without a neutralizing network.

The 2N267 has the same electrical characteristics as the 2N247 except that it has a slightly larger feedback capacitance in the common-emitter type of circuit. The 2N267 has three flexible leads and is constructed with a smaller metal case having a length of 0.405 inch and a maximum diameter of 0.240 inch. It is intended for compact transistor designs where a high-frequency transistor having small size is a primary consideration.

Fuse type rectifier

Sarkes Tarzian has announced a new fuse type silicon rectifier to replace all selenium rectifiers in radio, TV and other electronic devices. The new unit, the M-500, has a peak inverse voltage rating of 400, with maximum dc current at 500 ma. With an input voltage of 130, at maximum current, the approximate rectifier voltage drop is 2.

This unit was designed primarily for use in television receivers where voltage-doubler circiuts operate directly off the line. The M-500 is ¼ inch in diameter and approximately 1 inch long; it fits into a standard fuse holder.

6883

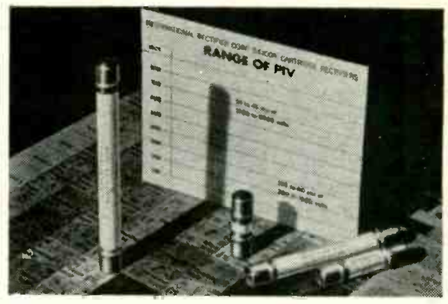
A small, sturdy, beam power tube, the 6883 may be used as an rf power amplifier and oscillator as well as an af power amplifier and modulator in mobile equipment operating from a 12-volt storage battery. Except for its heater rating of 12.6 volts at 0.625 ampere, the 6883 is identical with the 6146 which has a 6.3-volt 1.25 ampere heater.

The 6883 has a maximum plate-dissipation rating of 25 watts under ICAS conditions in modulator and CW service. For CW the 6883 can be operated under ICAS conditions with 90 watts input up to 60 mc and with 60 watts input at 175 mc.

Because of its high power sensitivity and high efficiency, the 6883 requires relatively low plate voltage to give large power output with small driving power.

16,000-volt silicon diodes

A series of high-voltage silicon diodes (see photo) announced by International



Rectifier Corp., includes units having peak inverse voltage ratings of 600 to 16,000 with forward currents of 100 and 45 ma, respectively. These diodes offer high rectification efficiency over an operating ambient temperature range of −55°C to 150°C and are applicable in all types of high-voltage low-current supplies.

2N206

A new junction transistor of the germanium p-n-p alloy type, the 2N206 has been announced by RCA. It is designed primarily for use in audio-frequency amplifier applications. The transistor is hermetically sealed, using a metal envelope with external insulating coating. It has flexible leads. The 2N206 is 0.240 inch in diameter and has a length of 0.405 inch.

Maximum ratings as a class-A amplifier are: collector-to-base voltage, −30; emitter-to-base voltage, −12; collector current, −50 ma; emitter current, 50 ma; collector dissipation (for 25°C ambient temperature), 75 mw.

In a common-emitter circuit with base input, the 2N206 has a current transfer ratio of 47, a low-frequency power gain of 46 db (with a load resistance of 20,000 ohms and an input resistance of 1,200 ohms) and a noise factor or 9 db. In such a circuit the dc collector-to-emitter voltage would be −5, the dc collector current −1 ma. END

Thirty-Five Years Ago

In Gernsback Publications

HUGO GERNSBACK, *Founder*	
Modern Electric	1908
Wireless Association of America	1908
Electrical Experimenter	1913
Radio News	1919
Science & Invention	1920
Television	1927
Radio-Craft	1929
Short-Wave Craft	1930
Television News	1931

Some larger libraries still have copies of ELECTRICAL EXPERIMENTER on file for interested readers.

In December, 1922, *Science and Invention* (formerly *Electrical Experimenter*)

Transmitting Power by Radio.
Pilotless Mail Planes, by H. Winfield Secor.
Horse Racing by Radio.
Broadcasting Niagara's Roar.
The Simplest Radio Outfit Contest (Seventh Prize), by George Goga (Pencil Radio).
Home-Made Radio Movies.
Radio Tuning Devices and Circuits, by A. P. Peck.
Radio for the Beginner, No. 10, by Armstrong Perry.
Radio Oracle.

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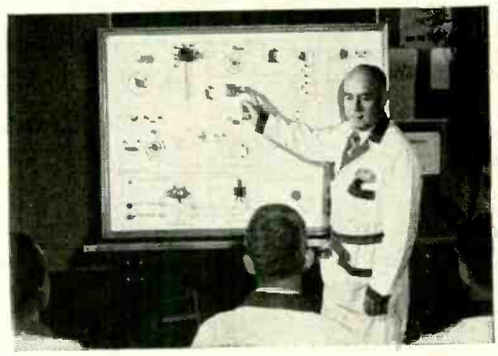


Jumbo-size operational panel of Guide's Autronic-Eye Circuit puts all parts out front for better, more efficient instruction.

Thirty modern GM Training Centers offer newest equipment and latest service techniques. There's one nearby . . . no matter where you live.

Technicians' News

COLOR AT FAIR

Color TV and captive service will keynote the lecture portion of the program at the Electronics Fair to be held at Farmingdale, Long Island (N. Y.) Dec. 6, 7 and 8. Talks on color antennas, test equipment components and both the standard three-gun and the Chromatic one-gun tubes and the complete associated color receivers will be featured prominently. Veteran service publisher Paul Wendell will discuss under the title "Fight for Survival!" the legal and economic repercussions of manufacturers getting into the service business.

Arrangements have been made, with the cooperation of RCA and Jerrold Electronics, to have an antenna distribution system for off-the-air color programs and a closed-circuit setup for times when no color programs are on the air so that exhibiting color TV manufacturers will be able to demonstrate their equipment at all times.

The Fair is being held at the New York State University, Farmingdale, N. Y. RADIO-ELECTRONICS is among the exhibitors, at booth 42.

CAPTIVE SERVICE OPPOSED

The decision of a number of large TV manufacturers to extend their factory service is meeting with sharp opposition at all points. Meetings have been held and plans made in Chicago, Detroit, Cincinnati; St. Louis, Mo.; Bridgeport, Conn., and other points to combat the new threat to the independent service technician. Cincinnati service technicians announced their meeting with a poster printed entirely in red, adopting the slogan "You Must Act Now—Tomorrow May Be Too Late." The Detroit meeting initiated a "Unite to

RADIO-TV ROUNDUP

Professional Radio-TV Technicians Invite Public to Use Professional Tube Testers Without Charge

A short cut to the short circuits, and to the other illnesses which sometimes plague radios and TV sets, is now open to those of the Greater Houston area.

Professional radio and television technicians renewed this week their invitation to one and all to test their radio and TV tubes on professional equipment under the supervision of a professional technician, and all without charge.

It was pointed out that only those people in the full-time business of radio and television set repairing can afford the elaborate, expensive testing equipment necessary to give completely reliable readings throughout the wide range of tubes to be tested.

Inferior machines may give false readings, indicating the need for a new tube when the tested tube is perfectly adequate for several months of additional service.

Important, too, is the fact that most repair shops sell only highest-quality tubes. Brand-name manufacturers, such as Westinghouse, very carefully check all out-going tubes. When newly manufactured tubes are found to be faulty in some way, they are junked by most nationally known manufacturers. Some, however, may be sold to companies who re-label them and sell them through outlets other than repair shops. These inferior tubes, which may be retailed at identically the same prices as full-quality tubes, may cause quite a bit of customer disappointment.

Colorful window banners identify participating repair shops. The banner reads "Radio and TV Tubes Tested Free, Under the Supervision of a Professional Technician."

Listed below are some of the participating firms:

A & L TELEVISION SERVICE
6709 Chocolate Bayou Rd.

ALEXANDER'S RADIO & TV SERVICE
7006 N. Main St

BRATTENG'S TV & RADIO CENTER
6904 Stella Link Rd.

BRAWDY RADIO & TV SERVICE
5910 Washington

COTTON TELEVISION & RADIO SERVICE
3143 Alabama St.

HOUSE OF TELEVISION
1972 West Gray

MELROSE TELEVISION SERVICE & SALES
1324 Berry Rd.

OLSEN RADIO & ENGINEERING CO.
1843 W. Alabama

S O S RADIO SERVICE
1641 Westheimer Rd.

CLAYTON SALES
Highlands, Texas

LAKE TELEVISION SERVICE
Lake Jackson, Texas

ADVERTISEMENT

TV technicians of Houston, Tex., have devised a competent answer to self-service tube testers. The advertisement above is self-explanatory.

Fight" program in which Detroit, Grand Rapids, Pontiac, Mt. Clemens, Tecumseh, Flint, Birmingham and Kalamazoo trade groups are participating. Technical and business clinics are also being held, to insure that the independent service technician will be at least as capable of handling repair of all types of electronic equipment as any repairmen likely to be hired by the manufacturers' service branches. These are being supported by all service groups, including among others the Television Service Association of Michigan (TSA), NATESA, NARDA and also the AEC American Electronic Council).

The Bridgeport meeting, which lasted from morning till 10 pm, agreed that servicing associations must stop "bickering." It adopted a 10-point program aimed at helping to stabilize independent operation and to combat manufacturers' interference in the independent service industry.

New England, New York, New Jersey and Pennsylvania were represented at the meeting, with Dave Krantz of Philadelphia acting as coordinator for the Pennsylvania federation, John Wheaton heading the New York State federation, David Van Nest making plans for the New Jersey group and Albert C. W. Saunders of Boston handling the Massachusetts representation.

NEW DIAGRAM SERVICE

A move to assist the smaller service organization which does not subscribe to a continuing diagram service has been announced by John F. Rider. Covering the products of the eight largest TV manufacturers over the past five years, a *single diagram service* called S-D-O (single diagram only) will permit technicians to obtain the data on a given chassis for the economical price of 50 cents. Schematic, voltage data, tube layouts, alignment information, trimmer locations, adjustments, etc., are supplied on a 17 x 22-inch sheet, which can be folded for convenient filing. Models covered in the first group of sheets, states Mr. Rider, encompass between 80% and 90% of the receivers sold during the past five years.

ARTS ELECTS

The Associated Radio & Television Servicemen, (Chicago) Illinois, elected their 1956–57 officers at the semi-annual business meeting held in September.

Howard Wolfson was elected chairman, Joe Ehlinger vice chairman, Delmar Kotrba secretary-treasurer, George Neize sergeant-at-arms. Member representatives for the south, west and north sections of Chicago were also appointed for the ensuing year. They are Martin Nebojsic, Anthony Bauman and Yuki Minaga. END

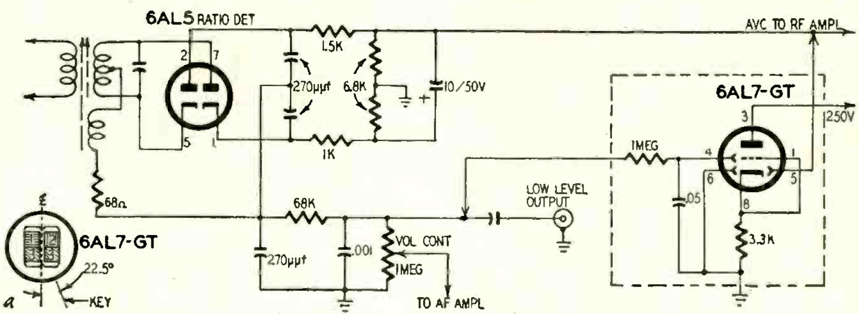
radio-electronic Circuits

TUNING INDICATOR FOR HEATHKIT FM-3

The Heathkit FM-3 FM tuner is more compact and an improvement circuit-wise over earlier models but still lacks a tuning indicator—a necessity when tuning for maximum fidelity. A 6AL7-GT electron-ray tuning indicator can be added without disturbing operation or appearance.

The FM-3 has a ratio detector with can be brought out through the rear louvers without marring the case. The tube can be mounted in an octal-based tuning-eye assembly such as the Amphenol 58-MEA8 clamped to louvers in the top cover or located elsewhere as desired.

The tube requires at least 250 volts for proper operation so an external



avc voltage for the cascode rf amplifier taken off the negative terminal of the electrolytic swamping capacitor (also called the storage or stabilizing capacitor). In many cases a 6AL7-GT is used merely to indicate maximum avc voltage. But, this is not satisfactory if the if's are broad or the if or detector circuits are out of alignment. Optimum performance is obtained when the set is tuned for zero dc at the audio take-off point because this insures that the carrier is centered in the detector or passband. This tuning indicator makes full use of the 6AL7-GT by using the dc voltages at the sound take-off and swamping capacitor.

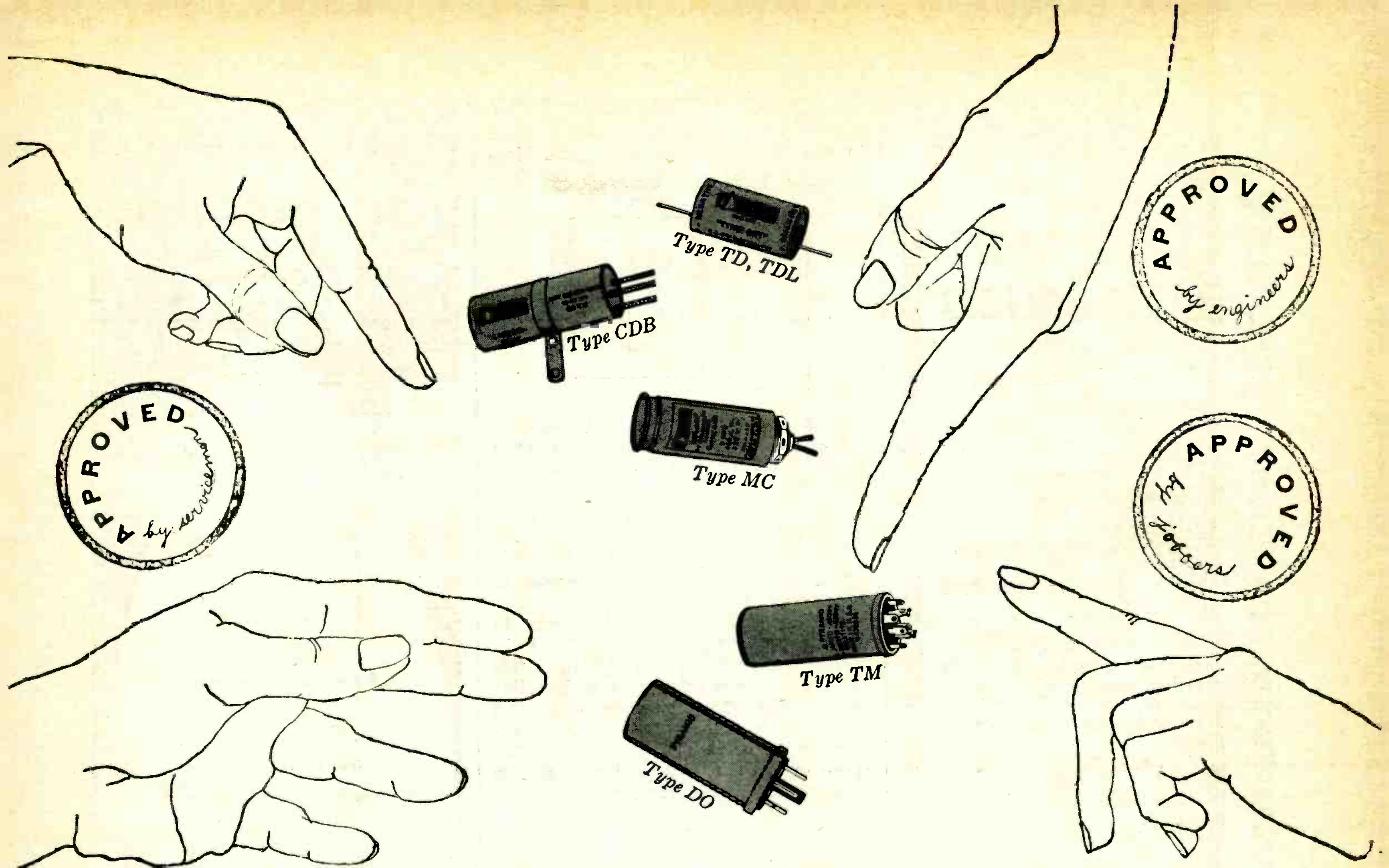
The tuning-indicator circuit and points for connecting to the tuner are shown in the diagram. The added components are enclosed by the dashed lines. The connecting points are accessible on terminal strips reached by removing the bottom cover. The leads power supply is needed. The target and heater voltages are available at the preamplifier power socket on Heathkit Williamson type amplifiers and can be tapped off many others.

Referring to inset *a* in the illustration, the height of the lower rectangles (3) varies with signal strength and is controlled by the avc voltage applied to electrode 3 (pin 5). At the same time, the height of the upper right rectangle (2) varies with the dc component at the audio takeoff and electrode 2 (pin 4). Electrode 1 (pin 6) is grounded and its rectangle has constant amplitude. Matching the heights of rectangles 1 and 2 places the if carrier in the center of the detector passband for minimum distortion. Rectangles 2 and 3 should reach maximum height simultaneously. If they don't, touch up the if or detector alignment while watching the indicator.—*John B. Perkinson*

NOVELTY XMAS LIGHTS

Strings of colored lights are almost universally accepted as decorations for Christmas trees. The effect is heightened by inserting a flasher unit in series with the line cord. The novelty flasher shown in the diagram uses neon lamps instead of an incandescent type and permits the use of an almost unlimited number of flashing lamps—each with its own flashing rate. This circuit is described in patent No. 2,717,-336 issued to Charles L. Craddock.

When the switch is first closed, full battery voltage is applied to the lamps and they fire simultaneously. As each lamp conducts, it develops a voltage across resistor R and capacitor C. The capacitor charges to the point where the voltage across the lamp drops to the extinguishing point and the lamp goes out. The charge across C gradually leaks off through R, the voltage across the lamp rises and the cycle repeats.



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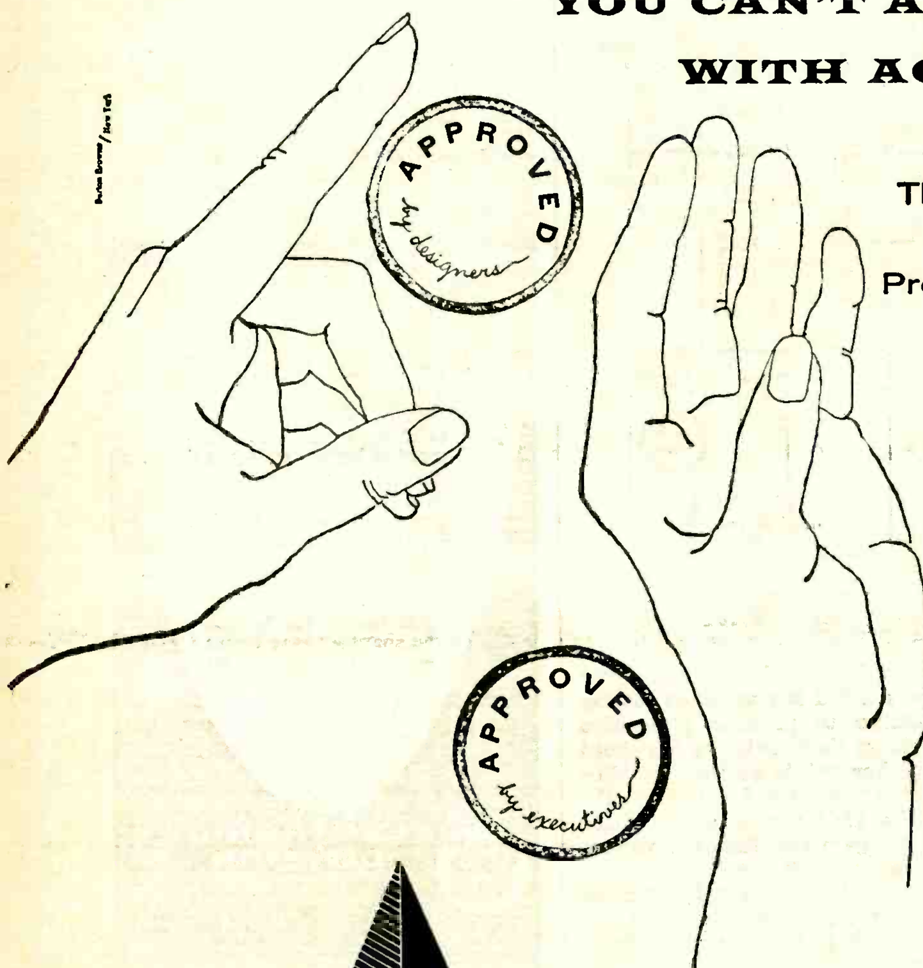

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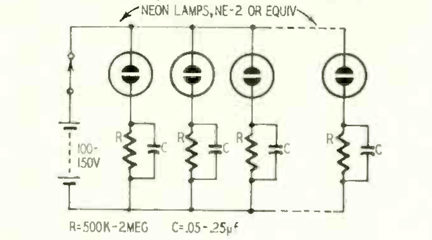
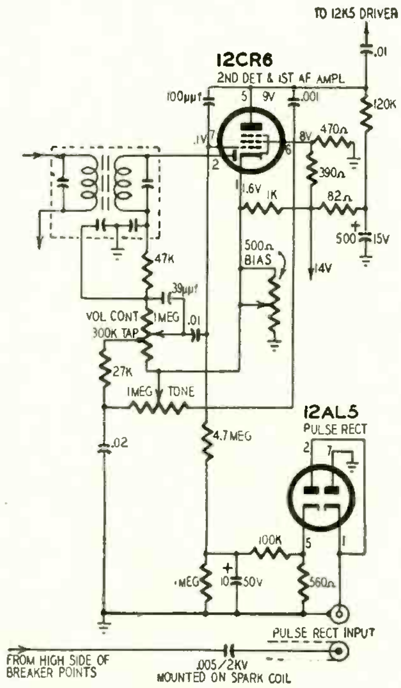
The values of R and C are selected to give the desired flashing rate. Normal variations in the lamps, resistors



and capacitors will give each lamp a slightly different flashing rate even when the same values are used.

THUNDERBIRD'S SPEED CONTROLS RADIO VOLUME

One of the latest developments in automobile radios is the speed-compensated volume control used in compensated volume control used in Motorola's model 79MS (Ford FEJ-18806-C) receiver for custom installations in the 1957 Thunderbird. The circuit automatically varies the receiver's volume in proportion to the speed of the car. The pertinent circuit is shown in the diagram.



A voltage is tapped off the breaker points and applied to a voltage-doubling pulse rectifier to produce a positive output voltage that varies as the speed of the breaker points or the car. This dc voltage is filtered and applied to the grid of the 12CR6 first af amplifier to cause the gain and thus the volume to vary with the car's speed.

Minimum volume is set by manual control and the speed-compensated circuit takes over to increase the volume as the car speeds up and drop it gradually to the preset level as the car slows below a certain speed.

Question Box

VERTICAL ANTENNA

I have a 50-foot vertical antenna for broadcast reception. It is mounted about 150 feet from the house to get away from the noise field of nearby power and telephone lines. My problem is the design of an efficient low-noise coupling system for feeding the receiver. What kind of transmission line should I use and how do I match it to the antenna and receiver?—E. S., Wausaukee, Wis.

A 50-foot vertical antenna is only about 1/24 wavelength long at the high-frequency end of the broadcast band. It will have a very low radiation resistance (around 1 ohm or less) and a very high capacitive reactance. This reactance limits the curent flow in the antenna and must be eliminated by adding an equivalent inductive reactance in series as shown. The inductance (loading coil) must be variable and its range determined experimentally. TV linearity and width coils are available in a wide range of inductances and you should be able to find one to do the job. The inductance ranges provided by the inductors shown may be satisfactory or you may have to use units with higher or lower ranges.

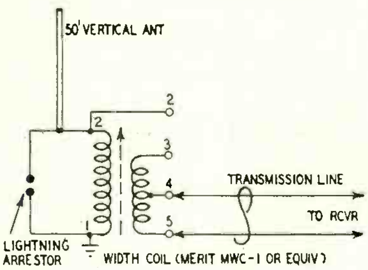


Fig.1

In the circuit in Fig. 1, the main winding of a width coil is used as the loading coil and the agc winding as a link coupling to the transmission line. The unit specified has several windings and taps that make it possible to try many different connections. Start with the connections shown and then try connecting the transmission line across various combinations of terminals 2 through 5. Readjust the slug tuning after each change.

Fig. 2 is a slightly different arrangement with the antenna base-loaded and the reactance of the lead-in tuned out by the variable capacitor. The loading coil is tuned by the slug. Try various connections and slug settings until you find the best combination. You can connect the base of the antenna to the tap on the coil—leaving the top end open—or ground the bottom end of the coil and connect capacitor to tap.

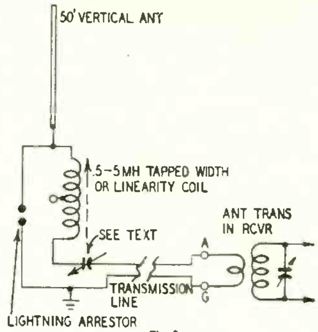


Fig. 2

In both circuits, the loading and tuning network should be housed in a weatherproof box and a good ground and lightning arrester should be provided for safety and best operation. The lead-in may be any convenient coax.

AUDIO CABLE

Manufacturers of hi-fi equipment often recommend low-capacitance audio cable for connecting pickups, tuners and other accessories to the amplifier and specify that the cable length should not be excessive. What is considered a low-capacitance cable and what length is excessive?—E. M. B., New York, N. Y.

Generally, a low-capacitance audio cable has a capacitance of around 25 μμf per foot and an outside diameter of 0.2 to 0.25 inch. Capacitance usually decreases as outside diameter increases. The very thin and flexible phonograph pickup type cable is not satisfactory for runs of more than a foot or so because of its high capacitance. Limit its use to the run from the cartridge to the nearest convenient terminal strip or tie point. Use low-capacitance cable for the rest of the run.

Cable such as Alpha 1704, Belden 8401, Birnbach 1841, Columbia 1318 and Cornish 2401 should fill the bill. RG-62/U and RG-71/U have a capacitance of only 13.5 μμf per foot and are recommended in cases where the added cost and slightly greater diameter are not important.

The length that may be considered as being excessive depends on the characteristics of the equipment being connected. For example, if you have a low-impedance high-output source such as a tuner or some magnetic type pickups, a run of 50 feet or so might not be considered excessive. On the other hand, if you are working from a high-impedance low-output source, the high-frequency losses are likely to be heavy.

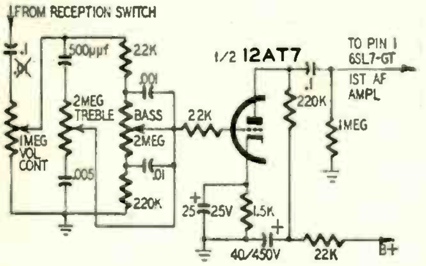
A length of 15 feet or so would not be considered excessive when low-capacitance cable is used between moderately high impedances in most installations.

TONE CONTROLS FOR SX-42

I want to add separate tone controls for bass and treble boost and cut to my SX-42 receiver. I will eliminate the *original tone control and am willing to add a tone amplifier or another stage if needed. Please print a suitable circuit.*

This receiver drifts badly for about 2 hours on FM when first turned on. Can you help me correct this?—H. K. H., Pacific, Mo.

The diagram shows how bass and treble controls can be installed in your receiver. A single stage of amplification compensates for the loss in the tone control circuit. The circuit in the diagram is inserted between the arm of the volume control and the grid of the tube to which the control originally connected.



You can install this circuit in most conventional radios and amplifiers. Plate supply voltages may be in the range of 150 to 250. (If the set or amplifier is an ac–dc type, you may have to install a filament transformer for the added tube.)

Warmup drift that continues for several hours is usually due to poor design and selection of the capacitors, coil and other components in the oscillator circuit and we do not recommend trying to eliminate the faulty parts in a set such as the SX-42. Instead, we suggest adding afc. You'll find complete details in the articles "Adding AFC to Your FM Tuner" and "Reactance-Tube Tuning Vernier" in the November, 1954, and May, 1953, issues, respectively. The afc adapter in the November, 1954, issue uses a 6K4 reactance tube. You can substitute half of a 12AT7 for the 6K4 (see Question Box, February, 1955) and use the other half for the 12AT7 in the tone control circuit above. END

"You've got an open speaker field, Doc. What've I got?"

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RADIO-ELECTRONICS is continually alert to maintain a high level of integrity in our advertising columns. In the case of tube advertising—which has suffered special abuses—we insist that all advertisers must warrant that their tubes are:

- **New and unused**
- **Not mechanical or electrical rejects**
- **Not washed or rebranded**

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

We investigate carefully when we have grounds to suspect that any advertiser is not living strictly up to these rules.

Technotes

VERTICAL JITTER

In the Westinghouse chassis V2233 C1 (Fig. 1) lost considerable capacitance. The result was an intermittent vertical jitter at intervals. The customer said the jitter was accompanied by a dimming of the electric lights such as occurred when an electric toaster or some other appliance was turned on.

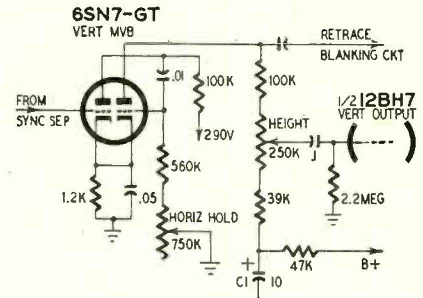

Fig.1

The jitter—almost a bounce with several rapid shakes up and down—was caused by a fluctuating line voltage with the corresponding fluctuations in the low-voltage power supply.

Inasmuch as only the vertical circuit was affected, the vertical supply was checked. Shunting the capacitors that filtered the B supply localized the trouble to C1.

Since the trouble occurred when the line voltage varied, the line voltage was jumped up and down by the arrangement shown in Fig. 2. The transformer

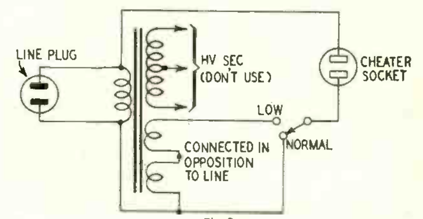

Fig.2

was from a junked TV dog. The secondaries are connected in series opposition to the primary so that the voltage may be dropped the 6.3 volts of the heater filaments and the 5 volts of the rectifier filaments simply by throwing the switch. Actually, the drop was about 2 volts more than 11.3 since the secondaries were lightly loaded. This device is very useful for cases of trouble caused by low high line voltage.—*L. A. Williams*

MOTOROLA 21T15

This Motorola had a rounding off of the left-hand corners of the raster. Linearity on the left side of the picture was very bad also. The vertical and horizontal sizes were below nor-

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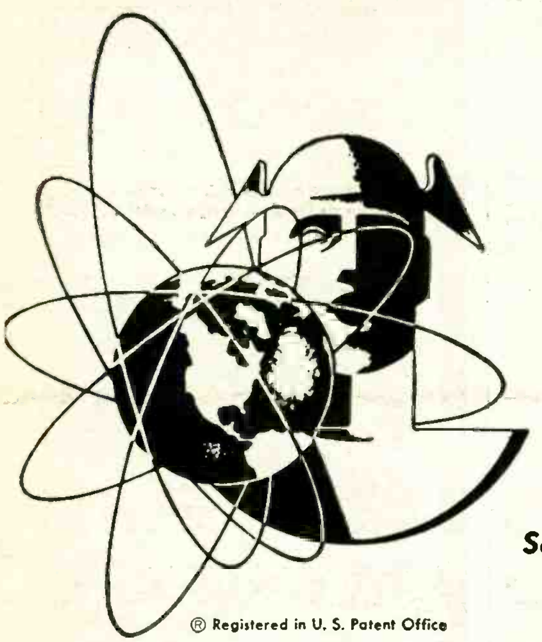

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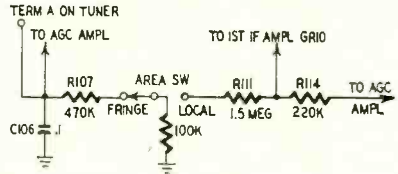
mal. The clue was found in the partial keystoning effect and the other symptoms which indicated yoke trouble. The difficulty was due to the 47-$\mu\mu$f capacitor across half of the yoke winding, which developed a partial short.

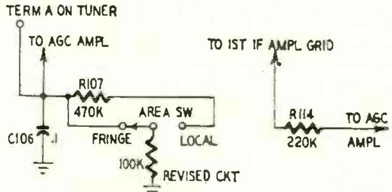
With the yoke energy reduced, the bootstrap voltage, which feeds the vertical output and horizontal circuits, is lowered. This in turn reduces both the vertical and the horizontal size.—*Peter Millano*

CROSLEY CUSTOM J

Due to variations in the characteristics of the 3BZ6 tubes in the if stages, it is possible under certain levels for the rf tuner bias to rise above its optimum operating level. When this occurs, the snow level will be higher than normal. To check this, short out the tuner bias at the tuner while the set is tuned to a weak station. If the snow level drops, the tuner bias is too high.



ORIGINAL CKT.



REVISED CKT

In weak signal areas, where it is not necessary to use the local position to control exceptionally powerful local stations, the following wiring changes (see diagram) will improve signal pickup—if the tuner bias is too high:

1. Remove R111.
2. Transfer R107 from its present lug on the area switch to the switch lug vacated by R111.
3. Connect a lead from the junction of C106 and R107 to the switch lug vacated by R107.

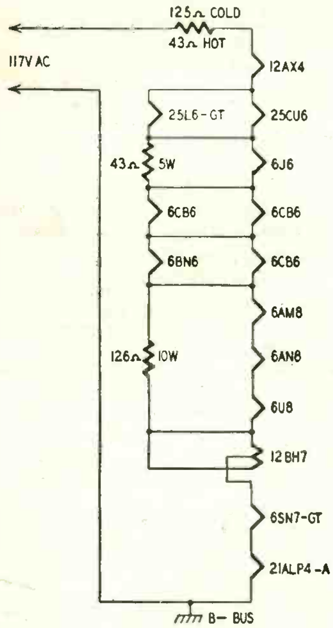
The above change removes the original local position and puts the original fringe (or normal) in its place. The super-fringe position is then put where the original fringe position was.—*Crosley Service Instructions*

OSCILLATION ON UHF

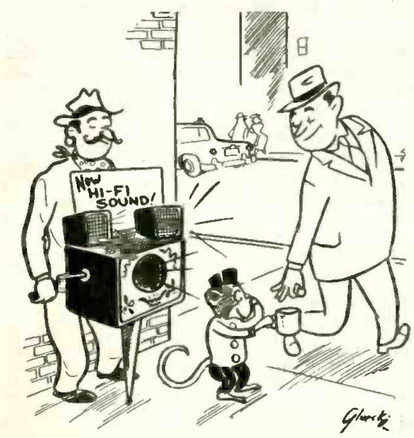
An RCA 17T200 produced strong oscillations, visible on the screen of the picture tube, when operating on uhf. All tubes in the converter section checked good and all wiring and components appeared normal. I then discovered that the trouble was caused by vibration of the set's metal cabinet against the uhf converter. The solution was simple—I placed strips of rubber tape on the converter mounting brackets.—*Henry S. Hartson*

CROSLEY 431 CHASSIS

This 21-inch chassis came in dead. A quick check uncovered an open heater in the 25CU6. After it was replaced, the heaters lit up for about half a minute—then went out. Another check showed the new 25CU6 heater to be open. I replaced it with another new 25CU6. Again, the heaters lit up and then went out—another burned out 25CU6. Digging out the schematic for the receiver solved the mystery.



The heater string is connected in series-parallel (see diagram). When the heaters are cold, the series resistance of the entire combination is low, causing more than the rated current to pass through each heater. Eventually, this will burn out one of the heaters, usually the weakest one in the string. If the 25L6 (which caused the trouble in my case) or any of the other parallel-connected heaters burn out, the second parallel heater (the 25CU6) has to carry too much current and, consequently, also burns out. Replacing each tube individually as I did does not help, for the new tube just burns out again. To uncover a defect of this type check the entire heater string for continuity. If one section of a paralleled pair of heaters is open, replace both at the same time. *Warren Smith* END



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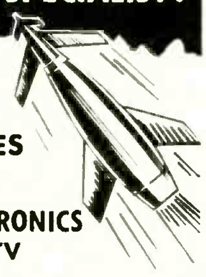

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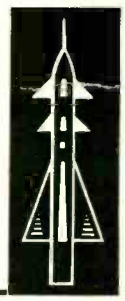

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Patents

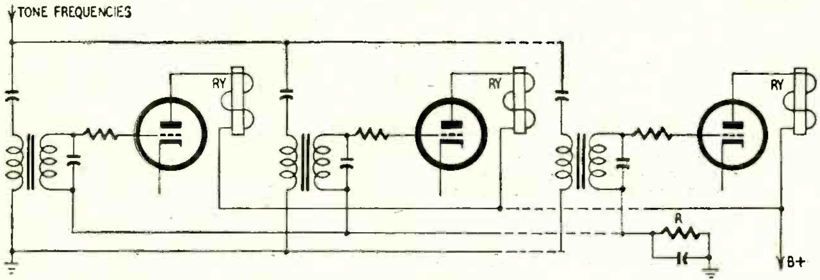
INTERMODULATION SUPPRESSION

Patent No. 2,734,950

Carl F. Jordan, Jr., Cedar Rapids, Iowa (Assigned to Collins Radio Corp., Cedar Rapids, Iowa)

This invention relates to systems which carry on communication by tone signals. The receiver in such a system includes several 1-tube amplifiers, each tuned to one of the tone frequencies. When a resonant frequency is received, the tube in the corresponding amplifier conducts and energizes a relay. Otherwise, it is blocked. During transmission, two or more of the tones may react to cause intermodulation. and the spurious tone may activate one of the stages. This can be prevented as shown in the schematic diagram. A three-stage amplifier is used.

Upon receiving a resonant frequency, the corresponding stage conducts and grid current flows through common resistor R. This



generates negative bias which is applied to all grids. It also reduces the sensitivity of the tubes, preventing any from responding to intermodulated tones. It does not prevent response to a *signal* which is always much stronger than the intermodulation.

TV REMOTE CONTROL

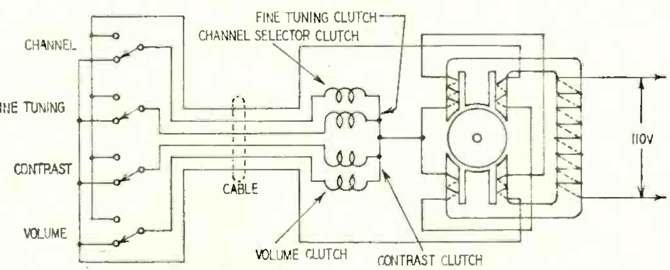
Patent No. 2,743,797

Ranald O. Whitaker, Indianapolis, Ind.

Remote control of a TV receiver is difficult because of the many adjustments needed for proper viewing. This novel method controls all essential functions by providing an unusual circuit in which a wound shaded-pole motor does double duty.

This type of motor is similar to the conventional phonograph motor, differing only in that a coil of wire is carried around each shaded pole in place of the usual heavy brass shorting ring. As long as the coils are open-circuited, the motor will not turn. As soon as a coil is shorted, the motor turns in the conventional manner. Each coil is effectively the secondary of a transformer of which the field winding is the primary and the motor frame is the core. Hence, it is possible to use the power developed in this "secondary" to operate solenoids, lamps or other types of electrical devices.

This patent uses the power so developed to operate clutches which engage the motor selectively to the various controls of the receiver. The electrical circuit is shown in the figure. Suppose the viewer desires to switch the set to a higher channel. He will then operate the CHANNEL switch against the upper stop. A circuit is thereby through the clockwise shaded winding and the clutch which engages the motor to the channel selector. The motor starts turning and the receiver is switched to successively higher channels.



To switch to lower channels the switch is operated against the lower stop. Other functions are operated in similar manner.

Underwriters' requirements for safety in the control circuit are met since the cable carries only low voltages and is isolated from the line. The system may be extended to provide control of additional functions. Several switch boxes may be placed about the room and wired in parallel to provide control from several positions.

TRANSISTOR AUDIO OSCILLATOR

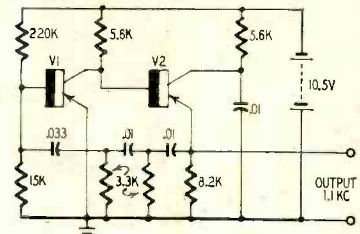
Patent No. 2,751,501

Everett Eberhard, Phoenix, Ariz. (Assigned to Motorola, Inc., Chicago)

Most audio frequency generators are of the R-C type. These provide good waveform and are generally preferred over circuits using coils for oscillation. The phase-shift method is used here.

V1 is an amplifier connected in common-emitter fashion. Thus it shifts phase by 180°. Its input impedance is low, its output impedance high. V2 is a common collector which (like a cathode follower) provides no phase shift. Its input impedance is high, its output impedance low. An R-C network couples the V2 output back to the V1 input. The network is designed for a phase shift of 180° at some predetermined audio frequency.

V1 amplifies any signal applied to it and feeds it through V2 and the network. If the signal is at the predetermined frequency, it will shift 360° by the time it returns to the input circuit of V1.



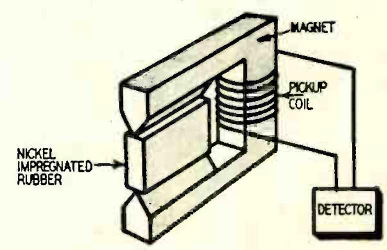
Thus it will reinforce the original signal and generate oscillations. The frequency is determined by R and C values of the network. In the diagram shown, the frequency is 1,100 cycles.

V2 does not amplify but plays an important role in the circuit. Its output matches the low impedance of the R-C network, while its input matches the high impedance of the V1 collector.

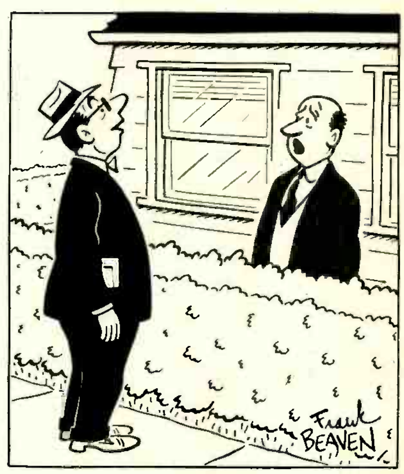
UNDERWATER TRANSDUCER
Patent No. 2,746,027

James J. Murray, Easthampton, Mass. (May be manufactured and used by U. S. Government without royalty payments)

This sensitive detector of vibrations under water uses a U magnet with wedge-shaped poles for flux concentration. The flux-control element, which consists of a block of rubber in which finely powdered nickel particles are suspended or dispersed, is placed between the poles. When the particles are displaced by a vibration signal they cause flux vibrations. These are translated into a corresponding ac voltage across the coil.



Rubber has approximately the same acoustic impedance as water, so the water vibrations are efficiently converted to ac. The nickel particles cannot be all of the same size and mass. The smaller ones will respond to higher frequencies than the larger ones. The result is a low-Q transducer with a flat response over a wide band of frequencies. END



Suggested by Garkis Kalfayan, Alexandria, Egypt

"That's a super aerial you've got there."
"Sure! It cost so much I had to sell my set to pay for it."

try This one

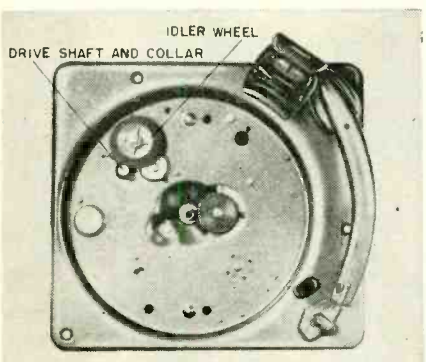
CONVERT 78-RPM CHANGER TO 33⅓ RPM

You may have a 78-rpm changer that seldom is used now that 33⅓-rpm records have become popular. Many of these older changers can be converted to 33⅓ rpm.

In addition to changing the speed it's usually necessary to replace the phono cartridge and add a sliding counterweight to obtain the correct stylus pressure.

To change the speed, the main drive shaft is filed to a smaller diameter. We recommend that the phono cartridge be replaced with a ceramic cartridge such as the Sonotone model 1P-1S. A sliding counterweight, manufactured by the Mercury Scientific Co., can be added to the old tone arm or you can replace it with a lightweight arm.

As an example of the procedure you might follow, we converted a Webster Chicago 78-rpm changer to 33⅓ rpm. However we replaced the entire tone arm instead of adding a counterweight to the old arm.



The photo shows the 78-rpm changer as it looked when removed from a radio phono.

As can be seen, the drive shaft has a collar which is held in place by a hex screw. Remove the idler wheel. Then remove the collar with a hex wrench. The turntable speed will be reduced to about 43 rpm.

You are now ready to file. Turn on the motor. Apply the file to the drive shaft with moderate pressure. After filing for a short time replace the idler wheel and turntable. Check the speed with a stroboscopic disc. As the speed approaches 33⅓ rpm you will want to check it at frequent intervals.

You will be able to play both 78- and 33⅓-rpm records, with this particular changer, if you file only about ¼ inch down the drive shaft. It takes only a minute to slip the collar over the drive shaft and tighten the hex screw to change back to 78-rpm operation.

When the speed has been reduced to about 34 rpm, replace the tone arm and phono cartridge. Now begin checking the speed with the turntable loaded and the needle tracking on a record.

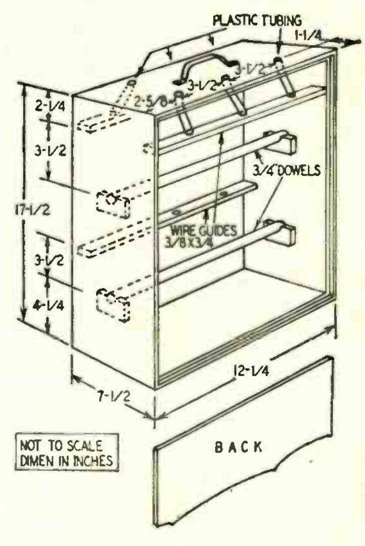
The new arm is a G-E 22X084-2. Plug-in heads are used with it. The net cost of the arm and plug-in head is around $3.25.

Note how the old arm is mounted. You may want to draw a simple sketch. The new arm is mounted in the same manner as the old. Don't forget to adjust the indexing and the tracking pressure after you install the new arm.

You may have a 78-rpm changer that can be converted just as easily. Arms for turnover cartridges and plug-in heads are available for other popular makes of changers.—*Frederic T. C. Brewer*

PORTABLE WIRE RACK

Here's a handy little box holding six spools of wire which you can carry right to the job or from one bench to another in the lab. The wire can't get tangled and the six ends are always protruding from the top, ready for use.



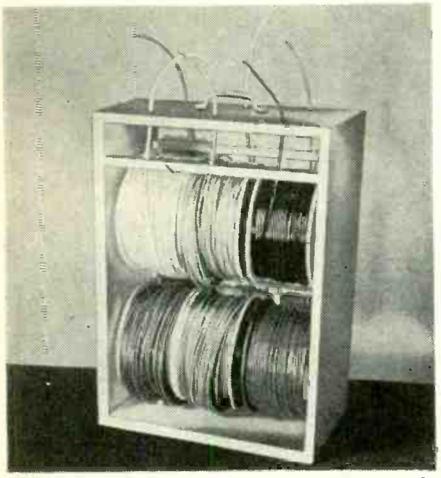
The box is easy to build, having ½-inch sides, top and bottom. A rabbet all the way around allows the ¼-inch plywood front and back panels to set in flush. The front one is nailed in place, while the back one is clipped in place. Two ¾-inch hardwood dowels hold the wire spools, and the wire is fed up through the wire guides.

The wire from the bottom spools comes up through the holes in the lower wire guide and then is threaded through the top guide and out through the top. Between the top wire guide and the top of the cabinet are six lengths of heavy plastic tubing of 5/32 inch inside diameter and 9/32-inch outside. This serves as a brake to prevent the wire from being pulled too fast and to keep it from falling back after cutting. The holes in the lower guide are ¼-inch in diameter and those in the upper guides and top are 5/32-inch with a

(Continued)

9/32-inch counterbore to hold the tubing in place.

Brass eyelets can be pressed in the holes in the top. Six turns of No. 14 music wire springs, 1- to 1½-inch in



diameter, are placed between the spools to keep tension on them and to prevent one from turning another. Four of these springs are required. A coat of gray paint, a handle on top and four rubber feet complete the cabinet.—*Karl Greif*

TV LEAD-IN SPLICES

To save yourself that extra trip back up on the roof when repairing or installing a TV antenna—be careful when you tape any lead-in splices. Taping the connection is where you are most likely to get into trouble.

The 300-ohm ribbon line is usually made up of a number of strands of fine copper wire. The first thing an installation man usually does when starting to make a splice is to cut and trim the wire ends so they are of the proper length, using, of course, his diagonal cutters. Next, comes the joining and twisting together the ends of the lead-in. Now you reach for the roll of electrical Scotch tape. You fish in your pocket for the wire cutters. Finding them you snip off a few inches of tape and begin to wrap . . .

The first wrap around is the one that counts because, if you haven't been paying attention, there is a good chance that the adhesive surface of the tape has picked up at least one strand of the fine copper wire nipped from the lead-in when we were matching our ends; transferred so innocently from the jaws of the diagonals! You can guess the rest. On several occasions this has happened to me and that strand caused a first-class short.—*George D. Philpott*

FEET PROTECT TEST SETS

I find that a piece of ½-inch foam rubber cemented on the bottom of my test instruments greatly reduces the amount of jarring and jolting that they take while being moved around. It also tends to reduce the chance of cracking a case and to lengthen the life of the instrument.—*Robert L. Beyer*

END

People

J. R. Johnson was promoted to vice president in charge of sales and merchandising for Standard Coil Products Co., Melrose Park, Ill. He had been assistant to the president. Photo shows

Oden Jester (left), assistant general sales manager of Standard, congratulating Mr. Johnson.

Dr. Harvard L. Hull joined Litton Industries, Beverly Hills, Calif., parent company of Triad Transformer Co., as a vice president. He comes to Litton from Farnsworth Electronics Co., of which he had been president.

Richard P. Thornton joined Amphenol Electronics Corp., Chicago, as marketing manager for the aircraft and guided missile industries. He was formerly associated with Ingersoll-Rand, P. R. Mallory and Westinghouse.

Jay Carver was promoted to the post of advertising and sales promotion manager for Electro-Voice, Inc., Buchanan, Mich. He came to the company early this year as manager of wood product sales, from the Cabinart Division of G & H Wood Products, where he was advertising manager.

Chester C. Pond was promoted to manager – product planning of the Philco Government & Industrial Division, Philadelphia, Pa. He had been product manager–special products and coordinator for sales efforts in the development of transistor and semiconductor business.


Barton Kreuzer, (left) director of product planning for RCA, Camden, N. J., was elected president of the Society of Motion Picture & Television Engineers. **Dr. Alfred N. Goldsmith** (right), a former RCA executive and now a consultant, received the society's highest award for the year, the Progress Medal.

Obituary

Robert A. Johnson, general manager of Hexacon Electric Co., Roselle Park, N. J., in Overlook Hospital, Summit, N. J., after a short illness.

John S. Mills, at one time vice president in charge of sales and advertising for Tele-Tone Radio Corp. and president of Rico Television Corp. and an executive with several other well-known firms, in Miami Beach, Fla. He recently established Mills Electric-Dynamics Corp. in Coral Gables, Fla., for the manufacture of hi-fi systems.

Personnel Notes

. . . **Milton R. Schulte**, vice president and director of Tung-Sol Electric Co., Newark, N. J., was elected to the new post of executive vice president.

. . . **Brig. Gen. David Sarnoff**, chairman of the Board of Directors of RCA, was feted at a dinner in New York on his 50th anniversary in electronics.

. . . **Lawrence G. Haggerty**, former president of Capehart-Farnsworth Co., was named president of Farnsworth Electronics Co., Fort Wayne, Ind.

. . . **Glen McDaniel**, RETMA's general counsel, was reappointed chairman of the association's Legal Committee. **Joseph A. Hatchwell**, Allen B. Du Mont Laboratories, was named chairman of the Service Committee, and **Julius Haber**, RCA, was reappointed chairman of the Public Relations and Advertising Committee.

. . . **Don Larson** was chosen business manager of the Western Electronic Show and Convention (WESCON). He has been general manager of the West Coast Electronic Manufacturers Association, co-sponsor of the WESCON. He will continue in that capacity until a successor is appointed.

. . . **Raymond B. George**, vice president–merchandising of Philco Corp., Philadelphia, Pa., was named vice president–sales promotion, and **Max Enelow**, advertising counsel, was named advertising manager, in a move to set up separate sales promotion and advertising departments.

. . . **Dudley A. Hansen** was appointed technical advisor and special assistant to the president of Phaostron Instrument & Electronic Co., South Pasadena, Calif. He will supervise Government contracts. Hanson is well known in the meter industry. END

Business

¢ $

Merchandising and Promotion

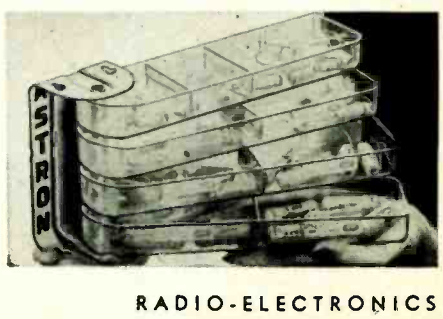
Amphenol Electronics, Chicago, is featuring a new five-color counter display to promote its "Tele-Couplers," an accessory which couples two TV sets to one antenna.

RCA president, Frank M. Folsom, awarded the President's Cup to five winners in its recent national contest for service technicians on ways of increasing customer satisfaction.

Westinghouse Electronic Tube Division, Elmira, N. Y., recently held a travel contest for its tube distributors. All-expense trips to the Caribbean will be awarded to the top winners and their wives.

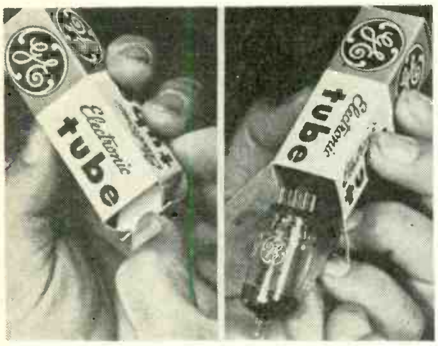
Winegard Co., Burlington, Iowa, launched an all-out advertising and promotion campaign on its new 1957 line of outdoor TV antennas. A heavy consumer campaign is included, backed by a complete dealer support plan including various types of sales aids.

Astron Corp., East Newark, N. J.,



has added the Swing Bin Baby plastic storage and display case to its sales aids for its Blue Point capacitors.

General Electric Tube Dept., Schenectady, N. Y., designed a new functional



carton for its tubes which gives added visibility, protection and ease of handling.

ORRadio Industries, Opelika, Ala., is offering recording tape dealers a

decal to identify them as "Irish" Brand dealers.

V-M Corp., Benton Harbor, Mich., has scheduled a heavy Key Quarter consumer advertising campaign backed up by a complete dealer sales promotion package in an effort to boost sales in the period from Nov. 15 to Feb. 15.

Production and Sales

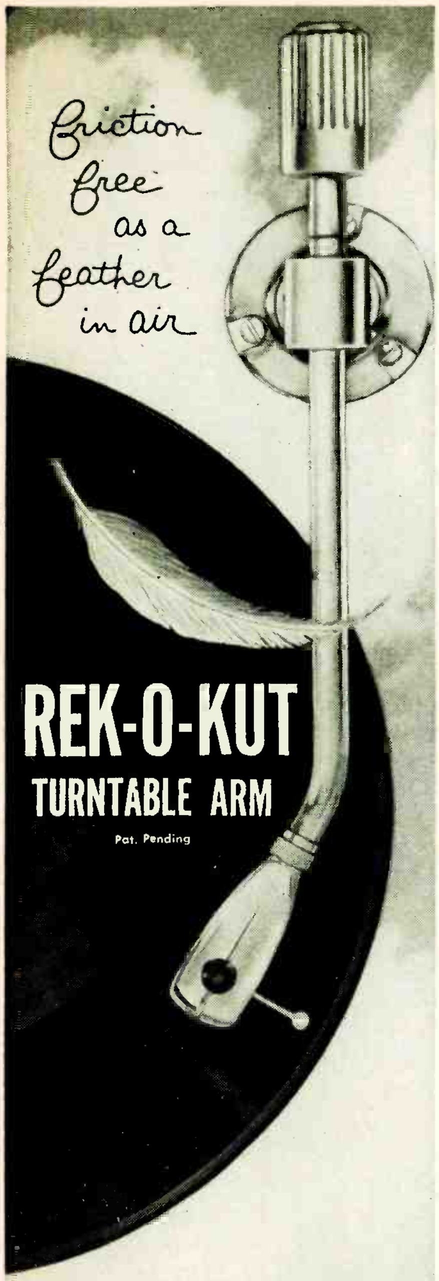
RETMA reported the manufacture of 4,365,060 television sets and 8,216,707 radios for the period from January through August, 1956. This compares with 4,820,991 TV sets and 8,707,477 radios for the like period in 1955. Retail sales for this period totaled 3,839,718 TV sets and 4,649,454 radios, exclusive of autombile sets, as compared with 4,171,139 TV sets and 3,189,608 radios for the first eight months of 1955.

RETMA announced manufacturers' sale of 6,837,728 TV picture tubes and 303,004,000 receiving tubes for the first eight months of 1956. This compares with 6,478,351 picture tubes and 300,080,000 receiving tubes in the period from January through August, 1955.

Mergers and Acquisitions

L. A. Young Spring & Wire Corp., Detroit, purchased the assets of Gonset Co., Burbank, Calif., manufacturer of communications equipment. Faust R. Gonsett, former president, became general manager of the Gonsett Division of L. A. Young.

Sprague Electric Co., North Adams, Mass., acquired a controlling interest in CREAS, an Italian capacitor manufacturer. END



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WANTED: Electronics men to qualify for Engineering Degrees by comprehensive examination. No courses. Excellent employment opportunities waiting. CRAMWELL INSTITUTE, RE-7, Adams, Mass.

TELEVISION Tuner Repairs. DAN'S TELEVISION LABORATORY, 606 Sunrise Highway, Babylon, N. Y.

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"HYPNOTIZE—One word—One finger-snap!" (Details—3c.) HYPNOMASTER, 846-H5 Sunnyside, Chicago 40, Ill.

COMPLETE Television Sets $11.95. JONES TV, 1115 Rambler, Pottstown, Pa.

TRADE-IN TV sets. Ship anywhere. Dollar per inch (10"—$10), (12"—$12), (16"—$16). Makes extra set or scads radio parts. Packing $5 extra. JUSTIS BROS., Newport, Delaware.

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WANTED—ELECTRONIC TUBES: Broadcast, transmitting, receiving, Magnetrons, Klystrons, miniature, sub-miniature, ruggedized, etc.!

TOP PRICES PAID! FOR FATTEST CHECKS—SELL TO REX! Write or phone description for immediate action. R. L. SANETT, W6REX, 1524 S. Edris Drive, Los Angeles 35, Calif. Phones: REpublic 5-0215, CRestview 1-3856.

AUTOMOBILE RADIOS, WHOLESALE PRICES. SELCO PRODUCTS, Department RE-1256, Danvers, Mass.

WANTED: ART 13, ARC 3, ARC 1, BC 788, and other Military Surplus. JAMES S. SPIVEY, INC., 4908 Hampden Lane, Bethesda, Md.

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TAPE RECORDED CODE COURSES, Novice—4 hours instruction, $11. The very best. Details—TAPECODE, Box 31-D, Langhorne, Pa.

TRANSISTOR KITS. Free Information. TRANSIT ELECTRONICS, Box 15-E5, Alden Manor, N. Y.

DIAGRAMS! Repair Information! Radios—Amplifiers—recorders $1. Televisions $1.50. Give make, model, chassis.—Norelco-Philips & Amperex tubes in stock! TV MILTIE, Box 101EA, Hicksville, N.Y.

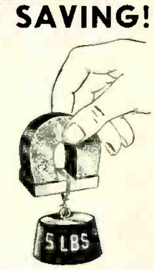
A SUPER MAGNET — AT A SUPER SAVING!

LIFTS MORE THAN 20 TIMES ITS OWN WEIGHT.

Now for a limited time only—you can buy this Little Giant magnet, the most powerful ever made, at a sensational bargain! The low, low price of $1.50 is **less than 50% of what you'd usually pay for this type magnet.** Experimenters and hobbyists will find hundreds of uses for this powerful 4 oz. **Alnico permanent magnet.** CAN LIFT 5 LBS. EASILY. Through a special purchase we are able to offer these Super magnets at this amazing low price. A limited quantity only. First come first served. Order several today. Low price includes keeper. Measures 1¾ x 1½".

Item No. 86
Special Bargain Price **$1.50**
(Shp. Chgs. 10c)

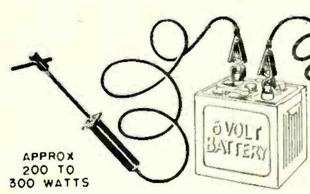
(Regularly priced at $3.50)



6-VOLT BATTERY, SOLDERING IRON AND WELDER

U.S. Army release. New. Guaranteed. Can be used to solder or weld when connected to any 6v storage battery. The high intensity arc created between the metal to be soldered and the carbon electrode (carbons supplied free with iron) can be used to heat tin or aluminum solder, light brazing and spot welding, melting metals, etc. Includes 2 carbons, 3 heavy duty spring clips, 2 pieces 5 ft. heavy duty wire cable. (Battery not included.) Ideal for use where current is not available. Ship. wt. 4 lbs.

APPROX 200 TO 300 WATTS



ITEM NO. 126
UNUSUAL BUY **$1.95**

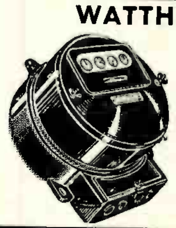
(P.P. & Hdlg. Chgs. 50c)

AMAZING BLACK LIGHT

250-watt ultra-violet light source. Makes fluorescent articles glow in the dark. Fits any lamp socket. For experimenting, entertaining, unusual lighting effects.

ITEM NO. 87
Ship. wt. 2 lbs. **$2.45**
(P. P. & Hdlg. Chgs. 35c)

WATTHOUR METER



Leading makes—reconditioned. Ideal for trailer parks. 100-110 volts, 60 cycles. 2-wire A.C. 5 amp. Heavy metal case 8½" x 6¼" x 5". Easy to install. Ship. wt. 14 lbs.

ITEM NO. 33
NOW ONLY **$4.50**
(P.P. & Hdlg. Chgs. $1.25)

250 POWER TELESCOPE LENS KIT

Make your own high powered 6 ft. telescope! Kit contains 2" diam., 75" focal length, ground and polished objective lens and necessary eye pieces. Magnifies 50x to 250x. Full instructions.

ITEM NO. 123
(Shp. Chgs. 10c) **$2.95**

HUDSON SPECIALTIES CO.
25 West Broadway, Dept. RE 12-56
New York 7, N. Y.

I am enclosing full remittance for items circled below. (Be sure to include shipping charges.)

OR, my deposit of $............... Ship balance C.O.D.
MINIMUM C.O.D. ORDER $5.00.

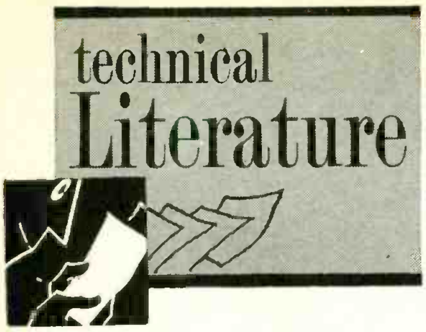
C.O.D. ORDERS ACCEPTED ONLY WITH 20% DEPOSIT. INCLUDE SHIPPING CHARGES.

86 87 33 126 123

Name ....
Please Print Clearly

Address ....

City ....Zone........State..................



technical Literature

RADIO–TV KNOBS

Catalog No. 57 describes and illustrates 200 different styles, shapes and sizes of radio–TV knobs. Also included in this 16-page brochure is a selection of switches, speaker kits and other service aids.

Gee-Lar Mfg. Co., Div. of General Cement-Textron, Inc., Rockford, Ill.

LOUDSPEAKERS

A new line of loudspeakers for commercial, industrial, institutional and PA applications and related equipment are offered in 24-page *Catalog 1070.*

Jensen Mfg. Co., 6601 S. Laramie Ave., Chicago 38, Ill.

PLATE-ASSEMBLY GUIDE

Specifications of ceramic plate assemblies, including circuit diagrams, constants, functions and a cross-reference section are contained in a new 20-page, pocket-size *Assembly Guide.* A special 10-page section gives replacement information complete with manufacturers' part numbers and correct Aerovox equivalent.

Any Aerovox Distributor or send 25¢ (coin only) to Advertising Dept., Aerovox Corp., New Bedford, Mass.

SPEAKER SYSTEMS

SC502 is a 6-page catalog type illustrated leaflet that gives information on precision loudspeakers, enclosures and speaker systems, their accessories, etc.

James B. Lansing Sound, Inc., Los Angeles 39, Calif.

ELECTRONICS CATALOG

Detailed descriptions, specifications and prices of over 125,000 items of 350 manufacturers are presented in the 1546 pages of the *1957 Edition of the Radio-Electronic Master* available in December. Its detailed indexes pinpoint the needed tube, test equipment, capacitor, resistor, relay, coil, antenna, transformer, recording or PA system, hi-fi equipment, hardware, tool, transmitter, communication receiver, etc.

United Catalog Publishers, Inc., 110 Lafayette St., N. Y. 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. All literature offers void after six months.

TAPE-PLAYING TIME CHART

A new chart indicates playing time for tape of standard lengths on reels of various sizes. Data are for standard 1½-mil tape except where 1-mil or ½-mil thickness is indicated.

The first four columns, for speeds of 1⅞ to 15 ips, for single-track tapes; the last two columns (3¾ and 7½ ips) for dual-track recording and recorded tapes.

ORRadio Industries, Inc., Shamrock Circle, Opelika, Ala.

PICTURE-TUBE REPLACEMENT GUIDE

Television Picture-Tube Replacement Guide. ETR-702B, lists 223 aluminized and nonaluminized tube replacements in classifications by size, base, bulb structure, external coating, anode contact, focus method, deflection angle, overall length, bulb diameter, neck length, anode KV and type of ion-trap magnet. The chart also furnishes characteristics of color picture tubes and metal-to-glass replacement information wherever possible.

General Electric Tube Dept., Schenectady 5, N. Y.

ELECTRONICS CATALOG

Over 27,000 items are presented in a new 356-page catalog. *No. 160* covers the latest high-fidelity components, television chassis, boosters, rotators and uhf converters, table model and portable phonographs, professional and home recording equipment, public address amplifiers and complete systems, amateur receivers, transmitters and other gear, industrial vhf radio and telephone equipment, as well as a wide selection of supplies, books, manuals, diagrams, tools, hardware and other radio, TV and industrial electronics items.

Allied Radio Corp., 100 N. Western Ave., Chicago 80, Ill.

PARTS CATALOG

Electronic Parts Catalog No. 65 supplies complete descriptions of industrial electronics equipment and parts, high-fidelity components and systems and radio, TV and amateur gear in its 308 pages. Also offered for the convenience of industrial buyers and engineers are special quantity prices.

Newark Electric Co., 223 W. Madison St., Chicago 6, Ill. END

CORRECTION

Tony Karp of Richmond Hill, N. Y. points out that the 2N94-A transistor in the flea-power transmitter (page 52 of the October issue) is an n-p-n type so the arrowhead on the emitter symbol must be reversed.

William C. Roach, of Norfolk, Mass., adds that the CK722 and 2N107, mentioned as possible low-cost substitutes for the 2N94-A, are p-n-p types requiring reversal of battery polarity.

Our thanks to both these alert readers for these corrections.

Books

RCA TRANSMITTING TUBES (Technical Manual TT-4). Commercial Engineering, RCA, Harrison, N. J. 5⅜ x 8⅜ inches, 256 pages. $1.

This is the first postwar edition of a manual that could be found in almost every prewar ham shack and radio engineer's bookshelf. As we recall, the earlier editions listed only those transmitting tubes with plate input ratings up to about 1,000 watts. The latest edition lists 112 types of power tubes with plate input ratings up to 4 kw and 13 rectifiers suitable for use with them.

The first 87 pages are devoted to power-tube fundamentals, construction and materials, applications, circuit-design considerations and rectifier circuitry and design. Included is step-by-step design data on af and rf power amplifiers, audio modulators, frequency multipliers and oscillators. Simple calculations are given for determining operating conditions for class-C radiotelegraph and plate-modulated radiotelephone amplifiers, multipliers and class-AB and -B modulators. There are 61 drawings and charts in this section of the manual.

The book concludes with 16 practical circuits including a vfo for the 80-meter amateur band, crystal oscillators for fundamental and harmonic output, modulators with 120 and 590 watts output, transmitters for 2- and 10-meter fixed or mobile operation and circuits of simple dielectric and induction heaters.

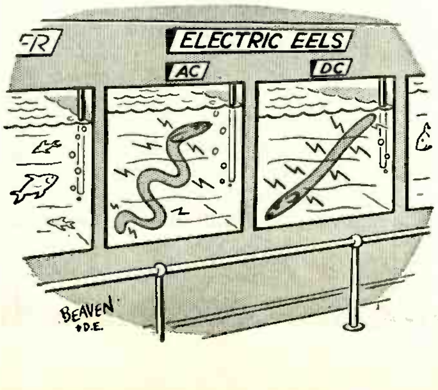
MAGNETIC AMPLIFIERS, by H. F. Storm. John Wiley & Son, Inc., New York, N. Y. 6 x 9 inches, 545 Pages. $13.50.

This, one of a series of books written by G-E authors, is intended for senior engineering students. It involves considerable math.

The magnetic amplifier is not a recent development. It was utilized by Dr. Alexanderson back in 1916 to establish radiotelephone communication with Europe. It was also used in the "colorama," a tuning indication for radio receivers, about 25 years ago. It is used at the Radio City Music Hall (New York) to control lighting and has many other practical applications listed in the book.

This text begins with a thorough description of magnetic theory to put the reader on solid ground. It continues with simpler saturable reactors with various loads, then with feedback. The amplistat receives considerable attention under various conditions. Cores, coils and rectifiers are covered in a separate chapter.—*IQ* END

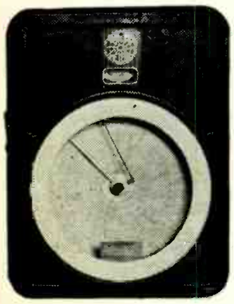
1956 ANNUAL INDEX



SAVE AT ESSE

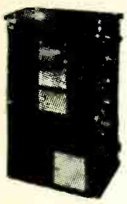
Leeds & Northrup Micromax Recorders

Strip type recorder used for controlling and recording wide variety of processes. Used originally for temp. range of 350-550° C. but may be changed for other applications. Operates on Wheatstone bridge principle using AC galvanometer movement. Original cost several times our low price. Removed from demilitarized equipment which in many cases was new. Sold as used but guaranteed, or money back if not satisfied. Ship. wt. approx. 165 lbs. **$179.50 Ea.**



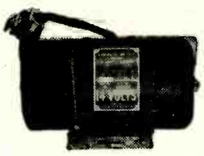
BAILEY METER RECORDERS

Used in application as above at same temperature range, etc. Operates on electronic principles using vacuum tubes. Used but guaranteed. Ship. wt. 165 lbs. $65.00 Ea.



14 Amp. Battery Charger While Supply Lasts

Cost Govmt. $300 ea. Our purchase of large quantity allows this bargain. Charges 6, 12, or 24 V. batteries at 14 amp. rate max. Operates from 110 V. DC. Mfg. by Ward-Leonard. Size 12" w x 20" h x 10" d. Brand new in orig. packing; wt. approx. 80 lbs. They'll go fast at this low price, so order now.......$7.50

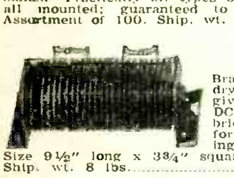


Brand New 12 V. Dynamotor

DM-30 Input: 12-14 V. 3.4 A. Output: 172 V.—138 MA. An ideal dynamotor to adapt to mobile uses on the new 12 V. cars. Don't pass up this buy even if your intended uses are not immediate. Size 6¾" L. x 3½" dia. 4" lead with 6 pin Jones plug. Ship. wt. 7½ lbs.......$2.75

Freq. Crystals...Less Than 5c Ea.

Imagine crystals costing Govmnt. $3.50 to $12.50 ea. in this assortment. 100 brand new; various freqs.; plenty in ham bands. Practically all types of holders: all mounted; guaranteed to oscillate. Assortment of 100. Ship. wt. 4 lbs.......$4.95



Rectifier Special New $1.95

Brand new GE copper-oxide dry disc rectifier designed to give output voltages to 90 V. DC @ 1 amp. Full wave bridge type. May be restacked for 6, 12 and 24 . DC charging currents up to 4 amps. Size 9½" long x 3¾" square radiation fins 24 cells. Ship. wt. 8 lbs.......$1.95

NEW Guaranteed Tubes

Removed from new radar & elect. equip. but never used.

FG-17 Thyratron.......$1.00 ea.
FG-32 Phanotron.......$2.00 ea.
2051.......65c ea.
5Y3GT and G.......30c ea.
12A6.......30c ea.
7193.......10 for $1.00
954.......10 for $1.00
VR-105.......50c ea.
6BG6/G.......$1.00 ea.

R-1/ARR-1 Receiver....$2.95

Described in Radio TV News, Jan. 1949 for use as 220 Mc. converter. Essentially a two stage RF acorn tube superhet converter as it now stands. Also can be used for a preselector. Small enough for mobile: only 3½" w x 3" h x 10" d. Rugged aluminum construction. Has four 954 acorn tubes. Filaments now operate on 12 or 24 V. by merely throwing switch in unit or can be easily modified for 6 V. operation. Dial is calibrated in range of 234-258 Mc. Operation can be changed for use from 50 to possibly 300 Mc. Cover not shown but included. Complete with conversion as written in above mag. Brand new demilitarized units. Ship. wt. 4 lbs.......$2.95

ARR-1 Antenna for above receiver and freqs. Ship. wt. 1 lb. New.......$1.25

Co-axial antenna relay for use with above or other transmitter-receiver combinations. Ship. wt. 2 lbs. New $1.25

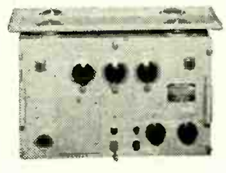
Miniature Storage Batteries

BB-51. 6 V. Consisting of 3 lead acid cells delivering 6 V. for 2.75 hrs. thru a 300 ohm resistance. Pin type terminals. Size overall 4-3/16" x 1¼" x 15/16". Ship. wt. approx. 5 ozs. New, dry-charge.......$1.75

BB-52. 36 V. Consisting of 18 lead acid cells delivering 36 V. for 3 hrs. thru a 1200 ohm resistance. Pin type terminals. Size overall 4⅛" x 1-7/16" x 15/16". Ship. wt. approx. 5 ozs. New, dry-charge.......95c

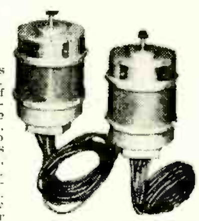
COMPLETE PACK BB-208 Includes 3 of the BB-52 and one BB-51 miniature storage batteries above, all packed in vacuum sealed can. New, dry-charge. Ship. wt. 3 lbs.......$3.95

OAV-1 TEST SIGNAL GENERATOR..$19.95



This signal generator was used to provide a test signal of constant frequency for operation and alignment of IF amplifier stages in the CG-46 ACQ type receivers. The generator covers the range between 150-250 megacycles. Amplitude modulated square wave output is obtained at frequencies of .1, 1, 10 and 100 kc. depending on the position of the freq. mod. pulse switch. A 15 Mc. signal is also provided by a second osc stage. Power is supplied by internal 115 V. 60 cycle AC supply connected to source by cord provided. Brand new with instruction book. Ship. wt. 62 lbs.......$19.95

SYNCHRO Motor and Generator Only $9.95 Per Pair



By simply connecting like wires of each unit and applying 110 V. 60 cycle current to junction of two rotor wires you have an electrical equivalent of a flexible shaft without the usual friction, backlash, and error. Dream up your own applications such as remote reading weather vanes, remote control antenna rotation, liquid level indicators, etc. Popular size 5 (6½" l.x3½" dia.). Cost Navy many times our low price. Ship. wt. 12 lbs. per pair. Removed from equip. Guaranteed. Per pair....$9.95

110 V. 60 Cycle Units

Size & Type	Approx. Weight (Lbs.)	Aprox. Length (Inches)	Approx. Diameter (Inches)	Price Used	Price New (Cases may be slightly nicked)
5F	5	6.0-6.8	3.4-3.6	$5.00	$10.00
5G	5	6.0-6.8	3.4-3.6	5.00	10.00
5DG	5	6.0-6.8	3.4-3.6	5.00	10.00
5CT	5	6.0-6.8	3.4-3.6	5.00	10.00
6F	8	6.4-7.5	4.5	7.50	15.00
6G	8	6.4-7.5	4.5	7.50	15.00
6DG	8	6.4-7.5	4.5	7.50	15.00
6CT	8	6.4-7.5	4.5	7.50	15.00
7G	18	8.9-9.2	5.8	10.00	(None)
7DG	18	8.9-9.2	5.8	10.00	15.00

110 V. 400 Cycle Units

Size & Type	Approx. Weight (Lbs.)	Approx. Length (Inches)	Approx. Diameter (Inches)	Price Used	Price New (Cases may be slightly nicked)
5F	5	6.0-6.8	3.4-3.6	$3.50	$7.50
5G	5	6.0-6.8	3.4-3.6	3.50	7.50
5DG	5	6.0-6.8	3.4-3.6	3.50	7.50

CT—Control Transformer; D—Differential Motor; DG—Differential Generator; F—Motor (Follower); G—Generator. Mfgd. by Bendix Ford Instrument Co., and General Electric. Specify.

New Torque Amplifier Only $9.75

FOR USE WITH SYNCHROS SIZE 5, 6, 7

Provides torque amplification and ease in rotation of input shaft. Rotating power applied to input shaft is reproduced in any direction on the output shaft. Torque supplied entirely by a 1/40 HP 110 V AC motor through gear and planetary drive hookup. Speed varies directly with rotation of input shaft with noticeable loss of accuracy. Motor requires capacitor of 85-120 mfd. for starting. Designed for use on gun control devices and cost the Gvnmt. hundreds of dollars to mfg. In cast aluminum case. Size: 12" h. x 5⅜" w. x 7½" d. Wgt. 23 lbs.

Packed in original wood box. Shpg. wt. 45 lbs. Brand New.......$9.95

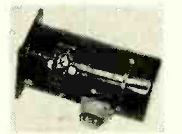
Starting capacitor for above Torque Amplifier, New..$1.00

RL-42-B Antenna Reel/Motor....$2.50

Used originally for remote controlling of automatic trailing wire antenna. Motor is ⅛ hp. x 24 V. DC with oil-less sleeve bearings. The gear train, breaking and disconnect mechanism, reversible and variable speed motor makes this an ideal unit for conversion to coil winders, etc. Ship. wt. approx. 5 lbs. Used.....$2.50 New.....$3.95

Kerosene or Gasoline Heater Reduced to $4.95

Brand new. Evans blue flame heater. Output approx. 50,000 BTU. Ideal for garage or shack where not confined. Size: 10" dia. x 12" high. Cost Govnmt. many times our low price. Shipped in orig. packing; wt. 47 lbs.......$4.95

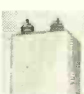


Golf Car Motor.....$4.50

New 1¾ hr. battery-operated motor for building up your golf car or other use. Operates from 12 to 24 V. with speed to 6000 RPM. Measures 4⅛" dia. x 9" long. ⅝" shaft. Wt. 11½ lbs. Ship. wt. 13 lbs.......$4.50

ER-25-6, 6 V. 25 AH Storage Battery

Plastic case size 7½" x 2-9/16" x 6⅜" h. Shipped dry charged. Fill with 1.265 sp. g. sulphuric acid. Ship. wt. 8 lbs. New.......$3.95



Oil Capacitors

4 mfd 600 V. S.......$1.00
2 x 1 mfd. 600 V. CD.......$1.00
.1 mfd. 1500 V. GE.......$1.00
.1 mfd. 3500 V. G.......$1.00
2 x .1 mfd. 4500 V. GE.......$1.00
.2 mfd. 5000 V. I.......$1.00
3 x .2 mfd. 4000 V.......$2.00
1 mfd. 4000 V. CD.......$2.00
.12 mfd. 15000 V. GE.......$3.75

All leading popular brands. All new; not shopworn. Guaranteed.

Trip Relay

Instantaneous class 9055 Type N. Mfg. by Square D Co. 600 V. max. Three ranges available—.067—.15 amp.; 23-47 amp.; and 56-117 amp. State choice. Ship. wt. 4 lbs. Brand new.......$1.95

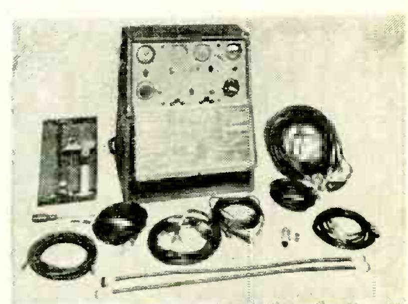
M-1 ODOGRAPH.................$179.50

An instrument used for vehicular mapping of terrain over which it is driven. Compass information is passed on thru a photo electric circuit to the plotting unit which combines this information with the speedometer drive for control of the pencil across the map paper, giving a map with possible errors of less than 1%. Will do survey work in hours that normally requires weeks. These instruments are new and the current mfgd. price is over $5,000. They are versatile in that parts can be adapted to other uses such as the compass unit to auto pilot boat control, etc. Ship. wt. 200 lbs.

U.S. Corps of Engineers rebuilt units.......$179.50 complete
Brand new units.......$279.50 complete

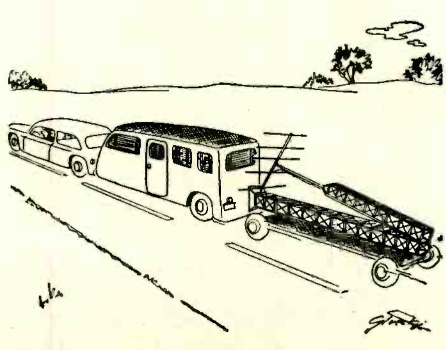
Test Set EE-1..New—$19.50

A test set for aircraft containing AC & DC volt. ohms. meter, tachometer, pressure gauge & test gauge cord & tools. In aluminum suitcase type case that opens forming sloping 2 sec. panel. Ideal for your test bench applications. Cost hundreds of dollars but yours in original evacuated shipping container. Ship. wt. 270 lbs. $19.50



ESSE RADIO CO. 42 WEST SOUTH ST. INDIANAPOLIS 25, IND.

REMIT SHIPPING CHARGE AND INSTRUCTIONS WITH ALL ORDERS. OTHERWISE ORDER WILL BE SHIPPED EXPRESS COLLECT. ALL ITEMS GUARANTEED TO YOUR SATISFACTION OR MONEY REFUNDED IF RETURNED PREPAID WITHIN 10 DAYS OF RECEIPT



"And you say this set has been working perfectly for the past two years?"

NEW MASTER VOLTOHMYST®

Accuracy of ±3% full scale on both AC and DC

RCA-WV-87B—offers many time-saving work-simplifying features for laboratory, production, servicing—can help improve the quality of your work!

The WV-87B is housed in a durable metal case for general use around the service shop or the lab or for shelf- or rack-mounting on the production line. The unusually large meter face, clearly calibrated scales, and VoltOhmyst circuit permit extraordinary ease and speed in taking highly accurate readings. Helps you work better, faster, more efficiently. You can be positive of the measurements you take when you use the RCA Master VoltOhmyst.

RCA WV-87B Master VoltOhmyst—newest addition to the world-famous line of RCA superior-quality Test Instruments—is available through your RCA DISTRIBUTOR. Price $137.50†. See him now for details and literature or write RCA, Commercial Engineering, Section L39W, Harrison, N.J.

Check these outstanding features:

• wide-vision open-face extra-large (7½") meter scale • mirror-strip on scale to eliminate needle-to-scale parallax • two-color, separate scales for speedy *peak-to-peak* and *rms voltage* readings • work-simplifying single probe with built-in switch for all Ohms and DC/AC Voltage measurements • high stability circuit free from effects of line voltage variations • meter tracking error only ±1% or less • accuracy of ±3% full scale on *all AC* and *DC* ranges • DC current readings as low as 10 μa.

ELECTRICAL SPECIFICATIONS

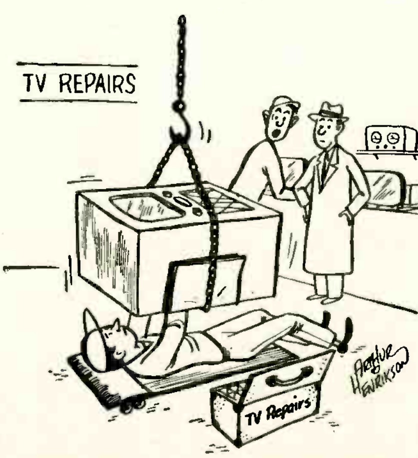
Operation	Ranges	Input R, C	Freq. Response
DC Volts	0 to 1500 (7 ranges) Low Scale, 0 to 1.5	*11 meg., 2 μμf	
AC Volts (RMS, sine waves)	0 to 1500 (7 ranges) Low Scale, 0 to 1.5	0.83 to 1.5 meg. 75 μμf to 85 μμf	30 cps to 3 Mc** (for source impedance of 100 ohms)
AC Volts (Peak-to-Peak values, sine or complex wave forms)	0 to 4200 (7 ranges) Low Scale, 0 to 4		
Direct-Current	0 to 15 a. (9 ranges) Low Scale, 0 to 500 μa		
Ohms	0 to 1000 megohms (7 ranges)		

MECHANICAL SPECIFICATIONS
Height: 10"; Width: 13½"; Depth: 7"; Weight: 8 lbs.

*1100 meg. with WG-289 Probe and WG-206 Multiplier Resistor.
**Crystal-Diode Probe WG-301A available to extend range to 50 Kc to 250 Mc within ±10%.
†User price (optional) Complete with WG-299C DC/AC-Ohms Probe, Low-Capacitance Flexible Cable, Current Leads, Ground Lead, Instructions.

RCA®

Radio Corporation of America
Components Division ***Camden, N. J.***



"Jim used to be an auto mechanic."

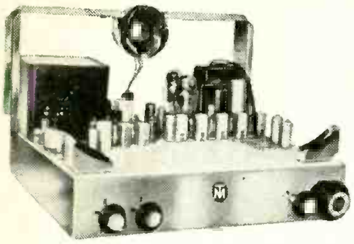
TECH-MASTER for '57 . . . *Excitingly New!*

VIDEO THEATRE ★ VIDEOPHILE ★ GOLD MEDAL TV ★ HI-FI KITS

Brochure mailed on request

CHRISTMAS GIFT OFFER

FREE—12" HI-FI SPEAKER with TWEETER with each purchase of a GOLD MEDAL TV CHASSIS (in addition to SPEAKER supplied).



The "GOLD MEDAL" #2430-N

OPERATES all 21", 24" and 27" (90°) Picture Tubes with unexcelled performance in Brilliance, Clarity and Fringe Area Reception. This TV Receiver is an improved version of the former TECH-MASTER #2430-9 that sold for $262.50.

Note the new low price!

- Latest #630 Type Advance Circuitry, using 30 Tubes.
- New Hi-Sweep Auto Transformer System for added brilliance.
- Full 4 Mc Band Width for picture clarity and definition.
- 5 Microvolt Sensitivity assures fringe area reception.
- New System of picture and sound synchronization.
- New Type Cascode Tuner with provisions for UHF.
- Picture Expander Control for low line voltage conditions.
- Full Horizontal and Vertical Blanking.
- Quick Action Keyed AGC circuit for stabilized control.
- Chassis beautifully plated in gleaming nickel.

Dimensions 20¼"W x 16¼"D — Shipping Weight 65 lbs.

COMPLETE ready to operate including all Tubes, CRT Brackets, 12" Speaker, Knobs, Etc. (less CRT) $194.50

CUSTOM-BUILT CABINETS FROM FACTORY TO YOU

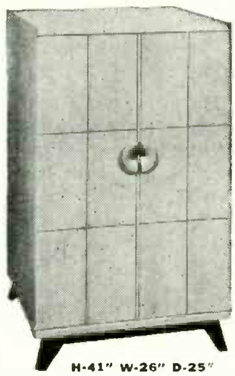
3 LEADING 1956 STYLES in Mahogany or walnut (blond 10% extra) • Ready drilled for any # 630 TV chassis and cut out for any 16", 17", 19", 20" or 21" picture tube at no extras in price • Also supplied with undrilled knob panel for any other TV set • EVERYTHING NECESSARY for an easy perfect chassis and CRT assembly is included • Each cabinet is delivered complete as pictured with mask, safety glass, mounting brackets, backboard, back-cup, hardware and assembling instructions • Each cabinet is shipped in an air cushioned carton **from FACTORY to YOU!**

GEM $35.91

GEM also available for 24" or 27" picture tube **$59.54**

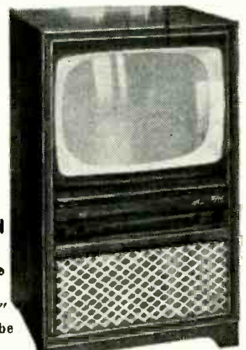
H-25" W-26" D-22"

WESTCHESTER $88.70



H-41" W-26" D-25"

MANHATTAN $53.43



MAN-HATTAN also available for 24" or 27" picture tube **$79.22**

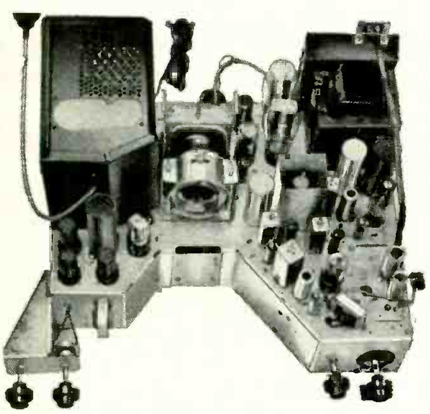
H-39" W-25" D-23"

WESTINGHOUSE OR CBS PICTURE TUBES

BRAND NEW in Factory Sealed Cartons—With a Full Year Guarantee

17" 70° #17BP4A / 90° #17AVP4A **$22.66**	21" 70° #21EP4B / 90° #21ALP4A **$32.21**	24" 90° #24CP4A Aluminized **$48.99**	27" 90° #27EP4A Aluminized **$74.31**

#630 SUPER DELUXE 31-TUBE TV KIT



Licensed under RCA patents

Engineered in strict adherence to the genuine RCA #630, plus added features ★ ★ ★ ★ ★

- Operates 21" and All 70° Picture Tubes
- Standard Cascode Turret Tuner for DX
- Cosine 70° Deflection Yoke for Definition
- Original 630 Synch. Chain for Stability
- 16 KV for Clarity and Brilliance
- Fast Action Pulse Keyed AGC
- Large Concert-tone 12" PM Speaker

NOW! You receive a COMPLETE SET of PARTS and TUBES. Everything needed is included, even WIRE and Solder. You will enjoy building the Chassis with "LIFE-SIZE easy to follow step-by-step ASSEMBLING INSTRUCTIONS" included with KIT. We pay the New Federal Excise Tax.

$109.98 (less CRT) NEW EXCISE TAX INCLUDED

Similar TV KIT for 24", 27" or any 90° CRT.......................................$119.44

21" TV CONVERSION KIT

NOW . . . Anyone with even a limited knowledge of TV—can Convert any Size, any Make **TV RECEIVER to operate 21" or any 70° Picture Tube.**

COMPLETE SET OF ESSENTIAL PARTS includes matched set of Todd 70° **COSINE DEFLECTION YOKE and TODD HV FLYBACK TRANSFORMER, FOCALIZER, 20KV FILTER, DRIVE TRIMMER, LINEARITY COIL, CONDENSERS, RESISTORS.**

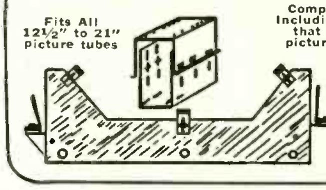
Your Price.... **$13.97** List Price $33.50

Incl. CONVERSION MANUAL with Step-by-Step Instructions & Diagrams.

Similar Kit for 24" or 27" CRT $15.98

UNIVERSAL Picture Tube MOUNTING BRACKETS

Fits All 12½" to 21" picture tubes



Complete—Including band that holds picture tube

$6.97

PULSE KEYED AGC KIT

Latest type, most accurate and the easiest Kit to install in any make **TV RECEIVER** including the #630. Improves performance and insures a steady picture on all channels.

COMPLETE SET OF PARTS $4.59

Including 6AU6 tube & Instructions

STANDARD CASCODE TUNER

For better all around performance. Complete with tubes and Brooks **CASCODE MANUAL** with step-by-step instructions and all extra parts needed. **$15.97**

FLYBACK TRANSFORMER

Latest single 1B3 type, for the 21" and all 70° Picture Tubes. It is similar to the popular No. X-053 and goes up as high as 16KV. With it you receive easy-to-follow instructions and schematic diagrams that apply to build, convert or improve practically all makes of TV Receivers **$4.86**

COSINE DEFLECTION YOKE

The latest achievement in the 70° type, with complete wired network. Will add new life to any TV Set, in brilliance, clarity and sweep. This is the same type we supply with our Kits, with it you receive easy-to-follow instructions and diagrams **$4.92**

18KV FLYBACK TRANSF.

This new Flyback Transformer now makes 90° conversions easy on any make TV Set. Customers report excellence on 24" and 27" TV sets built or converted with this Transformer. Instructions and schematic diagrams included **$5.24**

COSINE DEFLECTION YOKE

NEW 90° TYPE, with complete wired network. It solves all problems formerly sought for, in 90° Yokes, for undistorted clear pictures and ease of overall sweep. Instructions and schematic diagrams included for building, replacing and converting **$5.98**

TV CRYSTAL-CLEAR LUCITE MASKS

Framed in Rich Goldleaf Finish

Tube Size	Overall Dimensions	
17"—Rectangular	13⅛" x 16½"	$ 4.56
21"—Rectangular	16½" x 21¼"	6.92
24"—Rectangular	20¼" x 25¾"	11.84
27"—Rectangular	20¼" x 26"	12.18

Mention type and number of CRT used

TV PLASTIC OPEN MASKS

Used in conjunction with safety glass

17"—Rectangular	16" x 19"	$1.49
21"—Rectangular	18" x 22½"	2.38
24"—Rectangular	21" x 26"	4.93
27"—Rectangular	21" x 26"	4.93

Mention type and number of CRT used

TV SAFETY GLASS in HANDY SIZES

16" x 20"..... $2.94	*18" x 22½".. $5.16
16" x 22"..... 3.97	*21" x 26".... 5.87

*Available in new tinted grey 50c extra

Brooks LIFE-SIZE TV INSTRUCTIONS for building any #630 TV Receiver from the original 10" to the latest 27" **$1.25** postpaid	HINTS FOR BETTER PERFORMANCE on your #630 TV receiver........ **50¢** postpaid	Brooks CASCODE MANUAL, how to install Cascode Tuner in any make TV Set. **25¢** postpaid
90° TV CONVERSION MANUAL, how to convert any TV SET to 24", 27", etc. **50¢** postpaid	70° TV CONVERSION MANUAL, how to convert any TV SET to 17", 21", etc. **50¢** postpaid	A.G.C. STEP-BY-STEP INSTRUCTIONS, how to add A.G.C. to any make TV Receiver .... **25¢** postpaid

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

TELEPHONE COrtland 7-2359

"Just hold still a minute, sir, a little solder will do the trick."

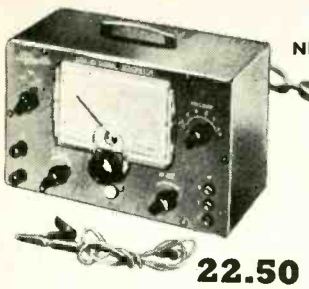
KEY TO SYMBOLS AND ABBREVIATIONS

* Construction Articles
† Section of full-length article
Clinic .... Television Clinic
Corres .... Correspondence
Pat .... Patents
QB .... Question Box
REC .... Radio-Electronic Circuits
RM .... Radio Month
TTO .... Try This One

Regular departments not indexed are Business, Technicians' News, New Devices, People, Technical Literature, Books.

END

LAFAYETTE SENSATIONAL VALUES! IN COMPLETELY WIRED TEST EQUIPMENT at LESS than the PRICE of KITS!



LAFAYETTE SIGNAL GENERATOR

NEVER BEFORE HAS A COMPLETELY WIRED AND TESTED INSTRUMENT OF SUCH ACCURACY AND QUALITY BEEN OFFERED AT SUCH A PRICE!

- FREQUENCY 120 KC TO 260 MC
- 120 KC TO 130 MC ON FUNDAMENTALS
- LABORATORY ACCURACY AND QUALITY

22.50

A completely wired and tested instrument not to be confused with units sold in kit form at almost the same price, but with a quality and accuracy of instruments 3 to 4 times its price. Six overlapping ranges generate signals of 120KC — 320KC, 320KC—1000KC, 1MC—3.2MC—11MC, 11MC—38MC and 37MC—130MC all on fundamentals with calibrated harmonics from 120MC to 260MC. Selector switch gives instant choice of ranges. Switch gives choice of internal modulation of 400 CPS or use of any external source at other frequencies. For audio testing the 400 cycle signal can be used separately. Outputs are unmodulated RF, modulated RF and 400 CPS audio. RF output is in excess of 100,000 microvolts and jacks are provided for choice of either high or low RF output. Stability is insured by special circuit design. Has a fine adjustment RF control. AF output is 2-3 volts. AF input is 4 volts across 1 megohm. Large clear 5 inch etched dial plate and pointer are protected by transparent plastic bezel. Common AF terminals for EXT-MOD input and INT-AF for audio tests eliminate need for special AF output connectors. Machine engraved panel lettering. Handsome gray metal case with carrying handle. Measures 6½" x 10" x 4½". Comes complete with pair of leads. AC line cord and plug. Operates on 105-125V 50-60 cycle AC. Shpg. wt., 8 lbs.

LAFAYETTE LSG-10 SIGNAL GENERATOR 22.50

NEW POCKET AC-DC VOM MULTITESTER

2,000 ohm per volt Sensitivity on both DC and AC

160 ua 3" METER
1% PRECISION RESISTORS
SILVER CONTACT SELECTOR SWITCH

8.95

FULL SCALE RANGES

DC Volts: 0-10; 0-50; 0-500; 0-1000 Volts — AC Volts: 0-10; 0-50; 0-500; 0-1000 Volts—DC Current: 500 ua and 500 ma — Resistance: 0-10K; 0-1 Meg — Decibels: —20 to +22; +20 to 36 db (0 db — 0.775 V)—Capacity: 250 mmfd to .2 mfd—.005 mfd to 1 mfd—Output Ranges: 0-10; 0-50; 0-500; 0-1000 volts

Best Buy in America! A very accurate and sensitive VOM. This Multitester is a complete instrument (not a kit) with high quality and sensitive 160 microamp meter; 2000 ohm per volt on both AC and DC. Single selector switch. 1% precision resistors, 3" meter. Features extreme versatility, accuracy and ruggedness. In attractive plastic front panel, with metal bottom for ruggedness and shielding. First capacity range requires 50 volt AC source. Second capacity range requires 10 volt AC source. Size 4¼"x3½"x1⅝". Complete with test leads and batteries. Shipping weight 4 lbs.

RW-27A .... Complete **8.95**

NEW! LAFAYETTE CAPACITANCE-RESISTANCE TESTER WITH "IN-SET QUICK CHECK"

COMPLETELY WIRED AND TESTED

- TWO INSTRUMENTS IN ONE
- CHECKS ELECTROLYTIC, PAPER, MICA AND CERAMIC CONDENSERS
- 4 DIRECT READING CAPACITY SCALES FROM .00001 MFD TO 1000 MFD
- CHECK FOR OPEN SHORTS, LEAKAGE AND INTERMITTENTS
- 2 RESISTANCE RANGES FROM 100 TO 5 MEGOHM

34.50

Here is a "must" for servicemen and lab technicians. A completely self-contained AC operated capacitance and resistance bridge, plus a quick check for in the set testing. Large 5 direct reading scale has 4 ranges of .00001-.005 MFD, .001-.5 MFD, .1-50 MFD and 20-1000 MFD. Resistance ranges are 100-50,000 OHMS and 10,000 to 5 megohm. Quick check feature enables you to check capacitors for shorts, open or intermittent while in circuit—no need to remove them from the set till you're sure they need replacement. Leakage test switch gives you choice of 25, 150, 250, 350 or 450 volts for checking leakage under correct potential. Separate power factor control with continuous settings from 0 to 50%. Operation is simple and accurate, using a magic-eye tube as the null detector. Attractively finished steel case with etched panel and rounded corners, measures 14½"L x 8¼"H x 5"D. Shpg wt. 19 lbs.

MODEL LC-4 .... NET 34.50

HIGH SENSITIVITY 20,000 OHM PER VOLT DC 10,000 OHM PER VOLT AC MULTITESTER

19.95

LOOK AT THESE FULL SCALE RANGES!

D.C. Volts: 0-6; 0-30; 0-120; 0-600; 0-1200; 0-6000 Volts — A.C. VOLTS: 0-6; 0-30; 0-120; 0-600; 0-1200 Volts — RESISTANCE: 0-10K; 0-100K; 0-1 Meg; 0-10 Megohms— D.C. CURRENT: 0-60 Micro-amp; 0-6; 0-60; 0-600 Milliamps — DECIBEL: —20 to +17 db (0 db—0.774V) — CAPACITY: .0001-.01; .005-.15 mfd — INDUCTANCE: 20-2000 millihenry —OUTPUT RANGES: 0-6; 0-30; 0-120; 0-600; 0-1200 Volts

The new Lafayette high sensitivity Multitester is a complete instrument (not a kit). In addition to its unusual sensitivity of 20,000 OHMS PER VOLT ON D.C. AND 10,000 OHMS PER VOLT ON A.C., and the extraordinary number and scope of its ranges, it is packed with features that would make it cost at least twice as much if made in this country. Uses 1% precision resistors, silver contacts on selector switch, 35 ua 3" meter. Dependable, rugged and accurate. Even the test leads are heavy duty with high voltage insulation. Voltage source required for low capacity range is 120V A.C., for high range capacity and inductance scale is 6V A.C. Attractive plastic front with metal bottom. Size 6¼"x4¼"x2½". Complete with batteries and leads. Shipping weight 4½ lbs.

RW-30A .... Singly, Each **19.95**
In lots of 3, Each **19.25**

NEW! LAFAYETTE CAPACITOR-RESISTANCE TESTER

COMPLETELY WIRED AND TESTED

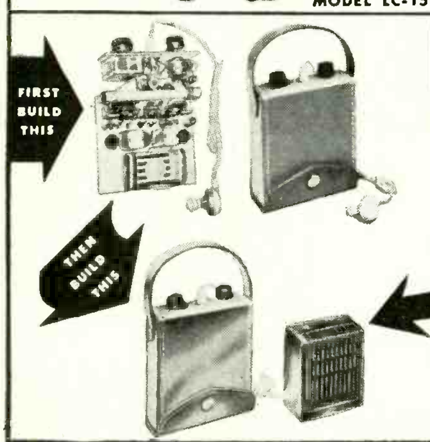
21.50

COMPLETELY WIRED AND TESTED

- CHECKS ALL TYPES OF CONDENSERS FOR CAPACITY, LEAKAGE, OPEN SHORTS OR INTERMITTENT CONDITION
- DIRECT READING SCALES FROM .00001 TO 1000 MFD AND 100 TO 5 MEGOHMS

A stable and accurate bridge type circuit measures capacitance in 4 ranges of .00001-.005 MFD, .001 to .5 MFD, .1 to 50 MFD and 20 to 1000 MFD. Two resistance ranges of 100-50,000 and 10,000 to 5 megohms. Check leakage under actual load with choice of 25, 150, 250, 350 or 450 volts available by selector switch. Power factor control from 0 to 50%. Checks for leakage, open, short, or intermittent operation. All readings taken directly off scales after setting magic eye to maximum. Completely self-contained power supply. Attractively finished steel case with rounded corners and etched panel. Operates from 110V AC. Size 9⅜"L x 7⅛"H x 5¼"D. Shpg. wt. 10 lbs.

MODEL LC-15 .... NET 21.50



4 AND 6 TRANSISTOR SUPERHET KITS POCKET AND HOME RADIOS FOR SPEAKER AND EARPHONE OPERATION

POCKET SIZE: 4"L x 3-5/16"W x 1"D BUILT-IN ANTENNA! REQUIRES NO EXTERNAL ANTENNA OR GROUND!

Lafayette engineers have designed this fascinating 4-transistor superhet receiver kit in a unique and interesting form. It is, by itself, a completely self-contained, pocket sized personal portable set which operates a miniature earpiece so only you can hear; by plugging into the KT-96 kit listed below, it is instantly converted to a full 6-transistor home radio, complete with speaker for the entire family to enjoy. Circuit features use of 4 transistors (2 high frequency and 2 audio type) plus a germanium diode. 2 I.F. stages and built-in high gain ferrite core and antenna. The result is a sensitive, stable and selective set covering the entire broadcast band. Requires no outside antenna or ground connection. The kit is furnished complete with transistors and all parts, including battery and chassis already drilled and punched. The earpiece and carrying case are accessory items, not supplied. All necessary pictorial and circuit diagrams are furnished with simple, easy-to-follow instructions.

KT-94 —Kit, shpg. wt., 2 lbs. .... Net **19.95**
MS-311—Leather Carrying Case .... Net **1.95**
MS-260—Super power dynamic earpiece .... Net **3.95**

2-TRANSISTOR PUSH-PULL OUTPUT KIT WITH SPEAKER SELF-CONTAINED IN BEAUTIFUL PLASTIC CASE.

• CONVERTS 4-TRANSISTOR KIT INTO A 6-TRANSISTOR HOME RADIO WITH SPEAKER

Add a completely transistorized push-pull audio stage to your 4 transistor receiver. Complete stage including speaker and case measures only 3" H x 2⅝" W x 1⅜" D. Plugs right into 4 transistor kit above. Converts your 4 transistor set to a 6 transistor plus diodes superhet receiver. Performance equal or superior to commercially wired sets selling at more than twice the price. Kit includes 2 transistors, 2 transformers, 2½" PM speaker, pre-punched chassis, speaker case to hold entire stage, battery, hardware, instructions and diagrams.

KT-96—Shpg. wt., 1 lb. .... Net **11.50**

LAFAYETTE RADIO

Dept. JL-1

JAMAICA 33, N.Y. 165-08 Liberty Ave. Write for FREE Bargain Packed Catalog!

100 SIXTH AVE., NEW YORK, N. Y.
BOSTON, MASS., 110 Federal St.
PLAINFIELD, N. J., 139 West 2nd St.
NEWARK, N. J., 24 Central Ave.
BRONX, N. Y., 542 E. Fordham Rd.

FREE! LAFAYETTE CATALOG

ELECTRONIC CATALOG PACKED WITH MONEY SAVERS

Packed with the largest selection of Electronic. Radio and T.V. Parts, and equipment, PA, Hi-Fi systems tubes, antennas, Transistor Kits, parts and components, Test Equipment, new build your own kits, tools, books, Microscope, drafting equipment, Binoculars, Telescopes, All Radio, TV and Ham supplies — ALL AT GREAT SAVINGS — For the economy minded servicemen, dealer, engineer and technician. CHUCK FULL OF BUYS! SEND FOR YOUR FREE COPY TO-DAY.

35 WATT HI-FI AMPLIFIER KIT WITH METERED OUTPUT AND 4 PUSH-PULL PARALLEL NEW EL84 TUBES

New Lafayette high power amplifier kit with a host of features not in any other single amplifier. Calibrated output meter permits use as either a recording or reproducing amplifier. EL84 power pentodes provide high peak power and low distortion required for better audio quality. Features exceptional control versatility and ample inputs for all associated custom hi-fi equipment. DC operated preamp filaments and balancing adjustment to minimize hum. Meter can be switched to indicate either recording voltage or output level of amplifier. Features rumble filter, loudness control, separate bass and treble controls, silencing switch, speaker selector switch, output balancing adjustment and monitoring jack.

SPECIFICATIONS

FREQUENCY RESPONSE: ± 1 db 20-40,000 cps. **HUM:** 85 db below rated output. **POWER OUTPUT:** 35 watts with 4% total distortion at full rated output. **INPUTS:** TV Sound, Radio, Magnetic Phono, Crystal Phono, Tape. **OUTPUT IMPEDANCE:** 4, 8 and 16 ohms; high impedance for tape recorder. **TUBE COMPLEMENT:** 3-12AX7, 1-12AU7, 4-EL84, 1-5U4. **FEEDBACK:** Negative feedback loops virtually eliminate distortion. **POWER:** 117V, 60 cps, 80/150 watts with auxiliary power receptacles. Removable escutcheon. Size 12⅛" L x 9¾" D x 4⅛" H.

A combination of high power, high fidelity, gleaming beauty and advanced engineering features unmatched at even twice the price. Supplied in complete kit form with simplified easy-to-follow instruction sheets. Shpg. w., 25 lbs.

KT-115—Complete kit, ...Net **59.50**

LAFAYETTE'S FM-AM TUNER KIT

- SIMPLIFIED DETAILED INSTRUCTION MANUAL
- MEETS FCC REQUIREMENTS FOR RADIATION
- GROUNDED GRID TRIODE AMPLIFIER
- ARMSTRONG FM CIRCUIT WITH FOSTER-SEELEY DISCRIMINATOR
- AFC DEFEAT CIRCUIT WITH FRONT PANEL CONTROL

The excellence of its design and the quality of its components combine to provide this compact high-fidelity FM-AM tuner with superb characteristics normally found in units costing several times as much, and with performance unbelievable at this low price. Features Armstrong FM circuit with limiter and Foster-Seeley discriminator. Simplified tuning with slide-rule dial and flywheel counterweighted mechanism. AFC defeat circuit combined with tuning control. Attractive etched copper-plated and lacquered finish.

SPECIFICATIONS

FREQUENCY RANGE: FM, 88-108 MC; AM, 530-1650 KC. **ANTENNA INPUT:** FM, 300 ohms; AM, Ferrite loopstick and high impedance external antenna. **CONTROLS:** 2—a function control for AM, FM, PHONO, TV and a tuning/AFC defeat control. **DISTORTION:** Less than 1% rated output: **FREQUENCY RESPONSE:** FM, ± .5 db 20 to 20,000 cps; AM, ± 3 db 20 to 5000 cps. **SENSITIVITY:** FM, 5 μv for 30 db quieting; AM, Loop sensitivity 80 μv/meter. **SELECTIVITY:** FM, 200 KC bandwidth, 6 db down — 375 KC FM discriminator peak to peak separation; AM, 8 KC bandwidth, 6 db down. **IMAGE REJECTION:** 30 db minimum. **HUM LEVEL:** 60 db below 100% modulation. **TUBE COMPLEMENT:** 2-12AT7, 1-6BA6, 1-6BE6, 2-6AU6, 1-6AL5 plus 1-6X4 rectifier. **SIZE:** 5¼" high x 9⅝" wide x 9½" deep (excluding knobs). **CONSUMPTION:** 30 watts. For 110-120V 60 cycles AC. Less metal case. Shpg. wt., 9 lbs.

KT-100 Complete kit, less cage. ....Net **34.95**
LT-10 —Completely wired...... Less metal case. ....Net **52.50**
ML-100—Metal cage for above, shpg. wt., 3 lbs...........................Net **5.00**

New!

HIGH FREQUENCY TWEETER WITH ACOUSTIC LENS

DIRECT IMPORTATION MAKES THIS PRICE POSSIBLE!

- FREQUENCY RESPONSE FROM 2000 CPS TO BEYOND AUDIBILITY
- LOUVERED ACOUSTIC LENS FOR UNIFORM SOUND DISPERSION
- HANDLES 25 WATTS OF POWER
- PRICED EXCEPTIONALLY LOW

14.95

New high frequency tweeter featuring a louvered acoustic lens for uniform sound dispersion and capable of handling up to 25 watts of distortion-free power. The directional tendency of high frequency notes is overcome by the natural wide dispersion angle of the short horn and the acoustic lens which disperses and radiates the high notes smoothly throughout the entire listening area. The lens is detachable for panel mounting, with a separate base for the tweeter furnished for external mounting where desired. Aluminum voice coil has 16 ohms impedance. Size: 4¼" long x 3" diameter, lens extends 2½". Requires a crossover network, preferably one with a level control, such as the LN-2. With full instructions. Shpg. wt., 5 lbs.

HW-7 ....Net **14.95**

METAL-CASED CONE TYPE HI-FI TWEETER

FREQUENCY RESPONSE 2000-16,000 CPS · HANDLES 20 WATTS OF POWER

5.95 Net

Highest quality cone type high frequency tweeter having a range from 2000 to 16,000 cycles. Especially efficient at higher end of audio spectrum where other cone type tweeters tend to lose clarity and volume. Entirely closed in a metal case with a base so that it can stand by itself or be mounted on a flat surface with mounting bracket supplied. Rated to handle 20 watts of power. A crossover network is required; the Lafayette LN-2 is ideal. Voice coil impedance 8-16 ohms. Size: 3⅛" x 2⅛" x 3" Diam. Shpg. wt., 3 lbs.

HK-3 ....Net **5.95**

CROSSOVER NETWORK

- CAPACITIVE-INDUCTIVE NETWORK WITH CROSSOVER AT 2000 CPS
- BUILT-IN LEVEL BRILLIANCE CONTROL

8.75

The frequencies above 2000 cycles are channeled to the high frequency tweeter by means of the high-Q inductance and capacitance comprising this efficient crossover network. The highs and lows are brought into acoustic balance by means of a continuously variable level-brilliance control. Control has a 2½ ft. long cable for remote mounting. Network matches 8-16 ohm speakers with insertion loss reduced to a minimum. Enclosed in metal case 6" L x 2⅝" H x 2⅝" D. With full instructions. Shpg. wt., 5 lbs.

LN-2 ....Net **8.75**

2 WAY SPEAKER SYSTEM 40-16,000 CYCLES

This 2-way speaker system is another excellent buy for the moderate purse. It is basically the same as the SY-85 system described at the top of the page, but incorporates the deluxe SK-68 speaker with 21.5 oz. Alnico V magnet. This results in more efficient reproduction and extension of the lower register. Complete system includes the SK-68 12" 25 watt woofer, HK-3 cone type tweeter and LN-2 crossover network with lever-brilliance control. Range of system 35-16,000 cycles. Shpg. wt., 18 lbs.

SY-87—Complete System..Net **27.50**
SY-86—Complete System, same as above except the HW-7 Tweeter with acoustical lens is supplied instead of HK-3. Shpg. wt., 20 lbs..........................Net **36.50**

New! **LAFAYETTE Mail Order Center**

Lafayette Radio **165-08 Liberty Ave. JAMAICA 33; N. Y.**

Dept. JL-2

NAME ____________________

ADDRESS ____________________

CITY ____________________

ZONE ____________________

STATE ____________________

SEND FREE LAFAYETTE CATALOG

CUT OUT AND MAIL TODAY!

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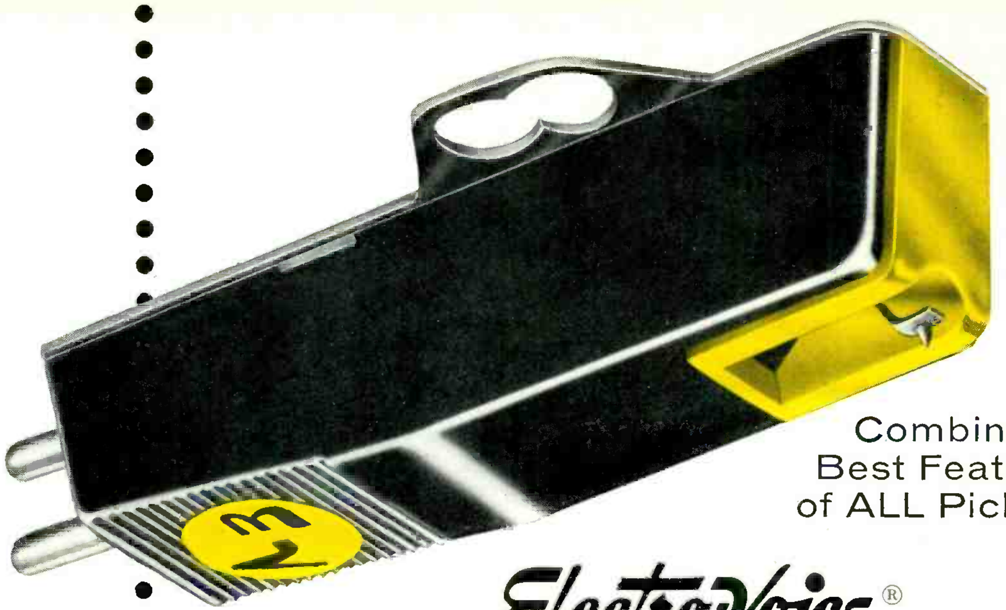


Combines Best Features of ALL Pickups!

Electro-Voice®

NEW IMPROVED 80 SERIES ULTRA-LINEAR CERAMIC CARTRIDGE

THIS *TRUE* HIGH-FIDELITY cartridge embodies the most advanced concept in pickups. Combines all the *benefits* of ceramic and magnetic cartridges (with none of the disadvantages) in one pickup that fits any arm or plug-in head! Enjoys absolute freedom from unwanted case resonance because of unique, die-cast housing. Not affected by moisture or humidity.

TWO BASIC SERIES. Standard Model 80 Series works into any amplifier having a ceramic input. Model 80M Series provides replacement for *all* magnetic pickups with no adjustments or circuit modifications required.

Here's Why You Should Use This Completely New Ceramic Cartridge

SUPERLATIVE RESPONSE! 20 to 20,000 cps.

LOWEST INTERMODULATION DISTORTION! LESS than 3% at 18 cm/sec.

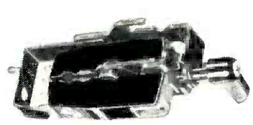
HIGH OUTPUT! 80 Series. 500 millivolts. 80M Series, 25 millivolts at 5.5 cm/sec.

NO HUM! Absolutely non-inductive. Not sensitive to motor and transformer fields.

HIGH COMPLIANCE! 3 x 10-6 cm/dyne—several times the average hi-fi pickup compliance.

NO PREAMP REQUIRED! Standard 80 Series works into any amplifier having a ceramic input. 80M Series works into any magnetic cartridge input.

NO MODIFICATION NEEDED.



E-V 80 Series Turnover Pickup Provides Extra Benefits. Two independent generating cartridges in one! Full power for stylus in use . . . no distortion or resonance from unused stylus.

TYPE	STANDARD E-V MODEL	MAGNETIC REPLACEMENT	STYLUS	NET	RECORD SPEED
Single Play	82S	82SM	3M Sapphire	$ 9.60	78 RPM
Single Play	82D	82DM	3M Diamond	23.10	78 RPM
Single Play	84S	84SM	1M Sapphire	9.60	*45,33,16 Talking Book
Single Play	84D	84DM	1M Diamond	23.10	*45,33,16 Talking Book
Turnover	86TD	86TDM	1M Diamond 3M Diamond	48.00	*45,33,16 Talking Book 78 RPM
Turnover	86T	86TM	1M Diamond 3M Sapphire	34.50	*45,33,16 Talking Book 78 RPM

NOTE: The numeral "4" appearing in the model number indicates microgroove stylus; the numeral "2" denotes 78 rpm tip. "D" denotes one or more diamond styli; "S" stands for sapphire stylus. *Also 78 rpm Microgroove.

LABORATORY PROOF OF EXCEPTIONAL PERFORMANCE