TRANSISTOR SOUND SURVEY METER

FEBRUARY 1958

Radio-Electronics

TELEVISION • SERVICING • HIGH FIDELITY

HUGO GERNSBACK, Editor

Automatic TV Fine Tuning

•

Big Performance From Easy-to-Build Small Amplifier

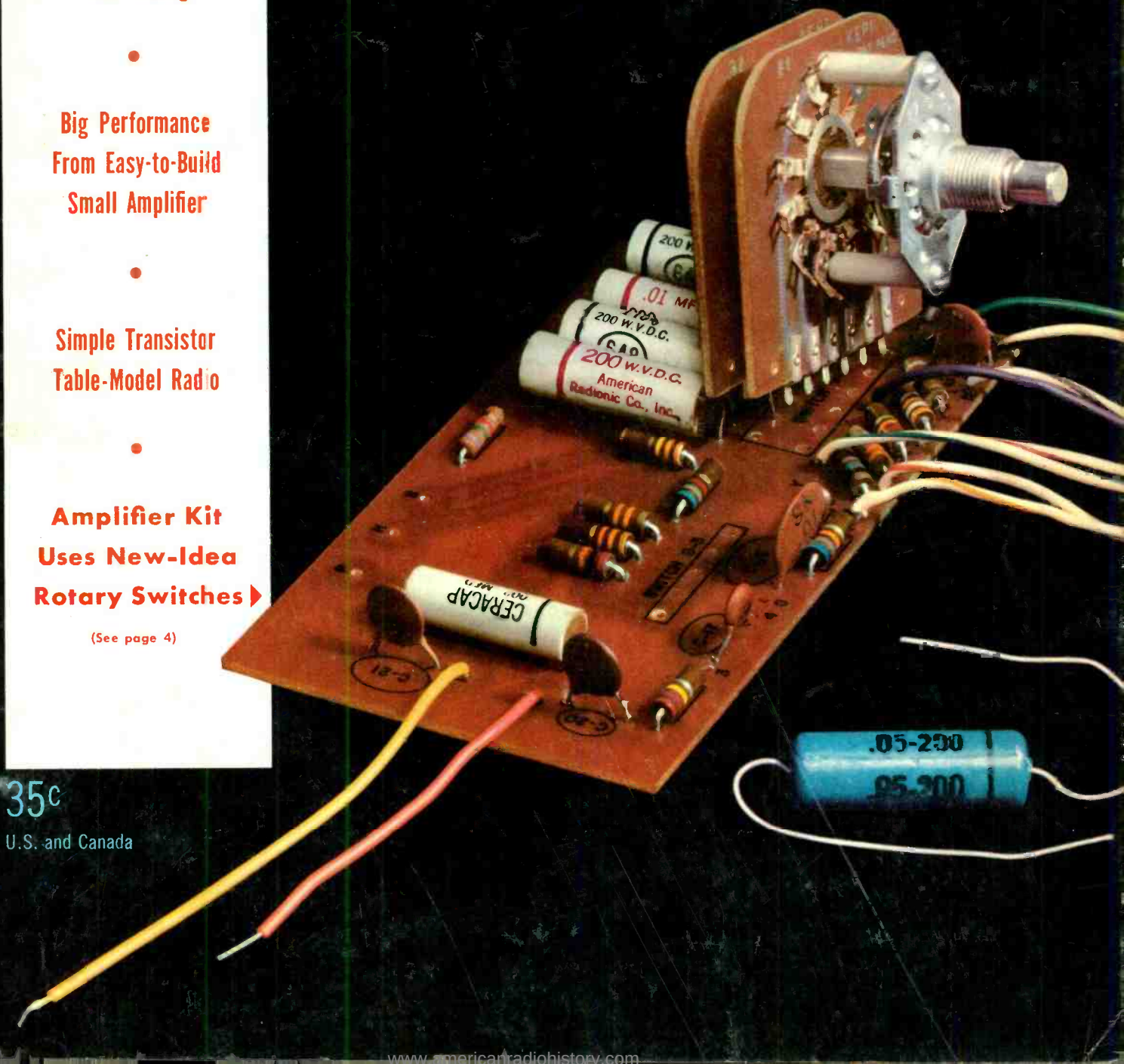
•

Simple Transistor Table-Model Radio

•

Amplifier Kit Uses New-Idea Rotary Switches

(See page 4)



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U.S. and Canada

the mighty nine plus two!

New Triplett Model 630-PL

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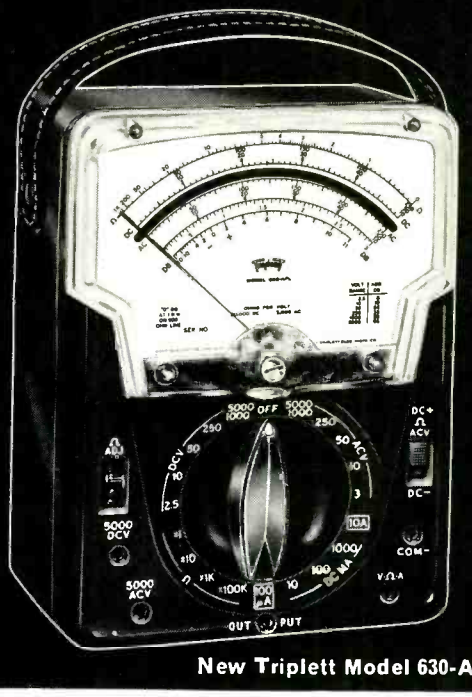
Now the Triplett Mighty Nine Has Expanded to A Line of 11 VOMs Tailored to Meet Your Preference, Purse or Purpose. Only Triplett Offers So Complete A Variety.

With the new 630-PL and 630-APL you get these important new features:

- Voltage scales for those who want ranges reading by 10's (2.5-10-50-250-1000-5000).
- Instant-vision, wider spread scales; streamlined case, handsome modern design.



New Triplett Model 630-APL

- D.C. Polarity Reversing Switch.
- 5 to 500,000 Cycles per second frequency response in A.C. measurements.
- 5000 ohms per volt sensitivity in A.C. ranges; 20,000 ohms per volt D.C.

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Triplett Model 630

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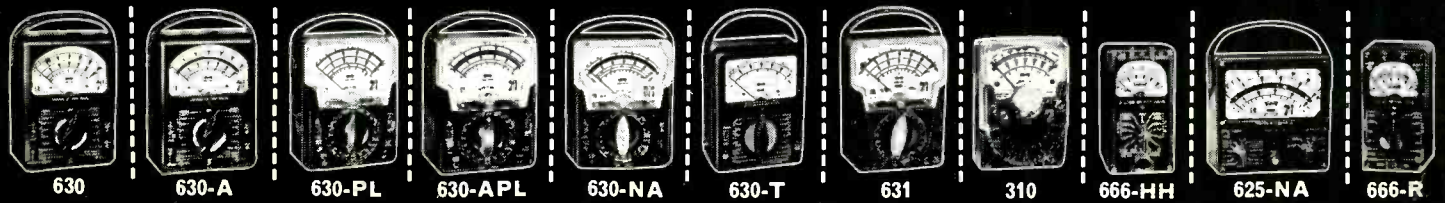

630 | 630-A | 630-PL | 630-APL | 630-NA | 630-T | 631 | 310 | 666-HH | 625-NA | 666-R

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FEBRUARY, 1958

Radio-Electronics

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EDITORIAL

ELECTRONICS

AUDIO—HIGH FIDELITY

TELEVISION

RADIO

TEST INSTRUMENTS

ON THE COVER

(story on page 53)

Printed-circuit rotary switch plugs into circuit board. This type unit is used in Allied Radio's Knight-Kits to simplify construction.

Color Transparency by Tom McKeown

RADIO-ELECTRONICS is Indexed in *Applied Science & Technology Index* (Formerly *Industrial Arts Index*)

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News Briefs

HEAT TO ELECTRICITY by direct conversion has been achieved in a unique electronic device. This thermionic converter, invented by Dr. Volney C. Wilson and developed at General Electric Research Laboratory, is based on the principle of boiling electrons out of a hot metal surface in a manner somewhat analogous to the "contact-potential" effect in ordinary electron tubes. Experimental converters of this type change more than 8% of the heat energy into electric power. The photo shows Dr. Wilson with his invention.

Not yet a commercial product, the converter has no moving parts. Two electrodes within the device are kept at high—but different—temperatures. Electrons boiled out of the hotter electrode flow to the cooler one, producing

an electric current. New approaches to electrode design and the gas within the envelope have increased efficiency.

Previous methods of converting heat to electricity have been based on the thermocouple, but this device's efficiency is normally well below 1%. An important difference between the thermionic converter and the thermocouple is that in Dr. Wilson's device the metals are separated by a gas. There is an electrical flow between the electrodes, but a smaller amount of heat transfer. Thus the electrodes can be at different temperatures, greatly increasing efficiency. In the thermocouple both elements are at the same temperature.

THE FIRST STEREO DISC available to the public is now on sale. It sells at $5.95, the manufacturer's standard price for high-fidelity records. Produced by the 45/45 Westrex stereo-disc system (see "Single-Groove Stereo Discs," RADIO-ELECTRONICS, January, 1958), the disc is made by Audio Fidelity Inc. The industry has not yet decided whether the 45/45 or the vertical-lateral system will be universally adopted. It is therefore unlikely that there will be any great mass production of records (or pickups) till standards are agreed on.

The new disc is similar to conventional records in size and appearance. It features "The Dukes of Dixieland" on one side and "Railroad Sounds" on the other.

STEREO-DISC PLAYBACK CARTRIDGE is now in limited production. Developed to play back the 45/45 Westrex stereo disc (see "Single-Groove Stereo Discs," RADIO-ELECTRONICS, January, 1958), the new cartridge is made by the Fairchild Recording Equipment Co.

It is a moving-coil type consisting of two coils—one placed inside the other and mounted at right angles to each other at 45° to the vertical axes. This system lets you use the cartridge with stereo or standard recordings since connecting the coils in series bucking causes the pickup to respond only to lateral excitation. Connect the coils in series adding, and the pickup will respond only to vertical excitation.

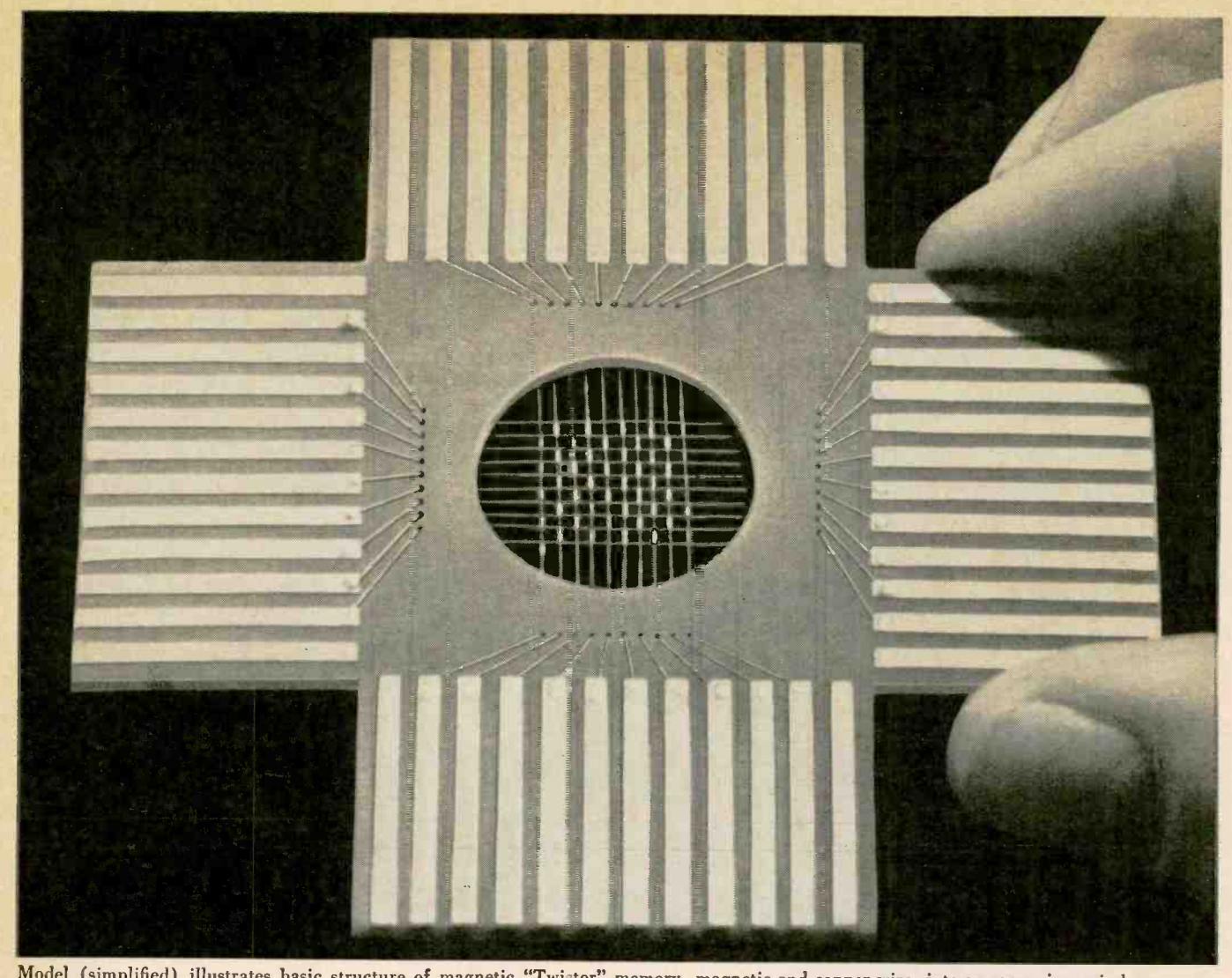
Cross-talk between channels is attenuated by approximately 20 db at 1,000 cycles. The cartridge uses a 0.5-mil diamond stylus and delivers approximately 3 mv per channel.

Due to its physical size, the cartridge cannot be mounted in standard pickup arms and because of this and other problems—associated with compliance, resonance and arm mass—it is supplied mounted in a specially modified pickup arm. The price is about $250.

FASTEST ELECTRONIC PRINTER, designed to turn out 4,680 100-character lines of copy per minute (about 65 feet) is 5 to 10 times faster than existing electromechanical printers. Combining their Charactron tube and the Haloid Co.'s Xerox Copyflo printer, this Stromberg-Carlson instrument has applications in electronic-computer readout, preparation of bank statements, billing, insurance notices, manufacturing control reports, addressing labels and other work in which a large amount of printing must be done in a short time.

In the unit (model S-C 5000), electrical input pulses are translated into a display of numbers, letters and symbols by a Charactron shaped-beam tube. (See "Charactron Tube Has Many Commercial Applications," RADIO-ELECTRONICS, October, 1953.) Inside the tube, which is similar to a TV picture tube, an electron gun shoots its beam through tiny letter-shaped openings

(*Continued on page* 10)



Model (simplified) illustrates basic structure of magnetic "Twistor" memory—magnetic and copper wires interwoven as in a window screen. Twisted condition of the magnetic wire shifts preferred direction of magnetization from a longitudinal to a helical path. One inch of twisted wire, thinner than a hair, can store as much information as ten ferrite rings. "Twistor" was invented at Bell Laboratories by Andrew Bobeck, M.S. in E.E. from Purdue University.

New twist in memory devices

An ingenious new kind of magnetic memory has been developed by Bell Laboratories scientists for the storage of digital information. Known as the "Twistor," it consists basically of copper wires interwoven with magnetic wires to form a grid.

"Twistor" gets its name from a characteristic of wire made of magnetic material. Torsion applied to such a wire shifts the preferred direction of magnetization from a longitudinal to a helical path. This helical magnetization has been applied to produce a magnetic storage device of unprecedented capacity for its size.

In a magnetic memory, information is stored by magnetizing a storage element. In conventional memories the storage elements consist of rings of ferrite. In the "Twistor," they consist of tiny segments of hair-thin magnetic wire. At each intersection of the grid, one such segment is capable of storing a binary digit.

The "Twistor" is simple and economical to fabricate, and its minute energy requirements are easily supplied by transistor circuits. Bell Laboratories engineers see important uses for it in future telephone systems which demand the compact storage of much information, as well as in digital computers for civilian and military applications.

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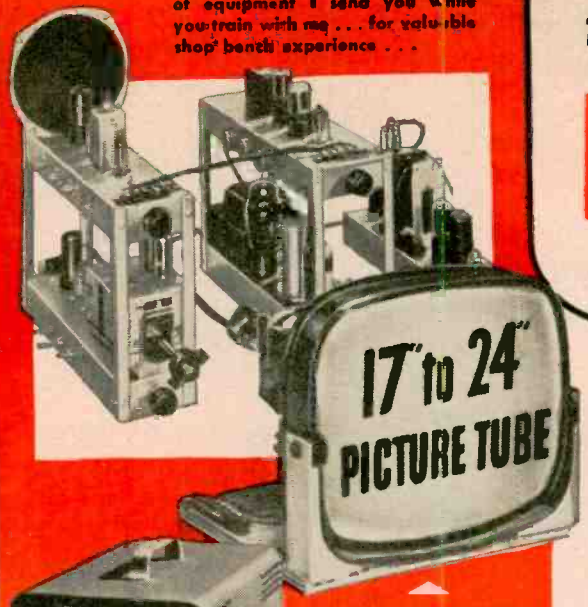

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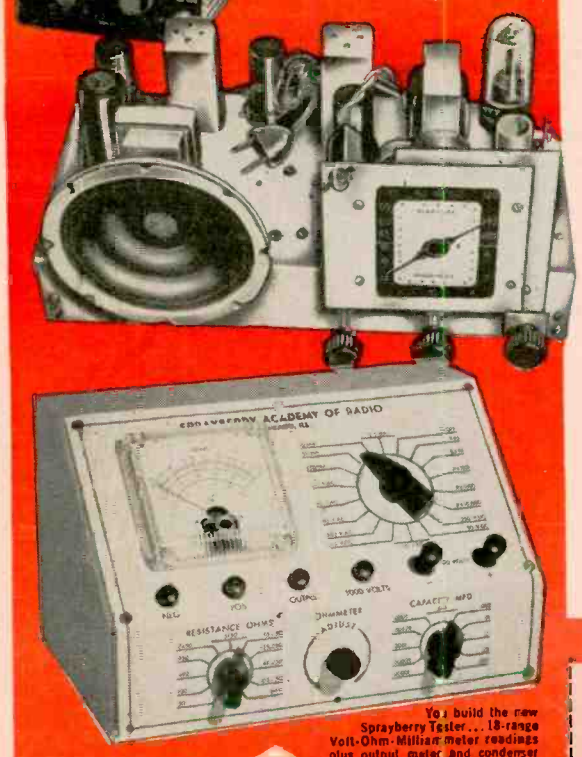

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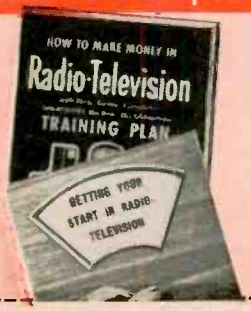

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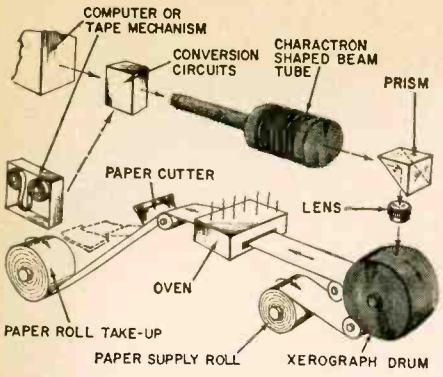

which form it into characters. The formed beam is then deflected electrostatically to the desired spot on the screen.

In the xerographic process these characters are optically projected onto the charged surface of a rotating selenium-coated drum. The images are developed with a colored-pigment powder, which is attracted by electrostatic charges on the portions of the drum that were exposed to light. At the point where the drum comes in contact with a moving strip of paper the powder is transferred from the drum to the paper. This is done by placing an electrostatically charged plate behind the paper. The charge on this plate is stronger than that on the drum and pulls the powder to the paper. The paper continues on through an oven that "fixes" the powder and on to the machine's output. As the drum continues to turn the exposed surfaces are automatically brushed clean and are ready to use again.

MULTIPLEX DEADLINE PUT OFF till March 1. This date represents an extension, by the FCC, to allow FM stations engaged in functional music operations additional time to convert from simplex to multiplex operation. (See "Multiplexing and You" in RADIO-ELECTRONICS, October, 1957.) Waivers to allow simplex operation beyond this date will be considered if the station shows that it is converting but cannot meet the March 1 deadline.

NO NEW TV STARTERS since January publication of our *Television Station List.*

The only change to note is in Albany, N. Y., where WCDA changed its call letters to WTEN and switched from uhf channel 41 to vhf channel 10. At the same time, it dropped its satellite in Hagaman, N. Y. (WCDB, channel 29).

Our count of US operating stations is 519 (429 vhf and 90 uhf), which includes 28 noncommercial (6 uhf).

DR. W. R. G. BAKER has retired from his position as a vice president of the General Electric Co. after 34 years with the firm. Dr. Baker, whose initials identify the pioneer television station in Schenectady (WRGB), has been appointed vice president for research of Syracuse University, N. Y. In his new position he will be responsible for

directing the University's contract research program.

During the years, Dr. Baker has been honored by the nation's leading professional and business associations for his contributions to the electronics industry. He has served as president of the IRE, is currently serving a second term as president of EIA (RETMA) and has received the highest awards granted by these groups—their medals of honor. He also holds the Army's Medal of Freedom citation for his advice and guidance on the problems of utilizing electronic devices to the maximum extent in modern warfare.

In March of this year he will receive the IRE's Founders' Award. This is bestowed on special occasions to outstanding administrative leaders in the radio and electronics fields.

Among his best known contributions to the electronics industry is the organization and direction of two national television system committees which recommended engineering standards to the FCC, paving the way for commercial monochrome telecasting in 1941 and color TV in 1953.

ELECTRIC EYE SENSES RADIATION. A new photoelectric device for counting or intruder alarm purposes uses a small amount of Strontium-90 to replace the light bulb found in conventional systems. It can be used where dust or smoke might obstruct a light beam and give a false indication. The need for a power source for the lamp is also eliminated. According to Paul Weisman and Stanley L. Ruby, Westinghouse engineers who reported the new device to the recent American Institute of Electrical Engineers meeting in Chicago, its advantages are high reliability and long periods of operation without repair. The beam produced by the radioactive material is not affected by shock, temperature or almost any other condition. A cadmium sulfide photocell picks up the radiation and a transistor amplifier strengthens the current to trigger other electronic circuits.

TAPE RECORDING is being recognized as an important and upcoming art which may face a manpower shortage in the near future. The Audio Engineering Society (AES) has announced that it is sponsoring a series of weekly lectures "The Principles and Practices of Tape and Disc Recording."

(*Continued on page* 18)

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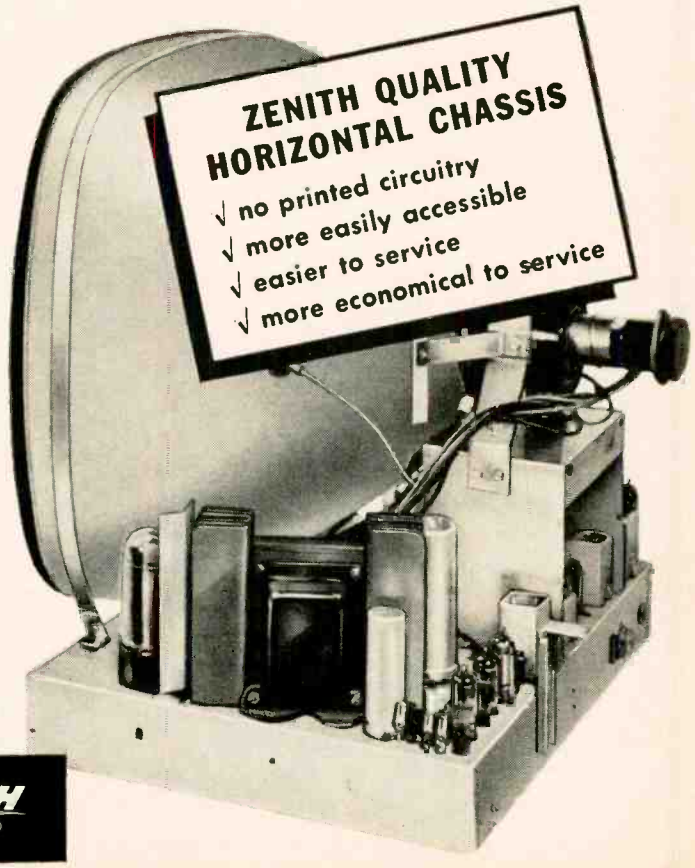

WE THINK IT'S WORTH THE EXTRA COST AND EXTRA CARE OF HANDCRAFTED STANDARD CIRCUITRY TO GET THE BEST PERFORMANCE AND LEAST SERVICE HEADACHES AND SO DO THOUSANDS OF DEALERS WHO WOULD SOONER SELL CUSTOMER SATISFACTION THAN A PRICE TAG!

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CHICAGO 39, ILLINOIS

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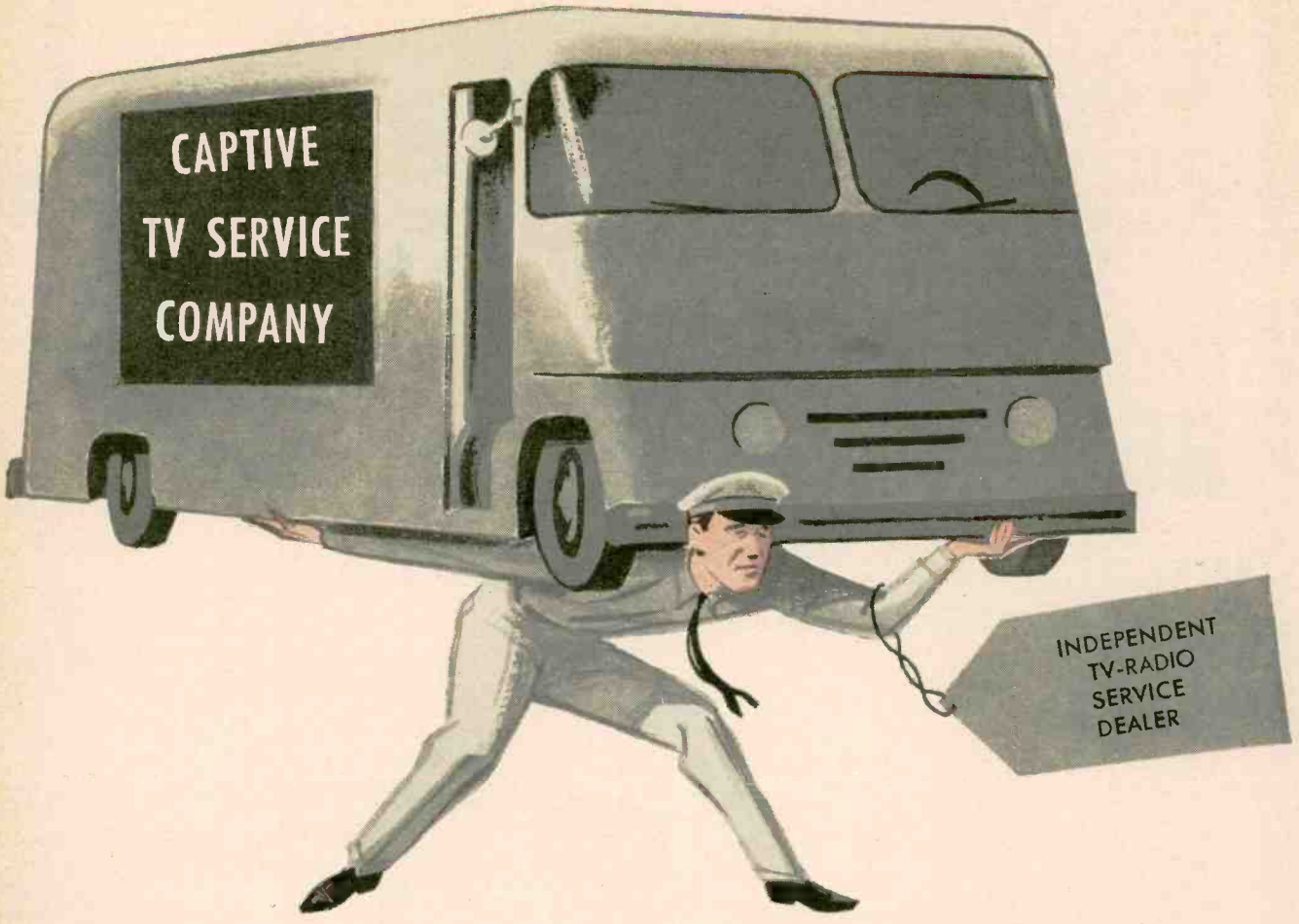
Mr. Independent Service Dealer:

are you helping to support your "competitors"?



Not if you buy and use Raytheon Television and Radio Tubes. Raytheon does not have a factory TV-Radio service organization — does not compete with you in any way for service business. Raytheon believes that TV-Radio service is *your* business and serving you is Raytheon's.

Every time you buy a Raytheon Tube you buy from the first tube manufacturer to help independent service dealers. For more than thirteen years Raytheon, through their Distributors, has offered independent service dealers the many benefits of the Raytheon Bonded Dealer Program. Support through national advertising, Western Union Operator 25 service and Group Life Insurance are among other business building dealer helps that Raytheon has pioneered for "independents".

But most important of all, Raytheon makes TV and Radio Tubes that are ideal for all replacement work, because they are designed to provide quality performance in all makes and models of TV and Radio sets. Use them with complete confidence that they are best for you . . . and for your customers, too.

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Fifteen lectures are planned. The series begins Feb. 20 at the RCA Institutes in New York City and continues for 15 weeks. A fee of $35 for members of AES, $50 for non-members, is being charged, but even with this slight deterrent, a large group of future tape recording engineers is expected.

Calendar of Events

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

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

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

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

EIA Industrial Relations Conference, Feb. 20–24, Town & Country Hotel, San Diego, Calif.

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

Hi-Fi Music Show, Mar. 7–9, Penn-Sheraton Hotel, Pittsburgh, Pa.

Hi-Fi Music Show, Mar. 21–23, Hotel Robert Treat, Newark, N. J.

IRE Show, Mar. 24–27, New York Coliseum, New York, N. Y.

Hi-Fi Music Show, Mar. 28-30, Lord Baltimore Hotel, Baltimore, Md.

Instruments and Regulators Conference, Mar. 31–April 2, University of Delaware, Newark, Del.

IMPROVED PHYSICS COURSES for high schools and colleges with the aid of television is a new aim of the American Institute of Physics. Prof. Grant O. Gale, on leave from the Physics Department of Grinnell College, Iowa, is making a nationwide survey to determine how effectively television can be used to provide physics teaching where none now exists, and to supplement and strengthen the effectiveness of present physics teachers at high-school and college levels. Other aims of the institute are: to make the study of a physics course a must for every secondary school student. To encourage *qualified* young people to seek careers in physics. To strengthen physics instruction in high schools and colleges for non-science majors.

NARTB CHANGES NAME. The National Association of Radio & Television Broadcasters has returned to its former name—National Association of Broadcasters (NAB). The change went into effect Jan. 1. Members voted to revert to the shorter name, feeling that it clearly includes both TV and radio.

TV VIEWING NOW OCCUPIES 11.5 evening hours a week, according to Cunningham & Walsh's 10th Annual Videotown Survey. Television has had other effects too. Entertaining and visiting have gone up from 12 to 20%. Movie attendance is less than ⅔ its pre-TV level. Magazine reading is still going down while newspapers have scarcely been affected. Radio listening shows a steady increase, but is still well below pre-TV level. END

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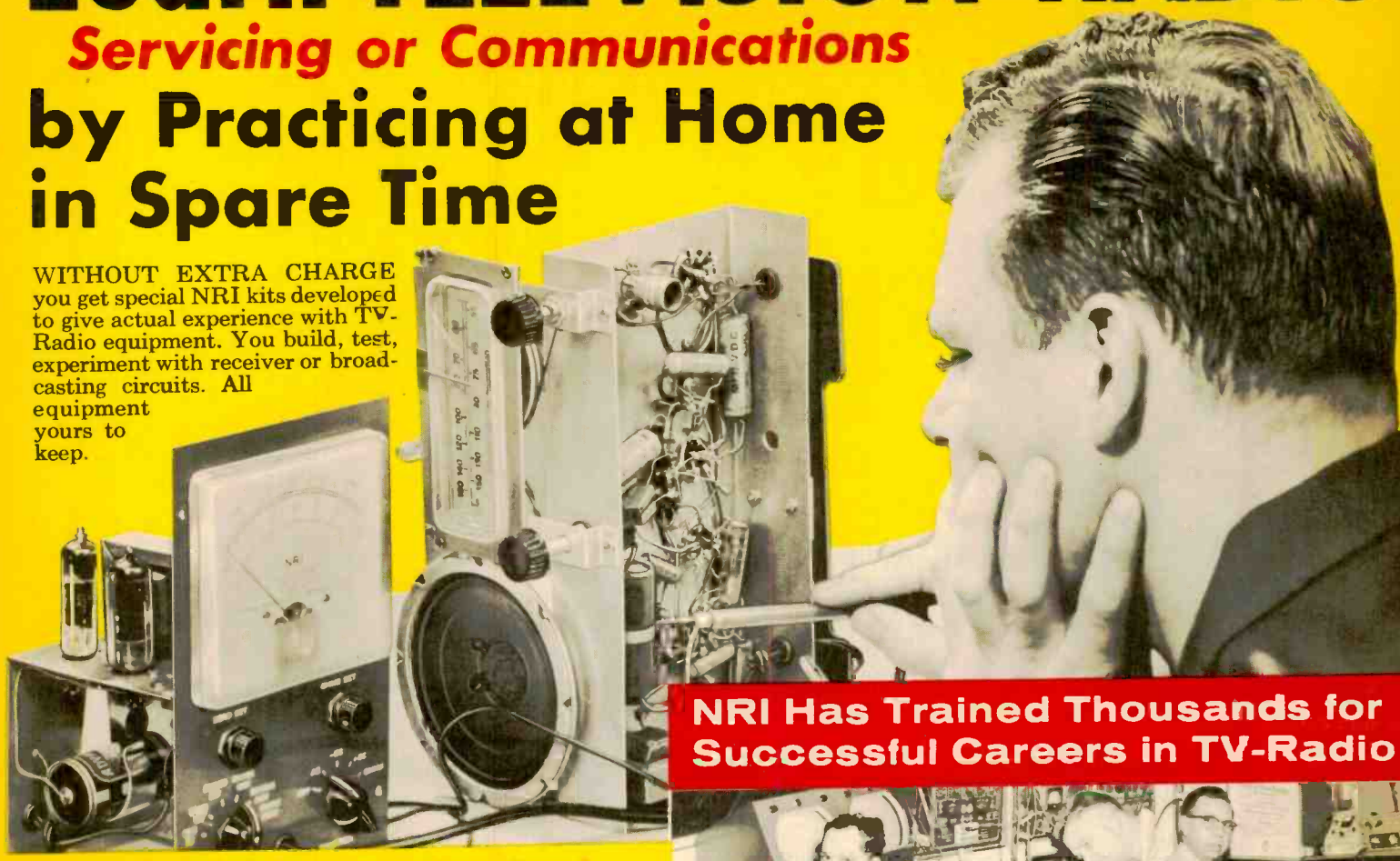
Servicing or Communications

by Practicing at Home in Spare Time

WITHOUT EXTRA CHARGE you get special NRI kits developed to give actual experience with TV-Radio equipment. You build, test, experiment with receiver or broadcasting circuits. All equipment yours to keep.



NRI Has Trained Thousands for Successful Careers in TV-Radio

Studio Engr., Station KATV
"I am now Studio Engineer at Television Station KATV. Before enrolling for the NRI Course, I was held back by limitation of a sixth grade education." BILLY SANCHEZ, Pine Bluff, Ark.

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

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

Have the High Pay, Prestige, Good Future of a Skilled TV-Radio Technician

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

Increased Opportunities in Growing Field

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

More Money Soon—Make $10 to $15 a Week Extra Fixing Sets in Spare Time

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

Act Now—See What NRI Can Do for You

NRI has devoted over 40 years to developing simplified practical training methods. You train at home. Get practical experience, learn-by-doing. Address: **NATIONAL RADIO INSTITUTE, Washington 16, D. C.**

The Tested Way To Better Pay

See Other Side

CUT OUT AND MAIL CARD NOW

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This card entitles you to Actual Lesson on Servicing, shows how you learn Television-Radio at home. You'll also receive 64-Page Catalog.

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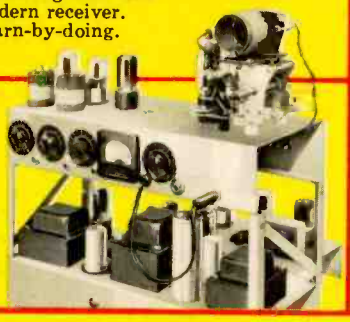
NRI Servicing Course includes all needed parts. By introducing defects you get actual servicing experience practicing with this modern receiver. Learn-by-doing.

YOU BUILD Signal Generator

You build this Signal Generator. Learn how to compensate high frequency amplifiers, practice aligning typical I.F. amplifiers in receiver circuits. Make tests, conduct experiments.



YOU BUILD Broadcasting Transmitter

As part of NRI Communications Course you build this low power Transmitter, learn commercial broadcasting operators' methods, procedures. Train for your FCC Commercial Operator's License.

YOU BUILD Vacuum Tube Voltmeter

Use it to earn extra cash fixing neighbors' sets; bring to life theory you learn from NRI's easy-to-understand texts.

For Higher Pay, Better Jobs
Be a Television-Radio Technician

Servicing Needs More Trained Men

Portable TV, Hi-Fi, Transistor Radios, Color TV are making new demands for trained Technicians. Good opportunities for spare time earnings or a business of your own.

Broadcasting Offers Satisfying Careers

4000 TV and Radio stations offer interesting positions. Govt. Radio, Aviation, Police, Two-Way Communications are growing fields. Trained Radio-TV Operators have a bright future.

J. E. Smith, Founder

Train at Home the NRI Way Famous for Over 40 Years

NRI is America's oldest and largest home study Television-Radio school. The more than 40 years' experience training men for success, the outstanding record and reputation of this school—benefits you in many ways. NRI methods are tested, proven. Successful graduates are everywhere, from coast to coast, in small towns and big cities. You train in your own home, keep your present job while learning. Many successful NRI men did not finish high school. Let us send you an actual lesson, judge for yourself how easy it is to learn.

No Experience Necessary—NRI Sends Many Kits for Practical Experience

You don't have to know anything about electricity or Radio to understand and succeed with NRI Courses. Clearly written, well-illustrated NRI lessons teach TV-Radio-Electronic principles. You get NRI kits for actual experience. All equipment is yours to keep. You learn-by-doing. Mailing the postage-free card may be one of the most important acts of your life. Do it now. Reasonable tuition. Low monthly payments available. Address: **NATIONAL RADIO INSTITUTE, Washington 16, D. C.**

NRI Graduates Do Important Work

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"Had no other training in Radio before enrolling, obtained job working on TV amplifiers before finishing course. Now Quality Control Chief." T. R. Favaloro, Norwich, N. Y.

NRI Course Easy to Understand
"I opened my own shop before receiving my diploma. I have had to hire extra help. I am independent in my own business." D. P. Cressey, Stockton, Cal.

Works on Color-TV
"NRI changed my whole life. If I had not taken the course, probably would still be a fireman, struggling along. Now Control Supervisor at WRCA - TV." J. F. Meline, NewYork, N Y.

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See Other Side for more information on the Tested Way to Better Pay

Correspondence

MAXIMUM IS THE WAY

Dear Editor:

Hooray for Art Margolis' article, "Do You Do a Maximum or Minimum Job," in the December, 1957, issue. I have used his method since I started my business, four years ago. I have 1,600 customers and keep another man working full time. My increase in new customers is about 30 per month, all taken from competitors. Apparently *MAXIMUM* service is what people tell their friends about. Hats off to Margolis, but I don't want him in Independence as a competitor—I like the ones I have!

WALT STEVENSON

Independence, Mo.

STOP PAY TV

Dear Editor:

It shocks me to find that there are so many people who would accept pay TV. This is not for me! Never in a million years! TV stations are paid by companies whose advertisements they spout. They get paid plenty too. So now we're going to have to pay the TV companies for the right to watch programs which were made to be watched for the price of the set and a little extra added to our electric bills. Not only that, but we will have to shell out to a group who have absolutely no right to the TV sets of millions of people all over the country. All this, just because they see a quick way to make money.

I'm sure that if enough people get together we could stop pay TV dead in its tracks. I'd sure like to hear of more people who are with me in this matter. I'd like to hear the views of those who are for pay TV too.

The show must go on, but without a little pay box on top of the set! Toll TV must be stopped!

(Name withheld by request)

Brooklyn, N. Y.

DISTORTION IN SPEAKERS

Dear Editor:

Maybe it's time for a disinterested bystander to intervene between Mr. Villchur and Mr. Klipsch. What is *really* important is the maximum intermodulation distortion produced by a long-throw direct radiator such as Mr. Villchur's AR-1. Taking his own figures of ½-inch maximum excursion at 30 cycles and substituting them in Mr. Klipsch's equations, let's calculate what distortion due to Doppler effect is for a frequency of 1,000 cycles, the

crossover frequency of the woofer in Mr. Villchur's AR-1.

According to Mr. Klipsch, the maximum *velocity* of the cone is given by the equation $V = A_o\omega$, where A_o is the maximum displacement (in each direction) and ω is 2π times frequency. Then $V = 0.25 \times 2\pi \times 30 = 47$ inches per second, for an AR-1 woofer at 30 cycles, ½-inch maximum *total* excursion.

The equation for frequency change due to Doppler effect (source moving toward observer) is: $f = f'\left[1 - \frac{V}{v}\right]$, where v is the velocity of sound in air, V the velocity of the source, f the radiated frequency and f' is the apparent frequency heard by the observer. Assuming v is 13,200 inches per second, then $1{,}000 = f'[1 - 47/13{,}200]$. Solving, $f' = 1{,}003/.6$ cycles—the *maximum* frequency distortion due to Doppler effect is only 0.36%, and this is at *maximum* excursion, *lowest* bass frequency and *highest* high frequency. Take a look at intermodulation-distortion ratings of high-power high-quality amplifiers at maximum output and I doubt if you'll find it necessary to worry about distortion introduced by Doppler effect. Granted, the smaller the cone excursion the smaller the distortion due to Doppler effect, but whether the difference is audible on program material is something else again. R. A. Joss
Montreal, Canada

CARTOONS—THE WINNER

Dear Editor:

I'm for more cartoons. You can't beat a good laugh, especially when the joke may have been on yourself.
AL BAKUTIS
Baltimore, Md.

I like 'em—cartoons I mean.
BOB FORREST
Stratford, Okla.

More cartoons! H. MEHRMAN, JR.
Far Rockaway, N.Y.

A speech or sermon gets plenty dull without a little humor, and so would a magazine. *Please*, have a few cartoons.
RUSSELL D. PANGMAN
Flint, Mich.

I would agree with Mr. Dickens that cartoons should be cut out completely unless you receive a really new slant, such as a cartoon on guided missiles or future electronic developments. The space usually used for cartoons could be used as a suggestion box for ideas sent in by readers. My vote is: no cartoons. BLAINE SEVERS
Long Beach, Calif.

As you can see, the overwhelming majority of the letters on the subject has been in favor of cartoons. We regret that RADIO-ELECTRONICS cannot write and thank personally all those who have helped us by expressing their opinions, but we can assure them that the cartoons are definitely in.—*Editor.* END

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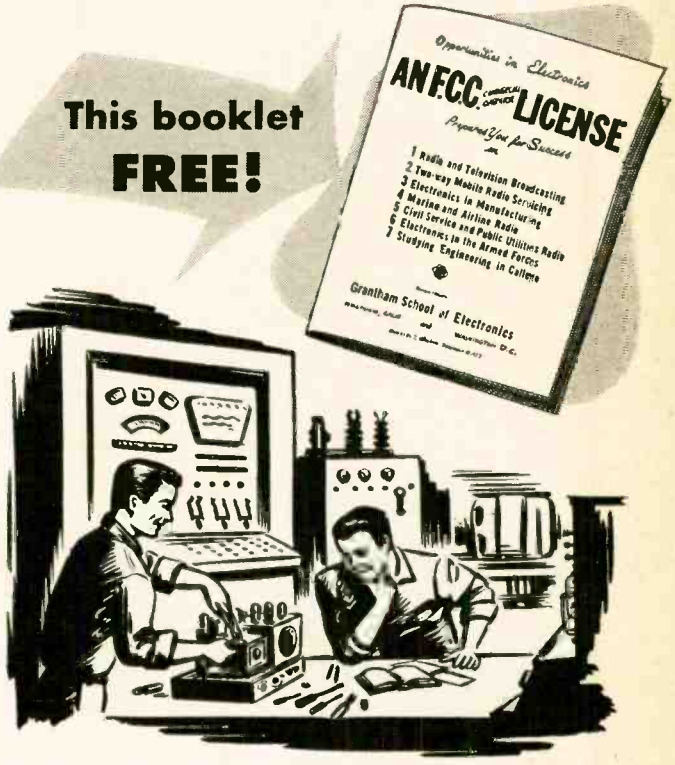

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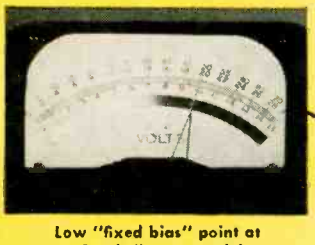
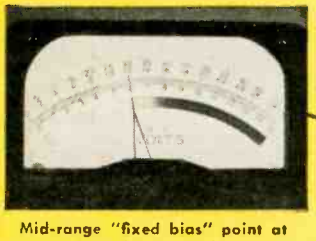
Sylvania IF Amplifier Tubes

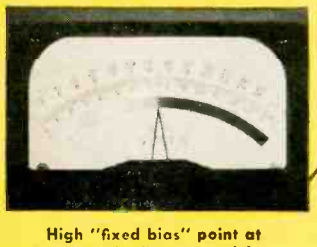
"fixed-bias" tested



Low "fixed bias" point at −1 volt (bottom scale)



Mid-range "fixed bias" point at −3 volts (top scale)



High "fixed bias" point at −7.5 volts (bottom scale)

In determining the plate current (I_b) and Transconductance curves, grid bias is fixed at three points. These points, representing conditions of weak, average, and strong signals establish the nature of the plate current characteristic curve. The "fixed bias" points selected vary according to tube type.

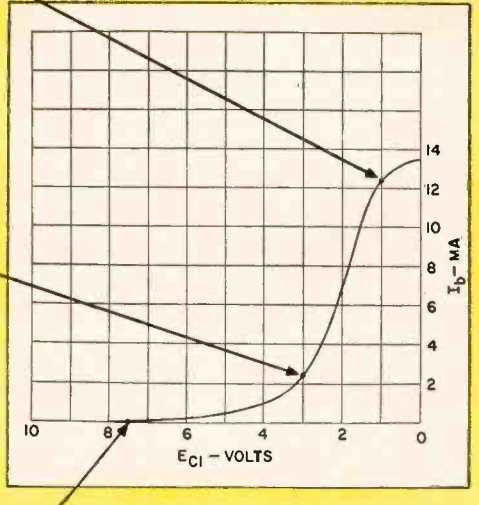


Plate current characteristics, shown on this typical test curve, are carefully controlled by the "fixed bias" test, assuring good performance and stable AGC functioning over a wide range of TV signal conditions.

Dynamic TV set conditions are set up in these test bridges making the "fixed bias" test a true measure of how the tube will perform in TV sets encountered by you in the field.

for stable performance and service dependability

It has always been Sylvania's policy to search for new and better ways to test tubes under dynamic conditions for closer control over performance. The "fixed bias" test is typical of these techniques. It places a more stringent, realistic measure on the tube's ability to perform under varying circuit conditions.

By controlling the plate current characteristics and transconductance of IF amplifier tubes, the "fixed bias" test gives the serviceman an extra measure of dependability regardless of make, model, or age of the TV set serviced.

The range of stable operation is controlled, too, for smooth AGC action over wide variations in signal strength.

These are the same reasons that Sylvania IF types are the choice of leading TV set manufacturers, attested by the wide assortment of Sylvania original types listed among IF tubes now in popular use.

In addition to the "fixed bias" test many other electrical tests are performed on Sylvania IF amplifier types including stability during life. During life tests, close controls are placed on interelectrode leakage.

In every way, Sylvania IF amplifier types offer you maximum assurance of trouble-free service based on sound, newly developed testing methods. Specify Sylvania IF amplifier tubes in the new yellow and black carton.

SYLVANIA

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320 heater voltages.

140 fixed bias potentials.

640 plate voltages.

640 screen voltages.

100 self-bias settings

1000 quality-value sensitivity ranges

Instant shorts indication.

ALL AUTOMATICALLY!

Active card magazine holds over 600 cards instantly available with time saving automatic filing feature.

SEE THE 121 TODAY!

Fully Automatic

Tests any tube in 8 to 12 seconds . . . including handling of tube test data card.

Here is the new, low cost version of the famous Hickok Cardmatic so popular with leading lab engineers. Especially designed for high speed service work, this new 121 is high quality in a lightweight portable . . . and the price is low too.

The Hickok Cardmatic switch sets up all tests automatically and eliminates fussing around with adjustments. You can accurately check a tube for dynamic mutual conductance, controlled emission, cutoff point "Knee" point, shorts, leakage, gas and voltage drop . . . and rectifier tubes at their rated loads. Any way you look at it, this new automatic tube testing machine will be helpful to you in your work. It will pay for itself in a very short time . . . and give you many years of accurate dependable service.

The new 121 incorporates a fully automatic mechanism actually incorporating 187 individual switches providing an almost unlimited number of voltage combinations to any tube element. This mechanism has been life tested in a cycling process over 100,000 times—without fail, and has proven superior to all other switching arrangements.

Now is the time to . . .
TRADE UP TO A HICKOK

Ask for a demonstration of the new 121 or write for descriptive literature.

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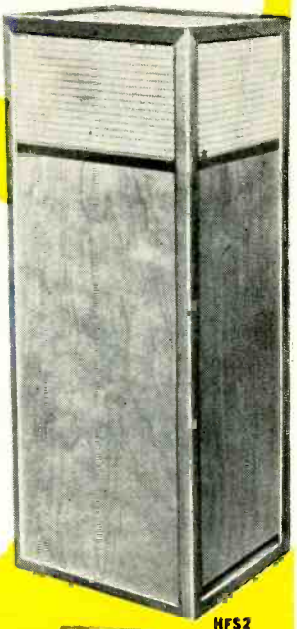

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BETTER ENGINEERING Since 1945 EICO has pioneered the concept of test instruments in easy-to-build kit form — has become world-famous for laboratory-precision instruments at low cost. Now EICO is applying its vast experience to the creative engineering of *high fidelity*. Result: high praise from such authorities as Canby of AUDIO, Marshall of AUDIOCRAFT, Holt of HIGH FIDELITY, Fantel of POPULAR ELECTRONICS, Stocklin of RADIO TV NEWS, etc. — as well as from the critical professional engineers in the field.†

SAVE 50% Mass purchasing, and a price policy deliberately aimed to encourage mass sales, make this possible.

EASY INSTRUCTIONS You need no previous technical or assembly experience to build any EICO kit — the instructions are simple, step-by-step, "beginner-tested."

DOUBLE 5-WAY GUARANTEE Both EICO, and your neighborhood distributor, guarantee the parts, instructions, performance . . . as well as *lifetime* service and calibration at nominal cost . . . for any EICO kit or wired unit.

BEFORE YOU BUY, COMPARE At any of 1200 neighborhood EICO distributors coast to coast, you may examine and listen to any EICO component. Compare *critically* with equipment several times the EICO cost — then *you* judge. You'll see why the experts recommend EICO, kit or wired, as best buy.

† Thousands of unsolicited testimonials on file.

HFT90 FM Tuner with "eye-tronic" tuning

HF61 Preamplifier

HF60, HF50 Power Amplifiers

HFS2 Standard Speaker System — revolutionary new generic type of system — incorporates the slot-loaded conical horn** and omni-directional cone tweeter.** More sonic detail, more **naturally,** throughout the audio spectrum. No other commercially available system approaches it in over-all musical quality & technical excellence. 45-20,000 cps essentially flat; clean useful range 30-40,000 cps. Impedance 16 ohms. HWD: 36" x 15¼" x 11½". **In Walnut or Mahogany, $139.95. In Blonde, $144.95.**

HFT90 FM Tuner equals or surpasses wired tuners up to 3X its cost. New, pre-wired, pre-aligned, temperature-compensated "front end" — drift-free. Sensitivity, 1.5 uv for 20 db quieting, is 6X that of other kit tuners. DM-70 traveling tuning eye. Response 20-20,000 cps±1 db. Cathode follower & multiplex outputs. **Kit $39.95*, Wired $65.95*. Cover $3.95. *Less cover, excise tax incl.**

HF61A Preamplifier, providing the most complete control & switching facilities, and the finest design, offered in a kit preamplifier, " . . . rivals the most expensive preamps . . . is an example of high engineering skill which achieves fine performance with simple means and low cost." — Joseph Marshall, AUDIOCRAFT. **HF61A Kit $24.95, Wired $37.95, HF61 (with Power Supply) Kit $29.95. Wired $44.95.**

HF60 60-Watt Ultra Linear Power Amplifier, with Acro TO-330 Output Transformer, provides wide bandwidth, virtually absolute stability and flawless transient response. " . . . is one of the best-performing amplifiers extant; it is obviously an excellent buy." —AUDIOCRAFT Kit Report. **Kit $72.95. Wired $99.95. Matching Cover E-2 $4.50.**

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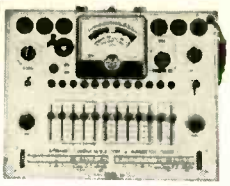

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COMPLETE with steel cover and handle.

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KIT $26.95 WIRED $39.95

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

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FUTURE TV POSSIBILITIES

. . . *The Greatest TV Developments Are Still to Come*

WHILE the fundamental idea of television goes back to 1884, when Paul Nipkow in Berlin invented the scanning disk, he never evolved a practical system, mainly because no fast photo-electric cells then existed. Practical television dates back only to the late thirties, a brief 20 years—much too short a time to evolve completely such a complex technical art.

There is no question at all that the truly great and important TV inventions still lie in the future. As all television scientists well know, we have hardly begun to exploit TV, compared to what the art will be 50 to 100 years hence, and in the still more distant future.

With color TV already achieved in a measure, its technical simplification is the coming goal. A single-gun cathode-ray tube is considered the next urgent step if the price structure of color sets is to match that of black-and-white receivers. We are confident that this problem will be solved soon.

Another step ahead will be the elimination of the present excessive high-voltage system of from 16,000 to 25,000 volts. It appears that in the near future *electroluminescence* or similar means, now in the laboratory, may be the answer. *Flat* electroluminescent TV tubes, it would appear, might be made to work well at 120 to 250 volts and less.

The long-heralded three-dimensional TV picture, of which we have spoken for years, seems to be closer to reality, too. It certainly is in the cards during the next 5 years.

TV Miniaturization is proceeding slowly and, while we have made a start with portable TV receivers, they are still far from the future cigar-box size. They remind us of the 1925 portable radios, weighing 40 pounds. Nor are our regulation portable TV's now battery-operated as were the 1925 portable radios. Today's perambulating TV receivers are still dependent on an outside current supply. Transistor, battery-operated, printed-circuit TV receivers will certainly appear in the foreseeable near future. Such truly portable sets with 6 x 4-inch screens will assuredly find a wide demand, provided the prices are within reason.

Still smaller TV receivers? Certainly. They are bound to evolve with the advancing art. In that direction we wish to propose the:

TV Wristime. This would be a TV worn on the wrist, *but having no watch.* The exact time is read on a miniature screen about 1-½ x 1-inches. The time is read when you press a tiny projection on the side of the pseudo "watch," thus: *11:45 AM* in good-sized figures. The time would flash every minute from a local *TV time station* operating on a quasi-*radioptical* frequency. Commercials would come on for about 50 seconds, between time announcements. Other TV stations might be tuned in by turning the central knurled stem on the TV "watch." The antenna could be the insulated "watch" housing or a ferromagnetic type within the plastic "watch" body. Wholly transistorized, with miniature chemical or isotope-atomic batteries and electroluminescent screen, the TV-Wristime is a distinct possibility for the future.

TV Phantomcast, first described here, will appear a startling idea, yet is based upon good science. The idea is to project a person or persons, or an entire scene, directly from a TV receiver into the middle of your living room! Fantastic? Not at all. It is an optical illusion, as indeed is the image you take for granted on your present-day TV receiver. The picture you see is but a small spot of light—a rapidly traced light ray on your fluoroscreen. The persistence of vision of the enormously fast moving light beam gives you the illusion of a picture in motion.

The phantomcast is based on a different optical principle. Here you use, for example, a bouquet of flowers, placed upside down. The picture of the flowers is then projected into a concave mirror and reflected forward above an empty vase. (See page 152) *Magically, now, the flowers appear right side up in the vase.* This is a *real* picture, too, which you can actually photograph. Similar optical illusions have been used for several generations in baffling stage illusions where a girl or magician appears magically in space.

The same optical principle will, in the future, be used to project a television picture forward several feet from the TV screen into the room, so that the President of the US or actors will appear directly in our midst. It is possible that the present-day cathode-ray picture tube will not be the best means to use in a phantomcast, because it will be difficult, although not impossible, to project the picture rearward to bring it to a focal point to center the phantom from 5 to 7 feet from the receiver. Electronically, there are several ways to phantom part of the picture. One would be by the multiplexing method. Technically, we feel that there are no insurmountable difficulties in the way of "phantomcasting". We are aware, also, that phantomcasting will not be accomplished tomorrow—it is strictly a solvable problem for the future, but we are convinced it will come about.

—*H.G.*

THE JODRELL BANK RADIO TELESCOPE

An outstanding pioneer in radio astronomy takes us on a guided tour of the world's largest radio telescope

By PROF. A. C. B. LOVELL*

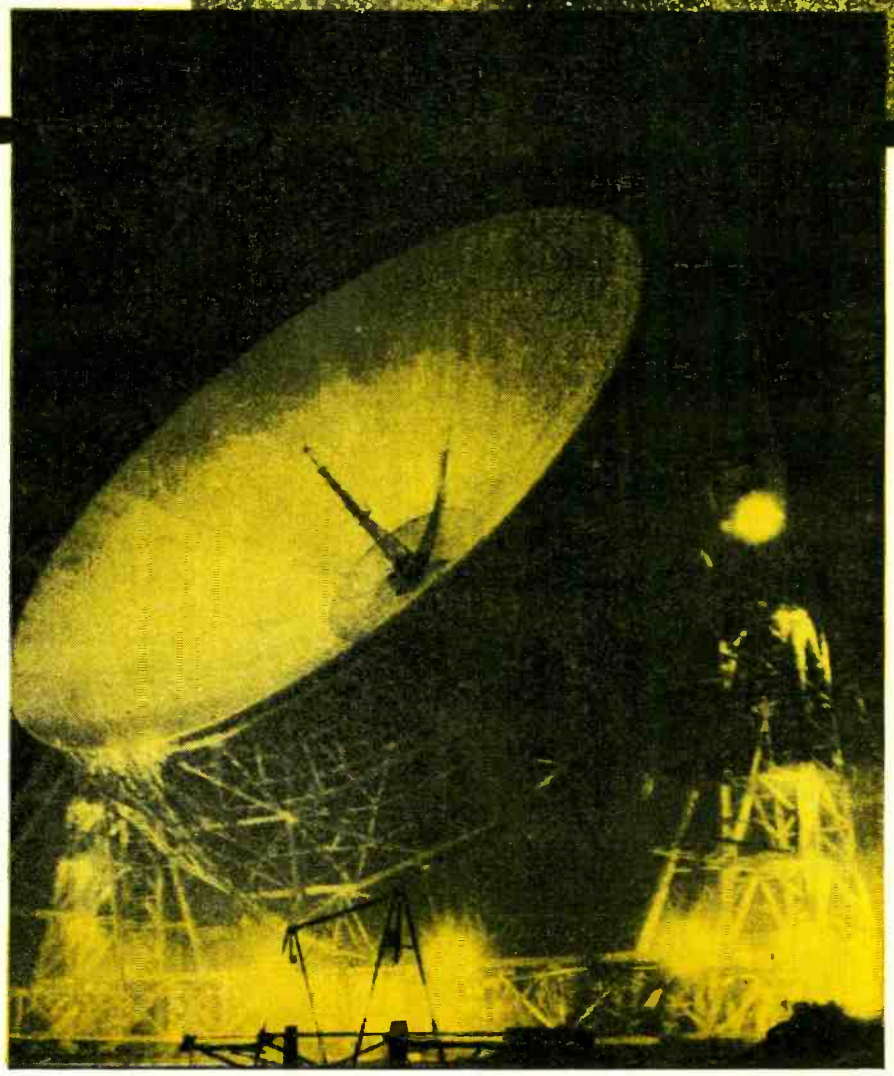
DURING the night of Aug. 2, 1957, the great radio telescope at Jodrell Bank, in Cheshire, England, received its first signals from outer space. A few nights later the region of the sky containing the intense radio source in Cassiopeia was scanned with the telescope in motion. Data obtained in a few hours equalled that from a month's work with previous radio telescopes, and these were only the preliminary test of the instrument.

The telescope is essentially a paraboloidal steel bowl 250 feet in diameter, with its focus in the aperture plane (straight up from the center), built so it can be directed toward any part of the sky. The total weight above ground of the moving structure is 2,000 tons. In principle the motion of the telescope is altazimuth (vertical and horizontal). The bowl, which weighs about 700 tons, is driven vertically by a Ward-Leonard speed-control drive system through two 27-foot racks from the dismantled battleship Royal Sovereign. These are mounted 170 feet above ground on two towers which rotate on a 350-foot circular railroad track to provide horizontal movement.

The drive is through two bogies (see photo) under each tower, again through a Ward-Leonard system. Four additional bogies, which are not powered, serve as wind carriages on each side of the structure. The towers are connected near ground level through a heavy pivot which is the fundamental locating part of the telescope. Power and instrument cables come through this central pivot into a motor room situated within the diametral girder immediately above the central pivot. This room contains the motor generator sets and controls for the Ward-Leonard systems.

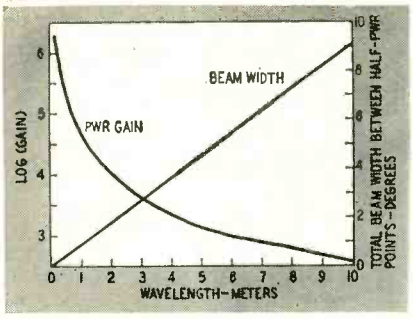
The 17-foot double-gauge railroad track on which the telescope rotates is mounted on deep-piled foundations which extend 90-feet underground in some places. The various power, control and instrument cables are taken into an annular laboratory below the central pivot and then through an underground tunnel to the control room. This control room houses the main control racks and console. The computer sytem consists of synchro resolvers (which resolve vectors into two mutually perpendicular components) working in servo loops to solve the necessary equations so the telescope can track a star's movement.

A wide range of movements can be selected at the control desk—for example, automatic sidereal (star tracking) motion at a given right ascension and



At night, outlined by the glare of floodlights, the massive structure scans the skies.

*Director of the Jodrell Bank Experimental Station, University of Manchester.



Calculated power gain and beam width of the 250-foot-aperture radio telescope as a function of wavelength.

declination, motion in galactic latitude and longitude, straightforward motion in azimuth and elevation, and various automatic scanning movements with a choice of rasters. Parallax corrections can also be introduced when it is desired to track a body in the solar system. There are no slip rings so that the danger of creating electrical interference is avoided, and the limit of motion is 420°, after which an automatic reversal takes place.

The telescope has a tracking accuracy of at least 12 minutes of arc at speeds up to 4° per minute. The maximum slewing speed is about 22° per minute in azimuth and elevation. The position of the telescope in azimuth and elevation is repeated back to the control room through synchros driven independently of the driving system by accurately machined chain racks. These positions are repeated to an accuracy of ±1 minute of arc.

The reflector

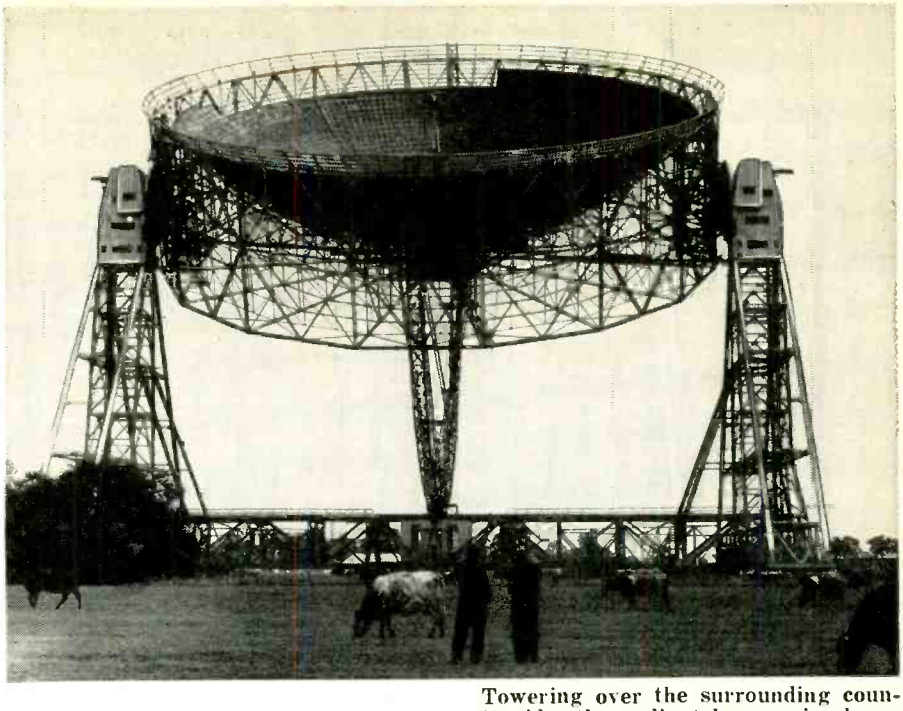
The reflecting membrane is of 1/12-inch-thick steel sheet. It is made from 7,000 individual 3 x 3-foot sections welded to the purlins of the steel framework. It was essential to insure good conductivity across these welded sections, otherwise the membrane would become very lossy at certain wavelengths. The primary antenna feed is carried at the focus on a steel tower built 62½ feet up from the paraboloid's apex. The tower's cross-section diminishes rapidly with height to avoid obscuration and scattering from the primary feed. However, it was essential to design it with enough stiffness to avoid displacement as the bowl turns over.

An important scientific requirement is easy access to the primary feed so that the operational wavelength can be changed readily. The aerial is mounted in a 50-foot steel tube which slides into the top of the aerial tower. With the bowl inverted it can be brought down to ground level and replaced by another 50-foot tube complete with aerial system. The radio-frequency cables from the aerial run inside this tube and can be reached from a small platform near the base of the tower when the bowl is facing toward the zenith.

In much of the work the radio-frequency preamplifiers and other parts of the receiving equipment must be mounted as close as possible to the aerial. These essential units will be kept in a small laboratory which swings underneath the bowl. Further laboratory space is available at the tops of the two towers, but even from these the minimum length of cable run to the primary feed is about 200 feet. Other scientific appartus will be installed on the base girders, but the main recording apparatus will be in laboratories adjacent to the control room.

In preliminary tests, the smoothness of the motion of the telescope in azimuth and elevation has exceeded all expectations, and the power loading has been a small fraction of that available. The theoretical curves showing the beam width and power gain as a function of wavelength are shown in the diagram. On the frequencies used (90 and 160 mc) the experimental values for the beam width and power gain have agreed well with these calculations. Further preliminary tests on frequencies of 408 and 1420 mc are now in progress. Distortions in the bowl are not believed to exceed about 1 inch relative to the focus and very good performance, even on the important hydrogen-line frequency of 1420 mc, is anticipated.

The telescope is adaptable for use either as a receiver for the galactic and extragalactic radio emissions or as a transmitter and receiver for the investigation by radar of meteors and other bodies in the solar system. Some of the tasks for which it will be used follow.



Towering over the surrounding countryside, the radio telescope is shown as it looked just before completion.

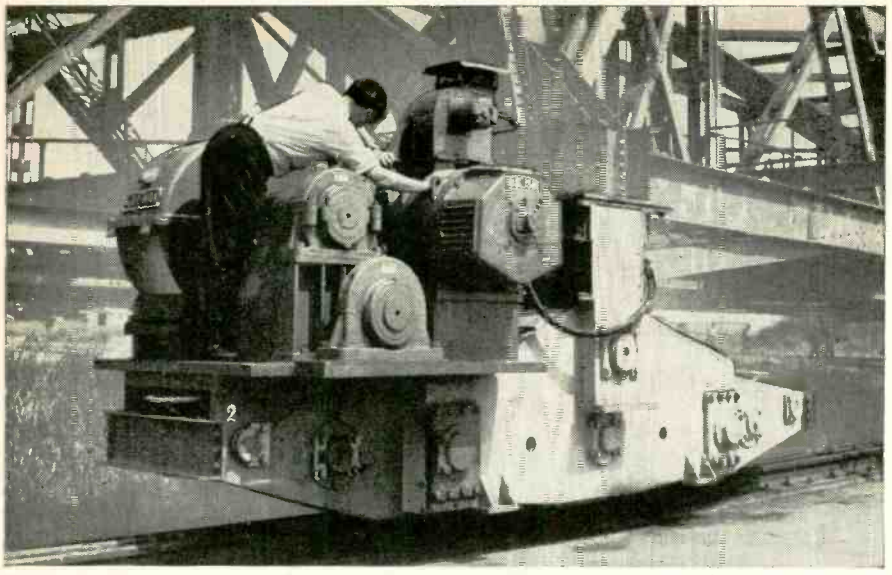
The pioneer observations of Jansky, and later of Reber, showed that the intensity of the radio emission varied markedly with the direction of the aerial beam, being most intense from the direction of the galactic center†. The variation was generally what might be expected if the stars in the Milky Way were responsible for the emission. However, neither Jansky, Reber nor any subsequent worker has succeeded in detecting radio emissions from any of the stars (other than the sun), nor have the localized radio sources since identified coincided with any typical common star. It is possible that Reber's original suggestion, that the radiation is emitted by the interstellar gas, is at least partially true, but the situation is very complex and the question of the origin of these galactic radio emissions will form a prominent part in the program of the new telescope.

Localized radio sources

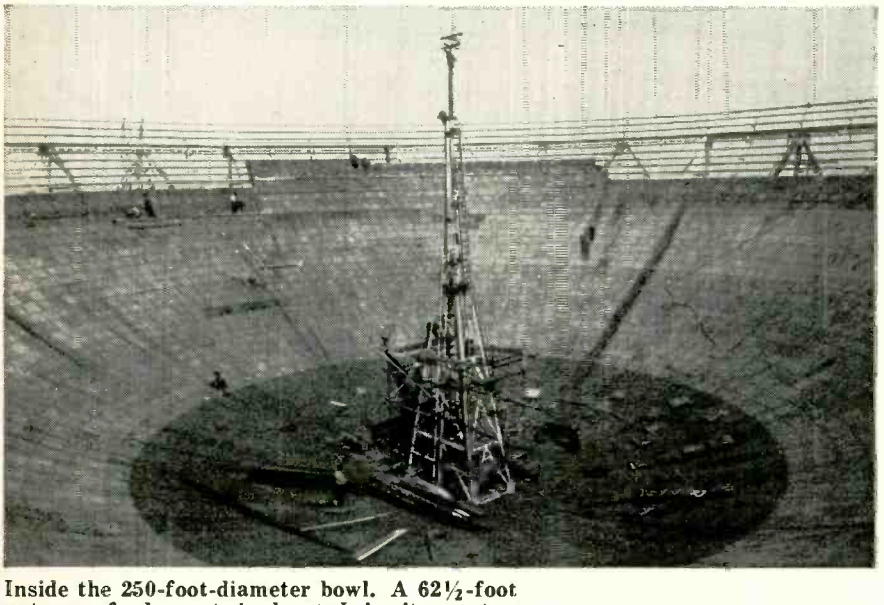
When some of the radiation from space was discovered emanating from localized radio sources, it was tempting to conclude that the background continuum was made up of large numbers of these discrete radio sources, unresolved by the available radio techniques. This situation would be analogous to that in which the Milky Way is viewed by eye or through a low-power telescope, when all faint stars appear as a continuum of light and only the brightest stars stand out individually.

It is now known that this view of the radio emission is untenable. Not only have improved techniqes failed to reveal the increased number of appropriately distributed sources, but the

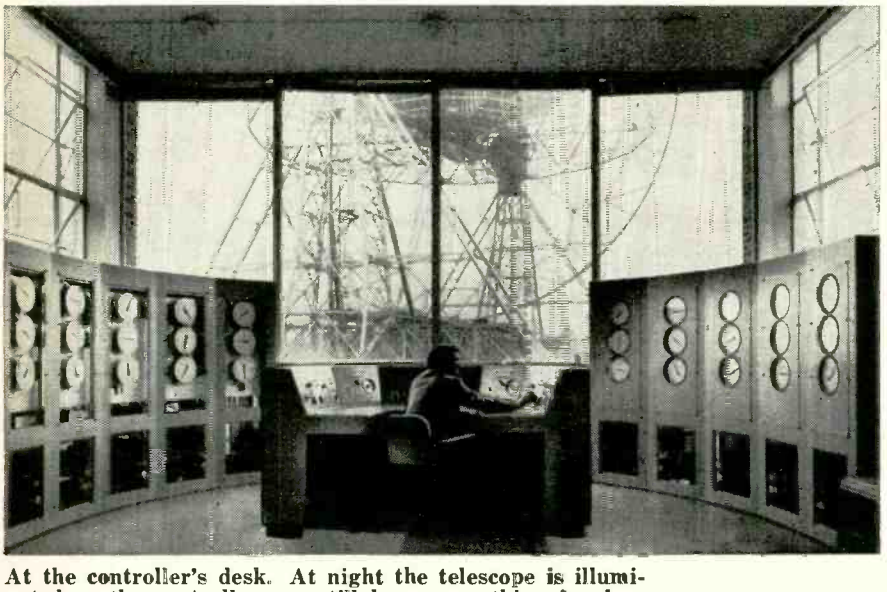
† *Radio Astronomy*, Lovell and Clegg. *Radio Astronomy*, Pawsey and Bracewell. *The Changing Universe*, Pfeiffer.



One of the four powered bogies which rotate the telescope. Eight nonpowered units are also used.



Inside the 250-foot-diameter bowl. A 62½-foot antenna feed mast is located in its center.



At the controller's desk. At night the telescope is illuminated so the controller can still keep everything in view.

spectra of the background and the sources are not compatible.

About 15 or 20 of the localized sources of radio emission satisfy the various criteria, such as appreciable angular extent, intensity and distribution, which makes it highly probable that they are members of the local galaxy. Seven of these have been satisfactorily identified with galactic objects. For example, the radio source in Taurus, which is the third most intense in the sky, is associated with the Crab nebula. The Crab nebula is the expanding gaseous shell of the supernova of 1054 AD. Its distance is about 4,000 light years, and the angular dimensions of both the telescopic and radio object are about 4 × 6 minutes of arc. The temperature of the gaseous shell, which is expanding at the rate of about 70 million miles per day, is 50,000°K, which is far too low to produce the observed radio intensity of 1.8×10^{-23} watt/m² per cycle per second (at 80 mc) by thermal processes.

It is possible that the radio emission can be explained as a synchrotron** mechanism resulting from the movement of high-energy electrons in weak magnetic fields. It now seems highly probable that supernovae like the Crab nebula are both powerful radio emitters and responsible for the generation of an appreciable fraction of cosmic rays.

There are two other well-attested cases of supernovae in the galaxy, those observed by Tycho Brahe in 1572 and by Kepler in 1604. Unlike the Crab nebula, these are not spectacular objects. Even so there seems little doubt that radio sources are associated with them.

The most intense radio source in the sky lies in Cassiopeia. Its angular extent is about 4 minutes of arc, and the flux density of 80 mc is 2.3×10^{-22} watt/m² per cycle per second. Although this was the first radio star to be discovered in the Northern Hemisphere, it was not until 1951 that a successful search for its visible counterpart was initiated with the 200-inch telescope by Baade and Minkowski.

The result of this search was the surprising discovery that this powerful radio emitter consists of a very faint extended nebulosity of a type previously unknown. The gaseous filaments of this nebulosity are in violent motion at thousands of kilometers per second. There is no satisfactory explanation of the mechanism of the generation of radio waves nor is there any agreement as to the nature of the object itself, although opinions have been expressed that it may be the remains of a very old supernova.

Radio sources

There are only three other agreed

**A device for accelerating electrons or protons in a circular orbit in an increasing magnet field by applying an alternating electric field in synchronism with the orbital motion. At sufficiently high speeds polarized light and, it is believed, polarized radiation, some in the radio spectrum, is produced. The polarization is in the direction of motion.

identifications of radio sources with galactic objects. These are the Cygnus loop and the nebulosities in Auriga and Gemini. These are all extended gaseous nebulosities of low photographic brightness, with filamentary structure. As with the Cassiopeia source, there is no agreed opinion as to their nature or that of the mechanism whereby they emit radio waves.

The only general conclusion which can be drawn from the present situation is that the galactic radio sources appear to represent a very rare type of celestial object characterized by an appreciable extension of diffuse gas of low photographic brightness. Whether they are different manifestations of the same phenomena (supernovae) or vary in character remains uncertain. Attempts have been made to associate the radio sources with other rare classes of galactic objects such as novae, planetary nebulae and globular clusters, but without success.

The new telescope, with its high definition and adaptability over a wide frequency range, is expected to be a powerful tool in the investigation of the problem of these galactic sources and of the continuum. Initially it is hoped to make measurements at a few selected points in the frequency range of 20–1,400 mc to study the isophotes (lines of equal brightness) of the continuum and the spectra of the localized sources.

At present, surveys in England and Australia have revealed between 2,000 and 3,000 localized radio sources. Apart from the galactic concentration of a small number of the intense and extended sources discussed above, these sources are distributed isotropically (identically in all places) and are probably extragalactic. A relatively small number have been identified with telescopic objects such as the Andromeda nebula and other similar nebulae, but it seems likely that the majority of these are quite abnormal and at very great distances. For example, the second most intense radio source in the sky lies in Cygnus, and this has been identified as two galaxies in collision at a distance of 200 million light years. The existence of this intense radio source (1.4×10^{-22} watt/m^2 per cycle per second at 80 mc) associated with a celestial collision nearly at the limit of penetration of the 200-inch telescope is one of the most remarkable features of radio astronomy, with far-reaching cosmological implications.

During the last few years a further half dozen or so radio sources associated with unusual extragalactic objects have been discovered. These include NGC1275 in the Perseus cluster and a source in Hydra, which Baade and Minkowski consider may be galaxies in collision. Other peculiar asociations include NGC5128, which has a dark band across it, and M87 from which a jet emanates.

The normal nebulae show a ratio of radio to optical emission of about 10^{-6}. Compared with this, the peculiar objects have a much greater ratio, of the order of 10^{-3}, reaching unity in the case of Cygnus. This represents an extremely high conversion efficiency, and the mechanism by which such objects generate radio waves is a challenging problem.

In a collision of galaxies the stars are too widely separated for significant collisions to occur, but the dust and gas, which represent an appreciable fraction of the galactic mass, will certainly suffer real collisions at velocities of, perhaps, thousands of kilometers per second. The key to the mechanism that generates the radio waves probably lies in this highly agitated ionized gas.

The collection of further data on both the normal and abnormal radio sources is essential to understanding the problem of the extragalactic radio emissions. The new telescope is well fitted to pursue this important task over a wide range of wavelengths.

Transmits too

The preceding examples of the new telescope's uses have all concerned the programs in which the instrument will be used as a receiving aerial. There are many problems in which it will be used as a combined transmitting and receiving aerial. (It has been used, for example, for tracking artificial satellites and their attendant rocket sections.—Editor) In these radar or radio-echo aspects of the work, the moon and the planets will figure prominently.

Radio echoes from the moon were first claimed to have been observed in 1946 by Z. Bay in Hungary. His recording system was unusual, and the first certain echoes obtained in the conventional sense on a cathode-ray tube were by the U. S. Army Signal Corps. Subsequently echoes were obtained by Kerr and Shain in Australia. These experiments showed that the moon echoes were subject to deep and rapid fading —an effect which is now believed to be due to a peculiarity of the moon's motion with respect to the earth, known as libration.

During this period, apparatus for lunar-echo studies was also under development at Jodrell Bank, and it appears that this is the only systematic investigation of the moon by the radio-echo technique which has yet been carried through. This apparatus works on a frequency of 120 mc and uses a transmitter giving 10 kw in 30-msec pulses at a recurrence rate of 0.6 per second. The receiver bandwidth is 30 cycles, and appropriate arrangements have to be made to allow for Doppler shift in the frequency of the returned signal.

The most important results obtained with this apparatus concern the long-period fading (20 to 30 minutes), which by cross-polarization experiments has been shown to be due to the rotation of the plane of polarization of the radio wave as it traverses the ionosphere (the Faraday effect). This immediately led to developing a moon-echo system by which the ionosphere's total electron content could be determined.

The technical difficulties in this work are considerable and, with the present aerial system, measurements can be made only with the moon in transit for about 10 periods in each lunation. The new telescope will immediately remove these handicaps and will enable systematic data to be collected about the total ionospheric electron content. This is bound to be of considerable importance to our understanding of the ionosphere and of solar-terrestrial relationships.

The problem of radio echoes from the planets is vastly more difficult and, as far as is known, no serious attempts have yet been made to solve it. The magnitude of the problem relative to the moon is indicated by the fact that success in detecting radio echoes from Venus would demand an overall power sensitivity between 1 and 10 million times greater than that required in the case of the moon. This assumes, of course, that the reflection coefficient of the planet would not be inferior to that of the moon.

The problem cannot be appreciably eased by increasing the length of the transmitter pulse with appropriate decrease of receiver bandwidth, because of the Doppler spread introduced by the rotation of the planet. The rotation period of Venus is unknown (this would, in fact, be one of the main scientific results to be expected from the experiment) but on the basis of current estimates, the Doppler spread would probably limit the useful pulse width to about 40 msec, which is only a few times longer than that used in the lunar investigations. The main factor must therefore be achieved in the gain of the aerial, by increasing the transmitter power, and possibly by integration of successful echoes.

The problem has been carefully considered at Jodrell Bank in relation to the very great gain of the new telescope, and an attempt to obtain planetary echoes will be made early in the research schedule. The complete return journey of the earth–Venus radio signal will take 4 minutes and success in detecting such a radio echo would be a spectacular technical accomplishment. Nevertheless, the experiment could not be justified on this basis, and it is hoped that with the telescope a systematic program will be possible in which the rotation period can be determined and information obtained about the Venusian surface and atmosphere.

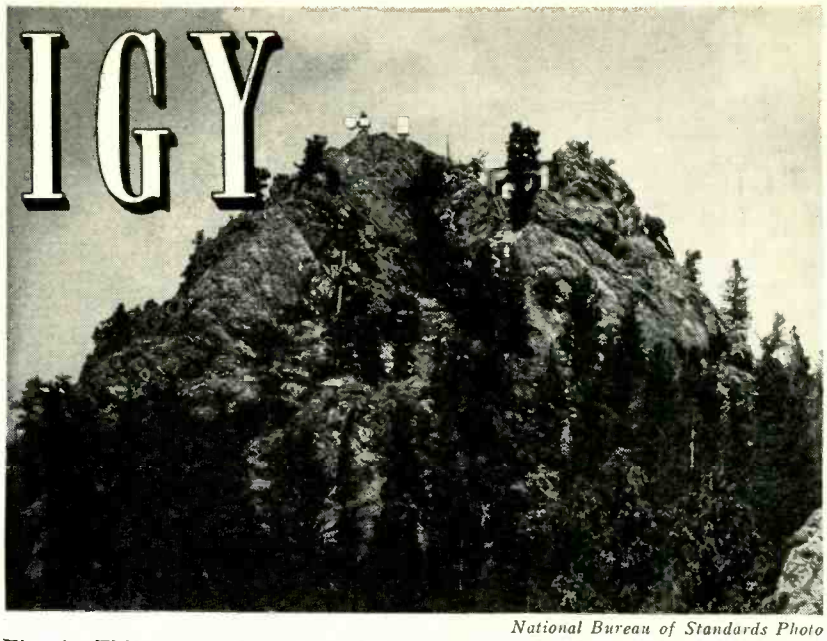
The telescope will also be used to study very faint meteors and the aurora borealis by the radar technique. As a receiver it will be applied to many other problems such as the radio emissions from the sun and the planets. In all these programs the great power gain coupled with the adaptability and ease of steering of the telescope is confidently expected to give results of outstanding interest as well as importance.

END

Electronics and the IGY

Part I: Electronics contributes to the success of the International Geophysical Year

By JORDAN McQUAY



National Bureau of Standards Photo

Fig. 1—This typical IGY observing station (Fritz Peak, Colo.) houses a photo-electric photometer and other optical equipment.

ONE of the most significant scientific undertakings in the history of mankind is the IGY or International Geophysical Year. It began last July and continues until next December — a period of 18 months.

During this time, more than 5,000 scientists and engineers of more than 60 nations are conducting intensive investigation and study of the earth, the atmosphere and the sun. Into these 18 months are crammed 30 or 40 ordinary years of research as science attempts to get a better picture of our geophysical environment.

At more than 1,000 field stations, scientists and engineers are exploring every major land and sea area. They are studying the earth's core and crust, and the atmosphere around our globe. And throughout these many and diversified studies and explorations, *electronics* plays an important role.

For only the science of electronics can detect, observe and measure many of the phenomena associated with the earth and the sun as they move through space. So great is this role of electronics that much of the success of the IGY depends directly on its use.

The IGY program covers a dozen major areas of scientific activity. These include meteorology, aurora and airglow, geomagnetism, cosmic rays, glaciology, gravity, longitude and latitude determinations, oceanography, seismology, solar activity, and rocket and satellite studies of the upper atmosphere. Although the earth-satellite program is perhaps the most popularized, this is *only one* of the areas of scientific activity during the IGY.

In most of these areas, electronics is utilized in some way to detect, collect, measure and record data concerning the earth and its atmosphere. Through electronics, these data provide not only new basic knowledge but also applications in many fields of human interest —from transpolar air travel to better radio communications, air navigation and weather predictions.

This, in essence, is the purpose of the IGY. And electronics is an important means of making many of these investigations possible.

Meteorology

With every advance of civilization, knowledge of the weather has grown more and more necessary. To cope with changes in the weather, reliable predictions—particularly long-range predictions—are needed.

One difficulty in predicting weather has been the lack of adequate data from the Arctic and Antarctic regions, which influence the world's weather.

During the IGY two drifting and several fixed ground stations in the Arctic and more than 50 ground stations in the Antarctic have been established to collect data influencing the weather. For the first time in history, adequate meteorological coverage of the Southern Hemisphere is being provided.

At these various ice-bound sites, balloon-borne weather instruments are sent aloft and radio back information on air pressure, temperature, humidity, precipitation and prevailing winds. Radiosonde and rawinsonde equipment provide this data at heights up to about 100,000 feet. At each site, information is collected and then transmitted—via radio circuits — to central points for analysis and recording.

In addition to the Arctic and Antarctic stations, there are more than a hundred other weather-observing stations in more temperate regions, particularly in the Western Hemisphere (Fig. 1).

Stations are not identically equipped. A variety of electronic and other measuring instruments is used at many sites.

Observations of solar radiation are made with pyrheliometers and recorders. Infra-red measurements are made with infra-red absorption-cell hygrometers. Sky brightness and sunshine duration are recorded with photometric switches. Atmospheric ozone is measured with Dobson spectrophotometers. Other ground-based devices detect and measure radiated sun heat, snowfall, wind and temperature. At selected sites throughout the world, the sun is photographed every 30 seconds.

Radiosondes at work

Important to the study of meteorology at the various IGY sites is a continuous knowledge of wind direction and velocity, air temperature and humidity and other data from lower regions of the upper atmosphere.

Instruments for recording these data are known as *radiosondes* and are carried aloft by balloons about 6 or 7 feet in diameter. Data collected by a radiosonde are broadcast to ground-based radio receivers for further analysis. Each radiosonde weighs about 2 pounds and is about the size of a hand telephone. Besides being a compact radio transmitter, it carries a thermometer, a hygrometer for measuring air humidity, a barometer and a miniature battery for a power source.

After release, the balloon rises while the miniature transmitter flashes vital statistics to ground-based receiving stations. Each receiver automatically

tracks the radiosonde and records the drift of the balloon as well as data transmitted by the radiosonde as it moves through space.

A combination of a radiosonde and several ground-based receivers is known as a *rawin* (Fig. 2) or rawinsonde. The system operates up to altitudes of about 100,000 feet, when the balloon bursts. The radiosonde is then eased down by parachute to forestall possible injury to persons or damage to property. Most balloons and airborne gear are lost. But they have fulfilled their mission in meteorology for the IGY.

Data collected by the rawin are sent by radio or wire lines to central control points, where they are recorded and analyzed further—usually by electronic data-processing machines. Data are stored on tapes or punched on cards and ultimately used for regional weather predictions.

Although these data — collected at altitudes up to 100,000 feet—are important, for long-range weather prediction there is a need for similar data collected from much higher altitudes. Collection of such data is possible only by use of special rockets.

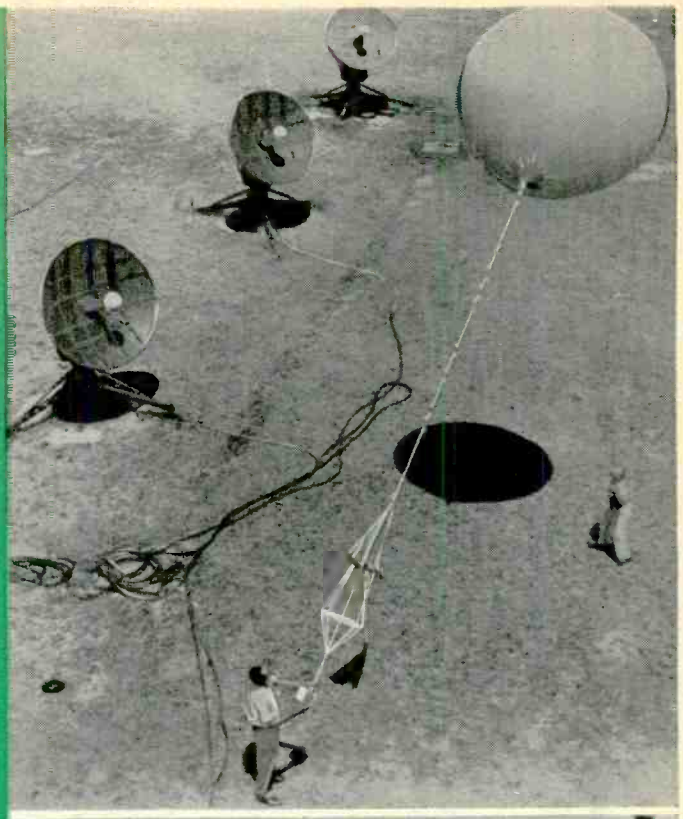


Fig. 2—A rawin set—a radiosonde and directional radio receivers—used to collect meteorological data.

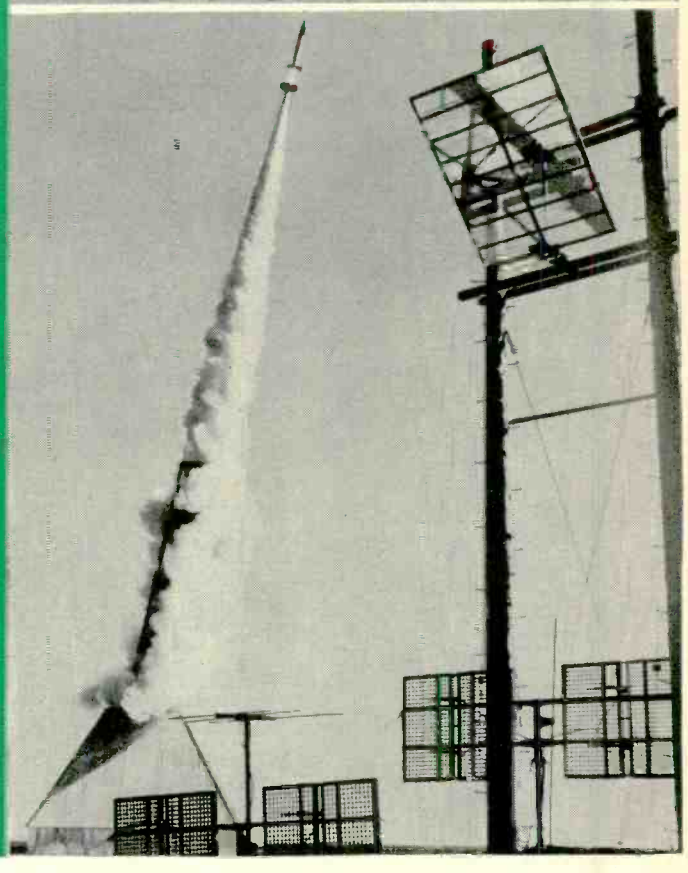


Fig. 3—An Aerobee-Hi rocket a few moments after launching.

U.S. Army Photographs

The upper atmosphere

Meteorological and other data are being collected from the upper atmosphere by four kinds of rockets:

The *Aerobee-Hi* is a liquid-fuel rocket. In a 6-cubic-foot space, it carries a payload of 150 pounds of scientific equipment to an altitude of about 170 miles. It is 23 feet long and about 15 inches in diameter.

The *Nike-Cajun* uses a solid propellant and carries a 40-pound payload to an altitude of more than 100 miles.

The *Nike-Deacon* also uses a solid propellant to carry a 40-pound payload to an altitude of about 75 miles. Both rockets use the Nike as a booster.

The *Rockoon* is a Deacon rocket carried to about 80,000 feet by a Skyhook balloon before the rocket is actually fired. It carries a 40-pound payload to an altitude of more than 60 miles.

Of the dozen or so rockets fired to date, most were the Aerobee-Hi type. The majority of them were fired in the Arctic region. See Fig. 3.

Particularly important in meteorology is the measurement of upper-air temperatures and the collection of air samples to determine their composition. This can be done with rockets, which also provide a way of determining wind speed and direction at heights never before possible.

Temperature increases with increasing altitude because the ozone absorbs ultra-violet radiation. Thus, great outbursts of ultra-violet radiation caused by a solar flare may result in temperature increases which are reflected at the earth's surface in marked weather changes. With these data, collected by the rocket and relayed to ground stations, much more accurate weather forecasting is possible.

Two methods of measuring temperatures at high altitudes with rockets have been used successfully during the IGY. One system is based on the principle that the speed of sound is influenced by temperature. The speed of sound is measured through a series of small detonations that occur just outside the rocket housing at closely timed intervals during flight. Microphones on the ground detect each burst, and the exact time of arrival is recorded by electronic data-processing equipment. At the same time, radar and optical tracking equipment determine the exact location of each detonation in space as the rocket ascends. The position and

Fig. 4—Miniature radar-beacon transceiver (right) and its power supply for rockets used to explore the upper atmosphere.

US Army Photographs

time of arrival of each of the successive detonations indicate the speed of sound through the layer bounded by each burst. Thus, the mean temperature for each stratum of atmosphere can be determined electronically.

Another method of temperature measurement requires knowledge of the angle made by the shock waves off the nose of the rocket during flight. These waves are detected by pressure-sensitive probes mounted on the outside of the rocket housing and, after amplification, are recorded on a magnetic tape inside the rocket. The data are also telemetered to a receiving station on the ground. From a knowledge of the fixed angle of the probes plus the location and speed of the rocket (determined by ground-based radar), the air temperature along the upward path of the rocket can be determined electronically.

Air is sampled at high altitudes by sending special vacuum bottles aloft within a rocket. At predetermined altitudes, the containers are opened, and then closed and sealed by electromechanical devices. Rockets are also equipped with instruments to detect and record other phenomena under study during the IGY.

Preliminary results during the IGY indicate that up to about 40 miles altitude, atmospheric gasses are completely mixed. Above that level, the amount of argon (a heavy gas) decreases and the amount of helium (a light gas) increases.

Rockets in flight are located and tracked by ground-based radar stations and sound-ranging stations. Each rocket carries a small transponder beacon (Fig. 4) which transmits a return signal to IGY stations on the ground.

Radar tracking also provides a measure of safety. If the rocket veers off course during its powered ascent, such a deviation is noted quickly by the ground-based radar equipment. If the behavior of the rocket becomes dangerously erratic, a change of signal is transmitted from the ground to the radio receiver in the rocket. This, in turn, breaks the fuel line and terminates the flight.

To protect the delicate electronic instruments in the rocket from landing shock, they are carefully packed and braced. Some rockets are constructed so the nose and tail assemblies are blown apart during downward flight. A nylon parachute brings down the nose section that houses the electronic measuring and recording equipment.

Most rockets carry out several different IGY experiments during a single flight. Thus the total number of flights is not indicative of the true importance of this phase of the IGY program.

The several ground stations used to track and control the rocket are connected via communications circuits—using conventional radio or wire facilities. Collected data are evaluated and stored at central locations by electronic processing and storing equipment.

Solar activity

Investigation of the upper atmosphere by radiosondes and rockets is supplemented by other IGY studies, all intended to enhance our knowledge of this region that surrounds us.

The atmosphere — extending above 100,000 feet and thinning out into nothingness hundreds of miles above the earth—plays a dominant role in our lives. It provides a shield against lethal radiation from the sun and from dangerous cosmic radiation. It maintains the heat balance of the earth, so surface temperatures are suitable for life. And it affects our lives in many other ways.

Under study during the IGY are events and conditions that take place more than 50 miles above the earth's surface. The sun dominates most of these events, which include aurora, airglow, cosmic rays, geomagnetism and other solar activities.

Any unusual solar radiation—either in intensity or kind—influences the upper atmosphere. This, in turn, affects radio communication, navigational systems and other electronic activities dependent to some degree on the transmission and reception of electromagnetic waves through space.

Solar activity is generally measured in terms of an 11-year sunspot cycle. Sunspot bursts or other active phenomena on the surface of the sun have lifetimes varying from a few days to a few months, invariably according to the 11-year time scale. Brief spurts of activity occur in some solar regions and may last from a few minutes to a few days.

Variations in any of these solar activities frequently determine weather conditions on earth. For this reason, the IGY program was purposely timed to coincide with the peak of sunspot activity so that geophysical events in the upper atmosphere would be at their maximum.

To observe these solar phenomena, a network of more than 400 ground-based stations has been established around the world. The stations are spaced to allow a continuous optical and electronic watch of the surface of the sun and the upper atmosphere. Events occurring in the visible as well as radio frequencies are measured and recorded. These include the number and size of sunspots, solar flares and solar (radio-frequency) noise—all correlated with time. At these and additional stations in the Arctic and Antarctic, aurora and airglow are also observed and recorded.

Aurora or dancing light is the visible evidence of the bombardment of the earth's atmosphere by charged particles from the sun. It is a luminous trace, usually occurring near the north and south geomagnetic poles of the earth.

Airglow is a faint glow of light, somewhat like aurora, caused by a chemical reaction in the upper atmosphere of Arctic and Antarctic regions. Both aurora and airglow interfere with radio communications.

At IGY stations in polar regions, aurora and airglow are observed and recorded with radiosonde equipment associated with photoelectric photometers, scanning spectrometers and high-dispersion spectrographs.

Photographs of aurora and airglow are taken at regular intervals with specially built automatic-sequence all-sky cameras—which cover the sky from horizon to horizon. Each instrument incorporates a 16-mm motion-picture camera which photographs the entire sky as seen in a convex mirror. Exposures are taken about once every 5 minutes.

Data on auroral forms and intensities are classified and recorded electronically in terms of sky location and time, reduced to punched-card form and filed for future reference. This work is done by conventional electronic data-processing machines.

During periods of marked solar activity, rockets are also used to obtain data for study and record. In airglow experiments, photon counters are encased in the rocket. These counters are used at various wavelengths in the visible spectrum with their output coupled to amplifiers containing photomultiplier tubes and filters. Auroral *particles* — almost infinitesimal dust — are collected and measured with Geiger counters, proportional and scintillation counters, ionization chambers and related equipment mounted within the rocket. All data collected by rockets are recorded and then telemetered to ground-based receiving stations.

When scientists cannot observe an aurora visually or photographically, the course of the aurora is followed with radar equipment. The path of an aurora can also be studied by means of radio and radio astronomy. The pattern of auroral interference with ordinary radio transmissions on the earth and with the arrival on earth of radio-frequency emissions from the sun and other planets provides valuable data for predicting radio propagation.

Cosmic rays are other solar phenomena. Although their origin is a mystery, their presence can be detected and their characteristics examined. These are essentially positively charged particles that bombard the earth from all directions. Excessive bursts of cosmic rays frequently coincide with other ionospheric disturbances and are so severe that they not only interfere with but sometimes prevent radio communication.

At the many IGY observation stations around the world, cosmic rays are studied with other solar activities. Used for this purpose are cloud chambers, ionization chambers, window Geiger counters, electronic impulse counters and other special instruments to detect and measure cosmic rays. Information is recorded in terms of time for later comparison with other solar disturbances and effects.

Raw data are exchanged between IGY stations via radio communication — usually using high-speed teletypewriters. At key central stations, data from all observing points are correlated and recorded by electronic data-processing equipment.

Ionosphere physics

A region of rarefied ionized gases — from 50 to 250 miles above the earth — is known as the ionosphere. It is electrically active because of ultra-violet radiation from the sun, and reflects radio waves from earth much as a mirror reflects light. For this reason, radio communication is entirely dependent on the ionosphere for long-distance transmission.

The region is far from stable. It is composed of layers of ionization which change radically with time of day, with season, and even from year to year. Its radio-wave reflecting characteristics also vary with prominent solar activities. A flare on the sun is frequently followed by an ionospheric disturbance that blacks out all long-distance radio communication. Active sunspots and violent auroral displays also affect the ionosphere and result in major paralyses of long-distance communication.

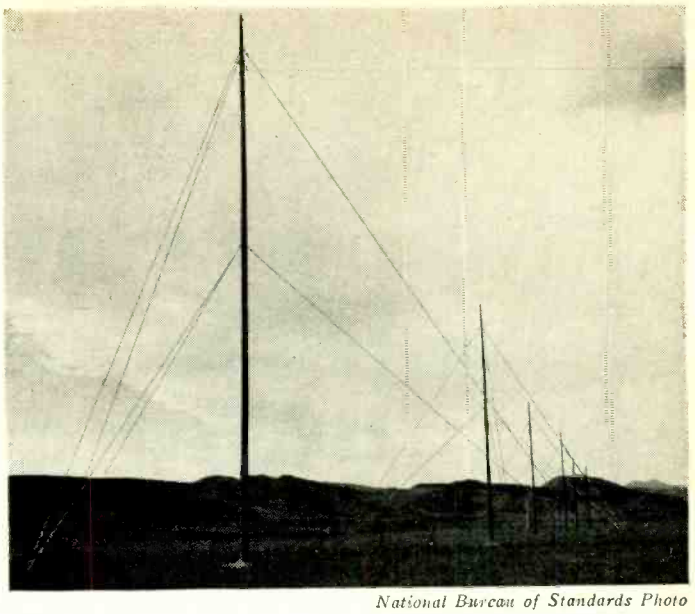


Fig. 5—Antenna array of an IGY observing station (Boulder, Colo.) used to study effects of the ionosphere on radio-wave propagation.

National Bureau of Standards Photo

Through detailed study of the ionosphere and its many and varied characteristics, some of the mysteries of this ionized region may be deduced during the IGY. Observing stations are endeavoring to collect data on the characteristics of all layers or parts of the ionosphere. Of particular significance are data on variations of charge density with altitude.

Layers are measured vertically and obliquely from each observing station at regular intervals, using automatic multifrequency ionospheric recorders. This equipment normally sweeps from 1 through 25 mc in a period of about 20 seconds, and this sweep is repeated about every 20 minutes. Radar data are recorded on 35-mm film, which is processed and scaled daily for significant ionospheric characteristics.

Rockets are also used to determine ionospheric charge densities in three ways: In the first, the delay time of an electromagnetic pulse sent from the ground station to the rocket is measured. In the second, two harmonically related signals are transmitted from the rocket in the ionosphere; with a known phase shift, the index of refraction in the vicinity of the rocket shell is a measure of the charge density. In the third, the charge density is determined from the effect of the ionosphere on DOVAP (Doppler, velocity and position) signals. Data are either recorded by electronic equipment within the rocket or raw information is telemetered to ground-based receiving equipment where it is recorded and analyzed.

Nearly a hundred observing stations have been established at points around the world specifically for the purpose of measuring the position and density of layers of the ionosphere. Much of this work, particularly in the Antarctic, has never before been attempted.

Data of this type from all ionospheric and other observing stations are collected and assembled to obtain a world-wide pattern for prediction purposes. See Fig. 5.

Other investigations of the ionosphere include the use of solar spectrographs, encased in rockets, to determine the distribution of ozone in the upper atmosphere. A radio-frequency mass spectrometer is used to measure the chemical and ion composition of the ionosphere. These plus wind and other measurements are either recorded electronically within the rocket or are transmitted to the ground observing stations for study and record.

Another field of intensive study is the recording and measurement of atmospheric radio noises. At principal stations of the global IGY network, noise is recorded continuously, 24 hours a day, on magnetic tape, with appropriate time references for comparison with other meteorological data.

Low-frequency or whistling atmospheric noise is the subject of a special study during the IGY in an effort to identify the origin and define the characteristics of this kind of radio interference.

Other IGY studies relating to the ionosphere include investigation of oblique-incidence forward scatter, sweep-frequency back scatter, absorption and other phenomena relating to the propagation of radio waves.

Any unusual solar or ionospheric activity in one region of the world is communicated to other IGY stations by a global radio network. This allows more intense study of the same phenomenon and its effects at various sites throughout the world.

Next month—a look at the earth satellite and its place in the International Geophysical Year.

TO BE CONTINUED

Want a picture of your favorite TV star or strangest oscilloscope trace? Then take it yourself!

Photographing C-R tube Images

By RHYS SAMUEL*

TV PICTURES or oscilloscope traces can be photographed successfully by anyone with a working knowledge of his camera. To the amateur photographer, this special branch of the art presents some new and interesting problems which can be solved with specific techniques and conventional equipment. For the professional photographer or technical writer, mastery of this phase of picture-taking can be profitable.

Shutter speed

Photographing TV and oscilloscope screens involves a special consideration —the scanning rate of the traveling electron beam. In TV receivers, the scanning rate is fixed. In oscilloscopes, it varies over a wide range, depending on the frequency of the displayed waveshape. This scanning rate determines the limits of permissible shutter speed. Failure to use optimum shutter speed is the reason why so many initial attempts at TV-screen photography fail. To understand why shutter speed is so important, it is helpful to recall the makeup of a scanned TV picture.

A televised TV scene is made up of 525 lines, including those lost in retrace. The 525-line scene (one *frame*) is composed of two separately scanned *fields* made up of 262.5 lines each. The fields are staggered or interlaced on the tube screen to produce a full-definition picture.

Each second 30 frames (60 fields) are transmitted. The time required to scan a complete frame is 1/30 second. Consequently, a shutter speed of 1/30 second is required to capture one complete televised scene. A faster shutter speed, such as 1/50, will capture little more than a single field. A speed of 1/100 will be much less than the time required to scan only one field (see Fig. 1). Because few cameras are equipped with a 1/30-second speed setting, 1/25 second is the recommended speed setting for obtaining full picture information (see Figs. 2 and 3).

The longest permissible exposure is determined primarily by the stability of the receiver picture. Practical difficulties, such as jumping field interlace, a shifting or jumping raster, motion in the televised scene and ambient-light conditions generally make exposures longer than 1 second impractical.

The recommended speed of 1/25 second should be used whenever film speed and aperture setting permit. When speeds slower than 1/25 second are used, the moving beam produces multiple exposures on the film. Because the raster is traced repeatedly, a denser latent image is produced.

Apertures and film speeds

Using a shutter speed predetermined by the scanning characteristics, consideration of the aperture-setting and film-speed possibilities reveals that a wide aperture and a very fast film are required. Select the fastest film available (see Table I) and use the largest aperture consistent with good depth of focus. Because the faceplate of the picture tube curves away from the lens and the plane of focus of the lens curves away from the faceplate, it is often necessary to stop the lens down from maximum aperture to obtain sharp corner and edge resolution. As a rule, the best compromise between definition and speed is made by closing the diaphragm about two stops from wide open for moderately fast lenses, such as f4.5's, and about three stops for faster lenses.

How was this picture made? Note sharp image on TV screen in fully lighted room. For answer turn to end of article.

Fig. 1—Result of too fast a shutter speed.

Fig. 2—Normal picture shot at 1/25 with f8 on Rolleiflex. Tri-X film. Correct exposure captures one complete frame.

*Electron Tube Division, Radio Corporation of America.

The ASA ratings shown in Table I are daylight ratings and can be used with standard development processes recommended for the films listed. Where the maximum lens aperture is insufficient for the application, the film ratings may be pushed at the risk of graininess. Larger negatives allow more latitude in processing than smaller negatives, such as 35 mm, because the image covers a larger film area and requires less enlargement.

Different cameras offer different advantages in this type of close-up photography. Many twin-lens reflex and 35-mm cameras with separate viewfinders and rangefinders suffer from parallax at short focal lengths. (The viewfinder and lens do not see exactly the same picture.) This shortcoming can be overcome. Open the unloaded camera or remove the back and temporarily secure the camera to its tripod. Hold a piece of ground glass in the film plane and move the lens all the way forward. While watching the image on the glass, move the tripod toward or away from the picture tube to establish the position which gives the sharpest focus. Because smaller cameras produce a small negative, focusing must be extremely precise. The advantage of the smaller camera is the availability of very fast lenses at moderate cost.

Studio or press type cameras are well suited to such close-up photography because they permit through-the-lens focusing on ground glass, have extension bellows for close-up work and accommodate larger negatives. Their primary disadvantage is that lenses with speeds greater than f4.5 are available only at very high cost.

TABLE I—PANCHROMATIC FILMS WITH ASA EXPOSURE INDEX OF 100 OR HIGHER

Manufacturer	Type	Daylight Exposure Index	Available in:
Kodak	Super XX Pan	100	roll, film pack, sheet, 35 mm, 828
Ansco	Superpan Press	125	sheet
Gevaert	Gevapan 33	125	35 mm, 120 roll, sheet
Kodak	Super Pan Press B	125	sheet
Du Pont	Arrow Pan	160	sheet
Du Pont	High-Speed Pan	160	sheet
Ansco	Triple S Pan	200	sheet
Du Pont	Superior Press	200	sheet
Kodak	Royal Pan	200	sheet
Kodak	Tri-X Pan	200	sheet
Gevaert	Gevapan 36	250	35 mm, 120 and 620 roll, sheet
Kodak	Royal X Pan	650 to 1600	sheet, 120 and 620 roll

Photographing TV

As in any new photographic problem, it is well to try different exposures at various aperture settings and keep track of the exact settings used for each exposure, beginning with a 1/25 speed setting. Three or four trial shots should be enough to determine the best combination of shutter speed and aperture setting for a given film and camera. The graph in Fig. 4 can be used as a guide in determining suitable combinations. Although test pictures may show that on some receivers a full frame or field can be captured at speeds faster than 1/25 second, close examination will disclose degradation of part of the picture. The effect of a complete picture is due to the persistence of the phosphor screen.

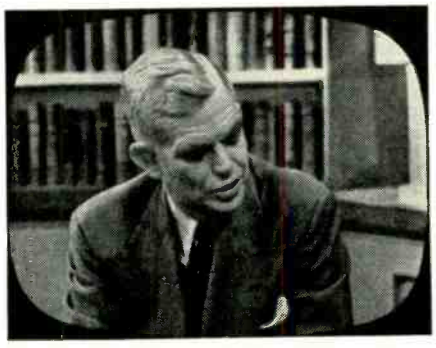


Fig. 3—Another perfect exposure. Same settings as in Fig. 2

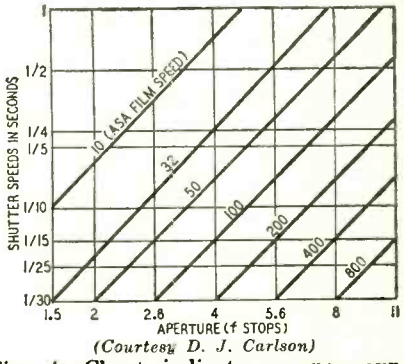
Because the television system has a fixed scanning rate, a TV receiver provides an excellent device for checking camera shutter speeds. When compur type shutters are used, an improper speed will result in a horizontal splitting of the picture into areas of different contrast and brightness, as shown in Fig. 1. Focal-plane shutters may produce a picture which has a brightened diagonal bar, such as that shown in Fig. 5. In this illustration, the shutter speed is slightly slower than 1/30 second, and a small portion of the third field is reproduced. In general, the compur type shutter is better suited to this type of photography.

Because of the fine-line composition of a TV picture, a sturdy tripod or other suitable camera mount is absolutely essential. The importance of precise focusing cannot be overemphasized. If the camera is equipped with a ground-glass viewer, a magnifying glass should be used to check focus at a point midway between the center and the edge of the picture tube. The camera should be focused at maximum aperture, then stopped down only enough to bring the edges and corners into sharp focus. Avoid jarring the camera when opening the shutter because any slight movement can blur the line structure of the raster on the negative.

After camera, lens and film problems are resolved, make sure that the TV receiver is in top operating condition. Check the interlace carefully and see that individual raster lines hold steady and are sharply focused. Check for maximum brightness without blooming. If necessary, clean the picture-tube faceplate and safety glass. Darken the room as much as possible to reduce reflections and eliminate stray light.

Oscilloscope traces

Photographing scope traces requires techniques similar to those described earlier, but introduces some additional problems. Because green, and occasionally blue, tube phosphors are used, the film should be a fast panchromatic type. Remember, the electron-beam scanning rate determines the shutter speed, and the scanning rate varies with the setting of the sweep-frequency controls. The lower the displayed frequency, the higher the light output for any given setting of the scope intensity control. Very fast waveshapes or fast-moving portions of waveshapes require longer exposure time than low-frequency waveshapes or slow-moving portions.



(Courtesy D. J. Carlson)

Fig. 4—Chart indicates proper exposures for various film speeds.

Fig. 5—One complete frame plus part of one field. Taken with Leica on Plus X. Shutter set at 1/30, aperture f2. Focal-plane shutter caused slightly brightened diagonal bar.

For example, the horizontal retrace of the beam is very fast compared to the display sweep and often produces a thin faint line. This characteristic is also evident on steep-sided waveforms, such as the negative-going part of a sawtooth waveshape (see Fig. 6). When these types of waveforms are photographed, expose the film long enough to burn in the faint sections of the trace (see Fig. 7). Again, some

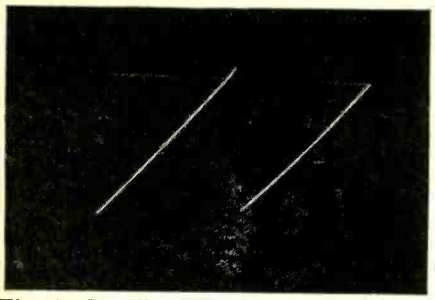


Fig. 6—Insufficient exposure time loses fast-moving vertical trace of sawtooth waveform. Horizontal retrace is barely visible.

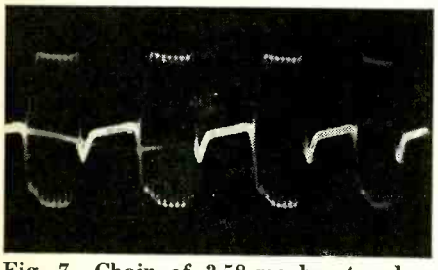


Fig. 7—Chain of 3.58-mc burst pulses keyed at 189 kc. Shot at f7.7 for 3 seconds with Graphic View 4 x 5. Royal pan film.

experiments may be necessary to determine the proper exposure.

If exposures longer than 1 second are required, B or T (bulb or time) shutter control positions or the lens cap can be used as an exposure control for long time exposures. END

ANSWER: It's no secret, but a double exposure! First exposure was shot at f25 at 1/2 second on Royal Pan. Two No. 2 photofloods were used at camera. Film was re-exposed at f7.7 for 1 second in a darkened room. The 4 x 5-inch Graphic View was focused on TV screen for both exposures.

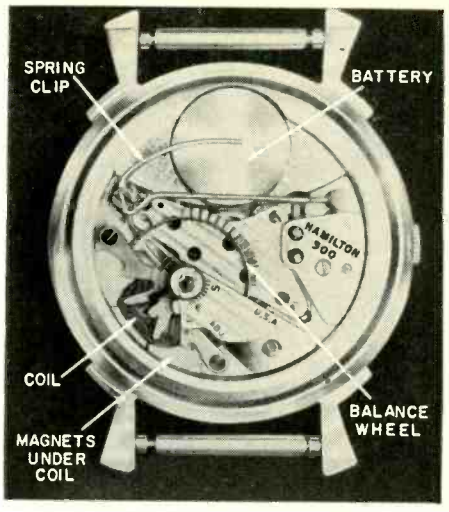
ELECTRIC WRISTWATCH

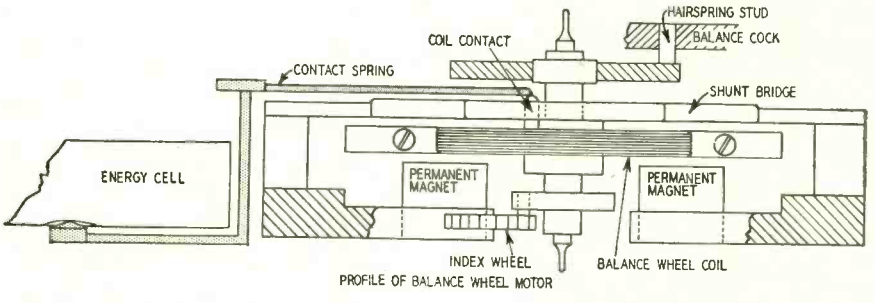
THE electronic technician may soon be seeing a new item on his workbench, the electric wrist watch. He may need a powerful magnifying glass or two and a couple of jewelers' tools, but an electric watch is driven by a tiny electric motor using batteries of a highly specialized type and requires service know-how more closely allied to that of a radio technician than the jeweler.

The Hamilton Watch Co., after 10 years of research and testing, has placed an electric wristwatch on the market. Driven by a miniature reaction motor, it has an accuracy of 99.995% and is powered by a button battery with a life of more than 12 months.

A miniature triangular coil is attached to the balance wheel which is used as the motor's rotor. Platinum-alloy permanent magnets, claimed to have the higest energy content of any magnet in the world today, create the motor's magnetic field.

Coil contact is made through a silver–gold-alloy contact on a nonmagnetic spring fastened to a mounting plate (see figure). As the wheel oscillates its contact brushes against the spring contact, sending a pluse of current through the coil. Timing is based on the natural oscillation period of the balance wheel.





Notes on the Getter

By NORMAN V. BECKER

IN high-gain audio circuits, tube noises such as hiss and frying are some of the most troublesome things encountered. They can be eliminated only by selecting tubes which are inherently quieter or by reducing stage gain with negative feedback. In the latter instance gain might have to be reduced by such a factor as to defeat the original purpose.

Hiss is created by dc resistance paths existing between various elements inside the tube. These leakage paths may be as high as 1,000 megohms and would not upset normal tube operation *if they remained constant*. But like a bad carbon resistor, they create noises of their own through random and erratic changes of resistance.

Leakage paths of this sort are primarily located on the top mica support wafer, where the support rods are punched through. If the wafer is contaminated by impurities, it becomes a highly unstable conductor, connecting tube elements through very-high-resistance paths. Unfortunately, contamination of the wafer during tube manufacture is almost unavoidable. Before sealing the tube envelope, as much air as possible is exhausted by vacuum pumps, but a small percentage of oxygen and other gasses remain inside.

This is where the getter comes into the picture. A small square loop of wire usually located at the top of the tube, part of it coated with an explosive substance similar to that used in photoflash bulbs. High-frequency radio waves penetrate the sealed envelope and heat the getter to a temperature high enough to fire this coating. This miniature explosion burns up the remaining atmospheric gasses inside the tube and, at the same time, splatters a mirrorlike silver coating over a portion of the inner surface (a familiar sight in glass tubes). *Some of this splatter falls on the mica wafer, making it slightly conductive.*

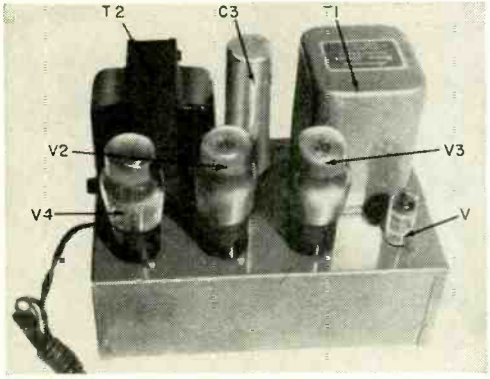
To reduce contamination of this sort, certain premium tubes are manufactured in which the space between getter and wafer is materially increased. In other types *two* top wafers are used—the upper one insulated from the lower—and act as an umbrella to receive most of the splatter. Another method is to punch oblong slots in the wafer. These openings effectively lengthen dc leakage paths and thereby reduce noise.

In designing high-gain input stages for microphones and low-output pickups, it is desirable to use premium tubes whenever possible. Special manuals describing these types are published by tube manufacturers, giving electrical data, physical dimensions, recommended applications, etc. In many instances premium tubes are directly interchangeable with standard types which you might now be using. In addition to reducing hiss, premium tubes are less microphonic, have lower hum and are generally more dependable—and are more expensive. END

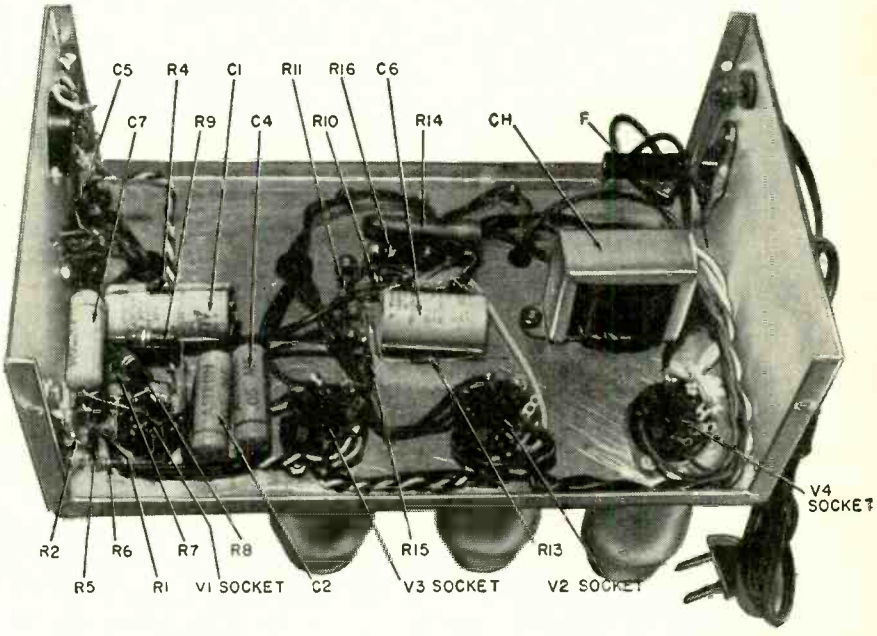
HIGH-POWER PERFORMANCE with a LOW-POWER AMPLIFIER

By CHARLES BALDWIN *

20-watt amplifier uses 6Y6-G's in an Ultra-Linear output stage



The finished amplifier, ready to use.



For a neat job, follow this layout.

THE trend, in the last couple of years, toward bigger power amplifiers has pushed many low- and medium-power amplifiers — even those of outstanding quality — completely out of the high-fidelity scene. When queried about their reasons for converting to the 50- and 60-watt power class, the high-power proponent replies with a glib, "It sounds better" or "It has better transient response"—and who can dispute his reasoning? But there are still survivors of a diminishing race of audiophiles who are able to satisfy their esthetic demands (and those of their purses at the same time) with a clean 15- to 20-watt amplifier.

It has often been said—and proved—that an amplifier may test well and sound poor. One factor which does not show up on test equipment is the way the unit performs with actual program material. The importance of this influence on sound reproduction has come more into the limelight during the past few years and explains, at least in part, the variances in lab-test and listening-test results.

A basic power amplifier, which performs exceptionally well on the scope *and in the listening room*, is described in the next few paragraphs. Before going into the details of this unit, it might be beneficial to clarify a few points in the high-power–low-power controversy.

Clean reproduction

The high-power advocates frequently claim clipping on dynamic peaks as the reason for increasing wattage. It is a known fact that peak clipping will distort the waveform by flattening the top and broadening the sides, producing strong odd harmonics. This, of course, is not desirable, but it is not the real menace to clean reproduction with low- to medium-power amplifiers. Sluggish response to and recovery from overload is much more perceptible than harmonic distortion and demands greater consideration than peak clipping. The main cause of this condition, contrary to some thinking on the subject, is a product of tube nonlinearity, dc instability in the amplifier circuit and power supply regulation.

As the signal level increases, the tubes draw more current and plate supply voltage drops, causing biases to shift to the new operating potential. The charge then on the blocking capacitors changes with an additional shift in plate supply voltage. When the overload signal is removed, the amplifier tries to recover and return to its normal operating potentials. Bias again has to shift, but this time the shift is a logarithmic or exponential decay—or transient oscillations in the more serious instances. This would not occur with a perfectly regulated power supply or a perfectly linear output stage.

A byproduct of this condition occurs with three- and four-stage amplifiers where plate supply voltages have been decoupled two or three times. The voltage drop on peaks in the earlier stages occurs after the output stage voltage has dropped. The bias on the different stages shifts at different times, result-

* Acro Products, Philadelphia, Pa.

ing in amplitude and overload distortion. The severity increases with direct-coupled stages, which are becoming more prevalent in amplifier design.

Another condition occurs with pentode- or tetrode-connected tubes which have a curvature in their transfer characteristic, causing a reduction of gain at high output levels. This in turn reduces high-level feedback where distortion becomes more noticeable and where feedback is needed most.

The Ultra-Linear[1] connection of the output stage is particularly helpful in correcting both of these conditions and the amplifier described in this article demonstrates these features.

The preceding discussion applies primarily to low-frequency transient effects involving relatively long periods of time, milliseconds to seconds, and detectable aurally or in the laboratory by pulsing the input with either dc or sine waves and noting response and recovery on the scope. High-frequency transients are usually less noticeable, covering only brief spans of time, measured in microseconds, and are not audible. However, there is a form of high-frequency transient distortion which is audible and does have undesirable effects on performance.

High-frequency transient characteristics can be determined, to a reasonable degree, by the way an amplifier responds to square-wave testing. A square wave can be treated as a type of stepped-pulse transient which is repetitious and maintains a fixed image on an oscilloscope.

The three factors which demonstrate response to transients by square-wave analysis are:

1. Overshoot and severe ringing, which indicate high-frequency peaking.
2. Transient recovery, which is a function of bandwidth and follows the overshoot or ringing.
3. Rise time, which is the length of time in which a wave reaches peak value and is also a function of bandwidth.

Overshoot or ringing is due to several factors and in the more severe cases is caused by feedback changing from degenerative to regenerative in the high-frequency regions. To maintain effective feedback up to 20 kc, the predominant harmonic component of which is at 60 kc, it is desirable to extend frequency response to at least the 60-kc point with a controlled, peak-free rolloff thereafter.

Nyquist stability

In many feedback amplifiers using three or more stages, a condition technically known as Nyquist stability may exist. This defines a type of marginal stability which results when the forward gain of an amplifier decreases—as might be encountered when a tube ages and loses sensitivity—or when the amplifier approaches overload and there is shifting of operating potentials, resulting in lower gain, or when the gain of the output stage is affected at high levels, typical of straight tetrode or pentode operation. This type of instability is heard as breakups on peaks.

Immediately following overshoot on complex waves, which are typical of sound, a train of decaying oscillations sometimes mild and sometimes severe appears on the waveform. The damping of these oscillations is essentially a function of rolloff. The frequency of the oscillations increases with bandwidth, thus placing the same number of oscillations on a smaller portion of the square-wave flattop.

Square-wave rise time is also indicative of bandwidth. This becomes apparent when you realize that a square wave is made up of a fundamental frequency plus third-, fifth-and-higher-odd order harmonics—all applied simultaneously. Under ideal conditions, a 10-kc fundamental is accompanied by a 30-kc third harmonic, with an amplitude equal to one-third the fundamental, and a 50-kc fifth harmonic equal to one-fifth the fundamental. Under conditions other than ideal, the 30-kc frequency would probably be less than the required one-third while the 50-kc frequency would represent an even greater deviation from the required one-fifth. The decrease in amplitude of the two harmonics would permit the fundamental to predominate and the rise time would tend to assume that of the base frequency. It can easily be seen from this, then, that for acceptable 10-kc square-wave response, bandwidth must be extended to at least 50 and on up to 100 kc for a 20-kc square wave. However, for all practical purposes, 60 kc can be established as a reasonable high-frequency cutoff point.

These conditions are encountered not only with 10–20-watt units—a similar situation can exist even with high-power amplifiers of 50 to 60 watts. However, a 20-watt peak would push a 20-watt amplifier to its rated limit while the same peak would represent less than half the power of a 50-watt unit and the internal disturbances would probably pass unnoticed. What happens in many instances when we go to higher power is that we're purchasing 50 watts to obtain a clean 10 to 20. No attempt is being made to knock the high-power units or their advocates. Power is relatively cheap and there are a limited number of low- to medium-power tubes with desirable properties. The purpose here is to show that excellent low power does exist for those who have an application for it.

Back to the amplifier

The 6Y6-G beam-power pentode has been around for quite a number of years—occasionally used as an audio output tube, but more often than not

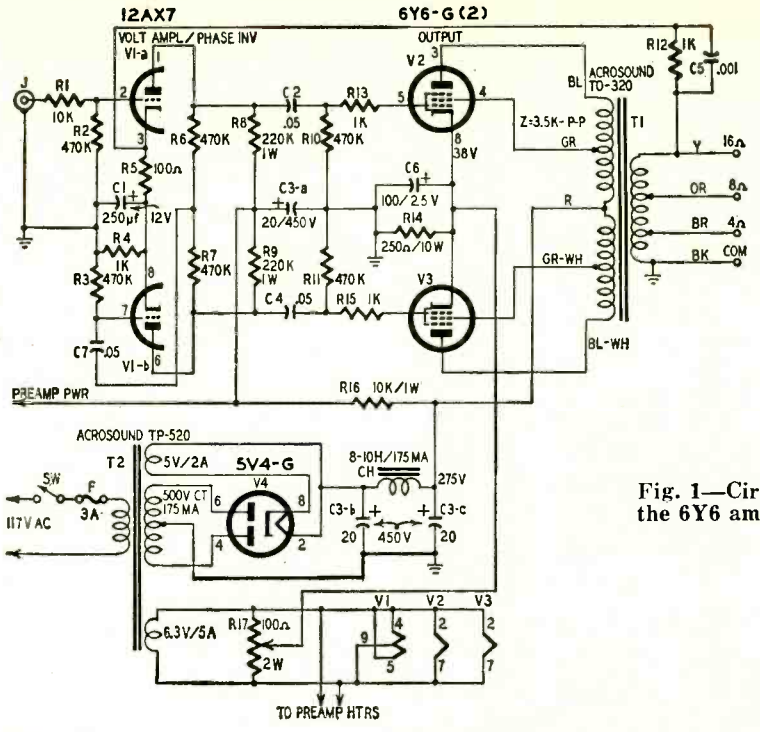


Fig. 1—Circuit of the 6Y6 amplifier.

R1—10,000 ohms
R2, 3, 6, 7, 10, 11—470,000 ohms
R4, 12, 13, 15—1,000 ohms
R5—100 ohms
R8, 9—220,000 ohms, 1 watt
R14—250 ohms, 10 watts
R16—10,000 ohms, 1 watt
R17—pot, 100 ohms, 2 watts, wirewound
All resistors ½ watt unless noted
C1—250 μf, 12 volts
C2, 4, 7—.05 μf
C3—20–20–20 μf, 450 volts, electrolytic
C5—.001 μf
C6—100 μf, 25 volts
CH—8–10 h, 175 ma
F—3 amps
J—phono jack
T1—Acrosound TO-320; primary, 3,500 ohms plate to plate; secondary, 4, 8 and 16 ohms, 20 watts, 30–20,000 cycles
T2—Acrosound TP-520; primary 47 volts; secondary, 500 volts ct, 175 ma; 5 volts, 2 amps; 6.3 volts, 5 amps
V1—12AX7
V2, 3—6Y6-G
V4—5V4-G
Fuse post
Octal sockets (3)
Noval socket
Chassis 10 x 6 x 3 inches

[1] U.S. Patent No. 2,710,312 assigned to Keroes Enterprises.

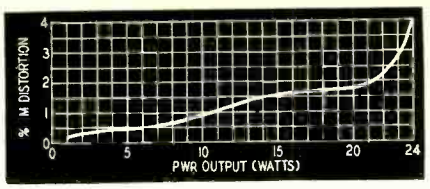


Fig 2—Graph shows IM vs power.

as a power supply voltage regulator. This tube's lack of popularity in audio applications is completely unjustified and is probably due to recommendations for its use as a voltage regulator. I hope that a few audiophiles will become interested enough to give the 6Y6-G an opportunity to prove its value in high fidelity.

The real beauty of the 6Y6-G appears under actual operating conditions rather than in the tube manual's specifications. Here is a tube which can truly be operated in pure Ultra-Linear class A and almost refuses to be driven into AB1 on peaks. The fine linearity of the 6Y6-G does not permit great changes in plate voltage and plate current with changes in signal level. From zero signal to 20 watts, plate voltage drops less than 1%, resulting in low-frequency transient characteristics comparable to many 40-watt amplifiers and superior to most 20-watt units. This unique characteristic, in conjunction with the tube's low inherent distortion, produces an output stage capable of very clean reproduction. Moreover, the 6Y6-G matches into a plate-to-plate load of 3,500 ohms. The lower primary-to-secondary winding ratio allows high frequency response to be extended, with substantial improvement in high-frequency transient characteristics.

The output stage is Ultra-Linear-connected and uses the Acrosound TO-320 output transformer which is designed specifically for the 6Y6-G. While Ultra-Linear operation improves performance with all tube types, there are a few tubes which respond exceptionally well to this mode of operation —the 6Y6-G is one of them.

By comparison with other power tubes in the same power class, the 6Y6-G is somewhat more difficult to drive, requiring about 24 volts rms at the grids for 20 watts out. This is well within the driver stage's capabilities and represents only a minor disadvantage. To keep sensitivity at a reasonable level, only 14 db of feedback is applied. A 1.8-volt input provides full rated output. Since few quality preamps put out less than 2 or 3 volts, this is no problem.

To complement the output stage, a voltage-amplifier–phase-inverter combination is used to maintain unparalleled balance under dynamic conditions and at the same time provide more than enough voltage to drive the 6Y6-G.

The inverter portion of the circuit shown in Fig. 1 appears to function in much the same manner as the conventional paraphase, but the voltage in this case is returned to the lower grid from a junction between two resistors in parallel with the plate loads rather than from a point in the grid loads of the succeeding stage. Under dynamic operating conditions, shifting bias and plate voltages, which are subjected to greater variations in the output stage than they are in the inverter stage, tend to upset inverter balance. With the seesaw inverter, balance is dependent on conditions existing in the same stage and greater dynamic balance is achieved. Coupling-capacitor tolerances need not be considered since they are not involved in the inverter circuit. Other than this, the seesaw inverter performs in a manner similar to the more familiar types in that any change on one side of the inverter will set up a proportional opposing or out-of-phase voltage on the other side.

Before we venture into performance

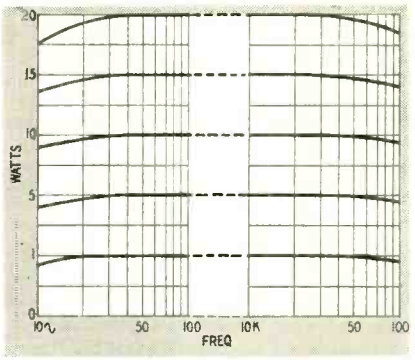


Fig. 3—Response curves for various power outputs.

specifications, one other feature of the 6Y6-G rates a moment's attention. Only 275 volts is required on the plates, which is a decided advantage cost-wise. This places the 6Y6-G amplifier within reach of those who demand highest quality at a minimum of cost and at the same time permits wider rating margins for the electrolytic capacitors. The power transformer is the Acrosound TP-520, designed to meet the voltage requirements of the 6Y6-G.

Amplifier specs

Performance-wise, this is a lot of amplifier. The intermodulation distortion vs power curve presented in Fig. 2 shows that the amplifier can be pushed beyond a 24-watt output, where sine-wave clipping begins, before IM distortion reaches 2%. At the 20-watt level, IM distortion is just at the 1.6% mark and this is with only 14 db of feedback. An additional 6 db would cut these figures just about in half.

At the 1-watt level, the amplifier is essentially flat from 13 cycles to beyond 100 kc, where it goes into a gradual rolloff and is down 3 db at 200 kc. The low plate-to-plate impedance is partially responsible for this fine characteristic and the result is improved high-frequency transient response. Even at rated power, where many response curves become quite ragged, the 6Y6-G still holds up and is ±1 db from 20 cycles to 50,000 cycles, with the same gradual rolloff noted at the 1-watt level. The waveform at 20 watts for 20 cycles and 20,000 cycles is essentially undistorted. Response curves are graphically illustrated in Fig. 3.

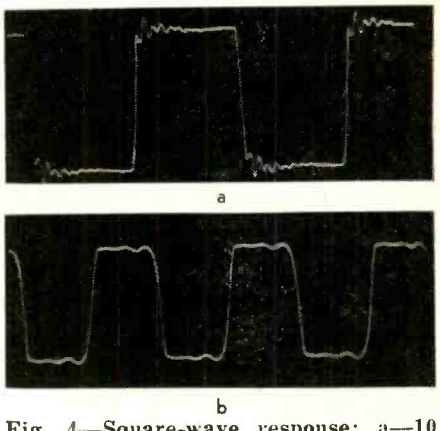
No standards have been established to distinguish between acceptable and unacceptable square-wave response. A set of permissible values have been adopted though, and were outlined a few years back by Langford-Smith:[2]

1. Overshoot—less than 5% of the peak-to-peak value of the 10-kc square wave.
2. Transient recovery time—less than 25% of the 10-kc square-wave flattop.
3. Rise time—3 microseconds or less. Equal to 6% of the duration of the 10-kc flattop. This was arbitrarily adopted to permit the extension of frequency response to 60 kc.

The 10-kc square wave shown in Fig. 4-a falls well within these standards, having overshoot of .07%, recovery time of 21% and rise time of .08%. The 22-kc square wave in Fig. 4-b is also virtually undistorted; however, the previously mentioned standards do not apply to this frequency. Optimum square-wave response is obtained by adjusting the value of the feedback capacitor for maximum rise time and minimum overshoot.

A stability test which is coming more into practice is to check square-wave response with capacitive loads—the higher the value of capacitance before ringing is evidenced on the square wave, the more stable the amplifier. Fig. 5 is an oscillograph of square-wave response with a .02-μf capacitor as a load. Ringing is evident although not serious, and performance is superior to many of the so-called rock-stable amplifiers. Oscillation begins with a .05-μf capacitor. The reactive components of a crossover network and the

[2] *Radiotronics*, Vol. 20, No. 6; June, 1955.



a

b

Fig. 4—Square-wave response: a—10 kc; b—22 kc.

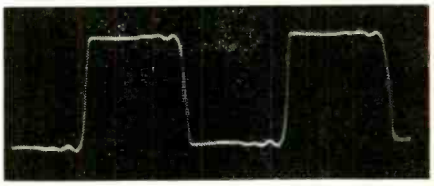


Fig. 5—Square-wave response with a .02-uf capacitance load. Ringing is evident, but not serious.

AMPLIFIER SPECIFICATIONS WITH VARIOUS OUTPUT TUBES

	6Y6	6V6	EL84	KT61
Rated output (watts)	20	15	20	15
Frequency response				
at rated output (cps)	20– 50,000	20–43,000	20–42,000	19–43,000
at 1-watt output (cps)	13–110,000	14–72,000	15–60,000	14–60,000
Sensitivity (for rated output) (volts)	1.8	1.4	0.8	1.3
Bias voltage	—38	—21	—12	—8.5
Grid voltage (at rated output)	24	17	9.5	8.0
Damping factor	10	12	20	22
Stability margin (db)	16	16	11	8
Feedback (db)	14	14	19	21
Noise and hum (db)	(87 to 90 below rated output)			
B-plus voltage (no signal)	275	325	325	325
B-plus voltage (rated output)	274	321	323	323
Intermodulation distortion (%)—60 cycles and 3,000 cycles, 4 to 1:				
(watts)				
1	0.25	0.25	0.15	0.08
3	0.45	0.60	0.25	0.13
5	0.47	0.82	0.35	0.20
7	0.52	1.18	0.51	0.32
10	0.78	1.35	0.83	0.49
12	1.02	1.42	1.10	0.63
15	1.50	2.00	1.76	2.72
17	1.52	5.00	2.35	9.40
20	1.61	12.00	5.30	
22	2.00		8.62	
24	4.10		10.00	
26	10.00			

increasing popularity and availability of electrostatic speakers substantiate the reasoning behind this test.

It was mentioned previously that some amplifiers measure well and sound poor. Here is an amplifier that sounds better than it measures—and it measures extremely well. A–B'ing, even with 30- to 50-watt amplifiers, left no question as to the superb qualities of this modest unit. When used to drive the low-efficiency AR-1, there was no sign of overworking, and above-average listening levels gave no indication of breakup or excessive distortion.

Construction is quick and simple. The lab model was built into a 10 x 6 x 3-inch Minibox chassis which allows straightforward layout with adequate ventilation for all components. Parts placement is not critical.

The underside of the chassis is just as simple and straightforward as topside. Point-to-point wiring is recommended whenever practical, with leads taking the shortest possible route. Heater leads are tightly twisted and dressed close to the chassis and away from grid leads. B-minus bus bars are frequently a must in amplifier construction; however, this is not true in this case and grounds are taken to the closest tie point with no adverse effects. The photographs show a compact but uncluttered arrangement.

Although not used in the lab model, a 100-ohm wirewound potentiometer across the 6.3-volt secondary with its slider going to the 6Y6-G cathodes is shown in the schematic. This arrangement reduces heater hum by placing a small amount of dc on the winding and is recommended when a preamp is powered from the basic amplifier. Since no preamp was to be powered from the lab model, one side of the heater winding was grounded at the first stage and the pot was eliminated.

When connecting the leads of the TO-320 primary, phasing of the two halves is important since reversing the leads will cause oscillation. The tracer leads go to the output tube driven by the lower half of the phase inverter.

As a matter of interest, the 6Y6-G output stage was removed and replaced by two other stages. All three units were tested under similar conditions and the results tabulated and presented in the table for comparison.

The popular 6V6 and the new miniature EL84 were inserted in the circuit with an Acrosound TO-310 which matches the plate-to-plate load of both tubes. The only other change is the 250-ohm 10-watt resistor in the output stage cathodes, which becomes 125 ohms with the EL84's.

Both transformers are almost identical, having the same rated power and frequency characteristics. The only actual differences in the circuit were the primary impedances of the output transformers, the output tubes and the B-plus voltage. Due to the decrease in current drain of the 6V6 type, plate voltage automatically increased to the required 325 volts.

Rather than point out any specific feature or show the favorable or unfavorable characteristics of each tube, I'll let the reader determine for himself what factors are important to him. Each tube is not without faults and, at the same time, each has desirable features.

Listening to the 6Y6-G was proof enough that excellent performance can be had with a 20-watt amplifier. This little unit sounds better than comparable amplifiers and really gives some 30–50-watters a run for their money. The 6Y6-G is an amazing tube and truly rates greater recognition in the high-fidelity field. END

TRANSISTOR PREAMP

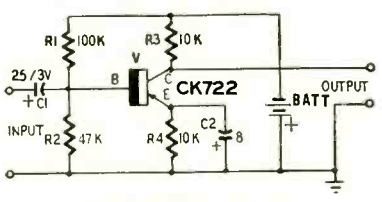
Tiny self-powered transistor unit boosts output of low-gain mikes

By ALLAN LADD

Here is a transistor preamp. which gives 30 to 32 db of gain, using a Raytheon CK722 transistor. Similar transistors such as RCA 2N34 or Raytheon CK721 give similar results with the added advantage of a slightly higher gain.

The table shows the operating conditions for the Raytheon CK722 transistor at various voltages when used in this circuit.

The preamp's waveform differs slightly for different types of transistors, and the frequency response curve of the CK722 transistor preamplifier shows that from 30 to 200 cycles the voltage gain rises gradually from 24 to 31 db. From 200 to 10,000 cycles the output is constant and perfectly straight and from 10,000 to 20,000 cycles the output drops 2 db. These results were obtained by using a constant input of .01 volt ac to the preamp.



R1—100,000 ohms, ½ watt
R2—47,000 ohms, ½ watt
R3, 4—10,000 ohms, ½ watt
C1—25 µf, 3 volts, electrolytic
C2—8 µf, 25 volts, electrolytic
V—CK722, CK721, 2N34
BATT—see text

Battery (Volts)	Ma	Voltage, collector to base	Rms Input (Volts)	Undistorted Output (Volts)	Gain Voltage
1.5	.05	0.55	.017	0.25	23
3.0	1.1	1.0	.02	0.6	29
4.5	0.15	2.0	.025	1.0	30
6.0	0.2	2.0	.035	1.5	34

The output response curve under normal working conditions, such as a microphone, will follow the curve of the microphone itself.

The preamp can be built in a very small space provided a midget battery is used. END

The fixed-bias Story

Is fixed bias really better? Tube data say yes; comparative listening may say no. Who's right and why?

By HERBERT RAVENSWOOD

IF we examine typical output tube data, we find that it is often profitable to use fixed bias, as opposed to self-bias, in an output stage. Fig. 1 is a comparison of the two basic circuits. Figs. 1-a and -b show automatic or self-bias circuits using common and separate resistors, respectively (common resistor R and separate resistors R1 and R2). Figs. 1-c and -d show fixed-bias circuits (without the supply; its exact circuit is not important). This too can use common voltage (Fig. 1-c) or separate voltages (Fig. 1-d). Let's see what difference is involved for some typical output tube types.

Take first the Mullard EL84/6BQ5, which is a miniature output pentode intended for high-power auto-radio and similar uses. Some manufacturers work two of these tubes in push-pull for a small power amplifier output, about 15 watts. The conditions stated by the manufacturer list the same power output, whether self- or fixed bias is used, with a 300-volt plate supply and pentode operation. For each, maximum power output is 17 watts.

Plate and screen currents at maximum output are 92 and 22 ma, respectively, whichever method of operation is used. The big difference is in the quiescent, or zero-signal, plate and screen currents. For fixed bias these are 15 and 1.6 ma, but for self-bias they are 72 and 8 ma.

While both circuits give the same maximum power output, considerable economy is possible in the design of a power supply, as well as in power consumption during operation, by using the fixed-bias arrangement.

Next let's look at the 6L6, 5881 and 807. Using self-bias and operating a pair in class AB1, the maximum output for any of these tubes is 24 watts. The 6L6, using fixed bias, will go to 26.5 watts in AB1 or 47 watts in AB2. The 5881 will also put out 47 watts by driving into the positive grid region.

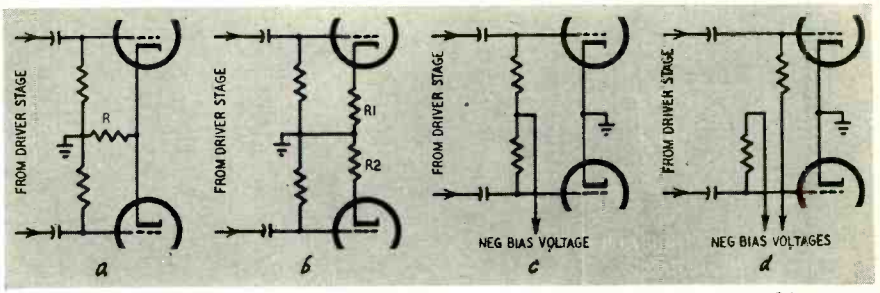


Fig. 1—Basic methods of biasing: a, b—self-bias; c, d—fixed bias.

The 807, with 600 volts on its plate and 300 volts on its screen, will deliver 80 watts in AB2.

We have some tubes that exhibit an even bigger difference. The 6550, working as a pentode with self bias, using a 400-volt plate supply and a 275-volt screen supply, gives a maximum of 55 watts. Going over to fixed bias, with 600 volts on the plate and 300 volts on the screen, we can get 100 watts.

Why the difference?

The reason for the difference is not too difficult to deduce. We could undoubtedly set up a circuit, with any of these tubes, to give the same maximum output on self-bias, using the same plate and screen voltage supplies that are permissible for fixed bias. The tubes would be quite OK *while delivering maximum output*. As soon as the input signal is removed, bias will drop considerably, allowing plate and screen current, under the zero-signal condition, which will exceed the permissible dissipation of the tube. Fixed bias keeps the tube within its dissipation rating all the way from zero signal to maximum output.

These are the figures from tube manufacturers, and countless engineers in different companies have set the tubes up and verified these operating conditions. Many amplifiers have been built, using fixed-bias conditions to get a bigger output. But, for all this evidence of the advantage of fixed bias, probably an even larger number of people have made comparative tests of amplifiers using these different circuits. Their impressions frequently contradict the test-bench figures.

Many readers have asked the reason for differences they have observed. And I have been present several times at comparative tests that have shown the same thing. What is the reason? Why should listening tests contradict, sometimes dramatically, the carefully conducted engineering tests?

First, the difference in the measured output is not more than 3 or 4 db, even in the most drastic cases, and this represents just about an audible difference. But surely, even then, we should be able to hear that the maximum output of the fixed-bias amplifier is just a little bit louder than that of the self-bias amplifier, before it goes into distortion? The difference appears to depend upon *how* it goes into distortion.

When you make comparative tests on the output of two amplifiers feeding the same speaker you naturally turn the gain control up until you hear something happen that suggests it is "reaching the top." The reason for the big observed difference in performance is due to just what happens when these amplifiers reach the overload point.

Practically all modern amplifiers use resistance-capacitance coupling between the driver and output stages. True, there *are* types which do not and we shall come to these a little later. However, the comparisons in which the

observed difference seems to contradict the measurements are those in which the drive stage *is* R-C-coupled to the output stage.

As soon as the output stage reaches the clipping point, in either type of amplifier, the output grids start to conduct current. At the same time the loading effect of this current on the driver stage considerably reduces amplification of audio voltage beyond this grid-current point. This means the feedback is reduced. Consequently, the input voltage received by the driver rises in a more rapid peak. This causes a rapid increase of grid current at the output stage grid. This is illustrated in Fig. 2. (The circuit of Fig. 2 does not show biasing arrangements, because the action depicted occurs whichever method of bias is used.)

This positive grid current causes other things to happen, too. As soon as it begins, it produces a negative bias, due to the charge on the output side of the coupling capacitor between driver and output stages. So, as soon as the clipping point is reached, *very little extra input* will produce a considerable negative bias voltage due to this grid current. Now for the difference caused by different methods of biasing.

Biasing effects

In the fixed-bias circuit, this additional negative voltage usually biases the tubes back well beyond cutoff. The fixed bias is already chosen to operate the tubes in AB1, if not nearer to a true class B. So a big piece of extra negative bias pushes them beyond cutoff, causing crossover distortion. Pushing the output tubes back further toward cutoff also reduces the current drain on the B-supply which, if regulation happens to be not too good, will cause the voltage to rise. This may slightly increase the gain of the amplifier's earlier stages and results in an even bigger grid drive to the drive stage. Thus on several counts the effect is cumulative. As soon as a little bit of clipping starts, in a fixed-bias amplifier, the waveform almost jumps from a practically pure sine wave to the kind of wave shown in Fig. 3.

The sudden change is because the effect is cumulative. As soon as a little bit of grid current starts to flow, the gain of the earlier part of the amplifier is boosted by a rise in B-voltage. The feedback disappears as soon as grid current starts to flow and causes the driver stage's input voltage to rise more rapidly. The whole thing acts almost like a triggered oscillation. As you turn the input to the amplifier up very slowly, you find the waveform goes steadily up until clipping quite suddenly changes the waveform from one to the other. There may even be a backlash effect. The waveform quite suddenly goes from a nice sine wave to a severely distorted one. Then, as you turn the input down again, the level at which it reverts to a sine wave is considerably below that at which it became distorted.

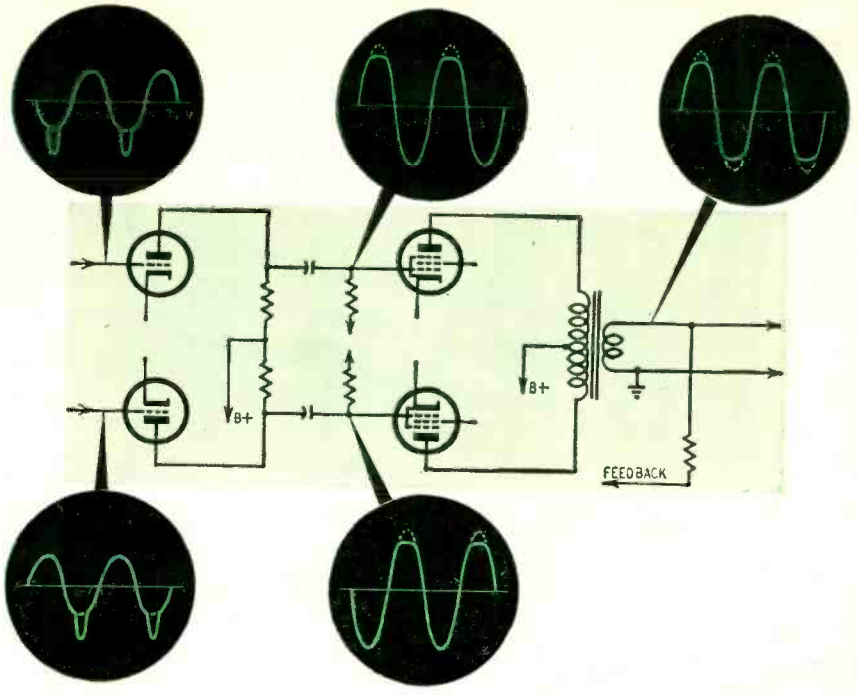


Fig. 2—How feedback aggravates the changes brought about in any amplifier when clipping begins.

Removing the feedback reduces some of the cumulative effect but makes crossover distortion worse because feedback does help reduce crossover distortion although it exaggerates clipping distortion. Thus, without feedback, the same fixed-bias amplifier would produce a waveform more like that in Fig. 4. Obviously, neither of these waveforms (Figs. 3 and 4) will sound very good.

In the self-bias amplifier, however, when this new source of negative bias due to clipping comes along, plate current naturally drops. This means the self-bias component of the negative grid voltage (actually positive cathode voltage) is reduced to compensate for the added negative voltage at the grid. The plate current will be somewhat less than before grid current commenced, but not enough to produce the exaggerated crossover distortion that occurs with fixed bias. Consequently, the effect of clipping is to readjust the bias and avoid a continuation of clipping on successive waves.

Due to the slightly increased bias, gain of the output stage is reduced throughout the entire waveform and the clipping does not become too severe. This means the self-bias amplifier can probably handle from 3 to 6 db more maximum input before running into the serious kind of distortion that occurs with the fixed-bias amplifier.

Numerous tests have shown that we do not judge the loudness of a particular program by the maximum signal level on peaks, but by the average or rms level of the whole program. So, if we can turn the average loudness up by 6 db on a self-bias amplifier before distortion begins to show, while there is practically no margin on a fixed-

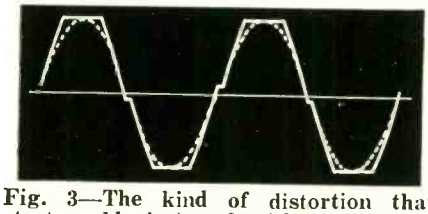


Fig. 3—The kind of distortion that starts suddenly in a fixed-bias amplifier, with feedback. The solid line represents a very slight increase of input from the dashed (sine wave).

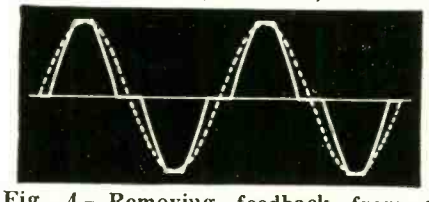


Fig. 4.—Removing feedback from a fixed-bias amplifier produces this change in waveform when clipping starts.

bias amplifier, the self-bias job will obviously sound a little louder.

In other words, the self-bias amplifier tends to exert a sort of avc action on the peaks to avoid distorting them too much, provided they are not too big. The fixed-bias amplifier, on the other hand, almost triggers itself into a form of distortion as soon as the maximum level is reached.

Notice that the use of feedback over the fixed-bias amplifier does not materially improve the situation. It alters the kind of distortion rather than eliminates it, and the kind of distortion that shows is actually exaggerated by the feedback rather than reduced.

A further reason for the difference in sound between fixed-bias and self-bias circuits is that the fixed bias goes into distortion and stays there until bias is restored to normal, a little while

after the overload point has gone. Therefore, the smaller parts of the waveform following the peak signal in an actual audio program are distorted as much as the peak signal. With self or automatic bias, this is not so. If distortion occurs at all, it is only on the peaks. As soon as the slide-back biasing effect has passed, the automatic bias action of the cathode resistor readjusts the circuit and avoids excessive distortion of the in-between signal. This difference is illustrated by Fig. 5.

How to use fixed bias

There is just one kind of circuit in which fixed bias can profitably get bigger output. This is shown in Fig. 6. If direct, transformer or choke coupling is used between the driver and output stages, this additional grid-bias effect does not occur. In such a circuit, appropriate design of the driver stage permits power drive or class-AB2 operation and gets the high maximum outputs that are available with such circuits.

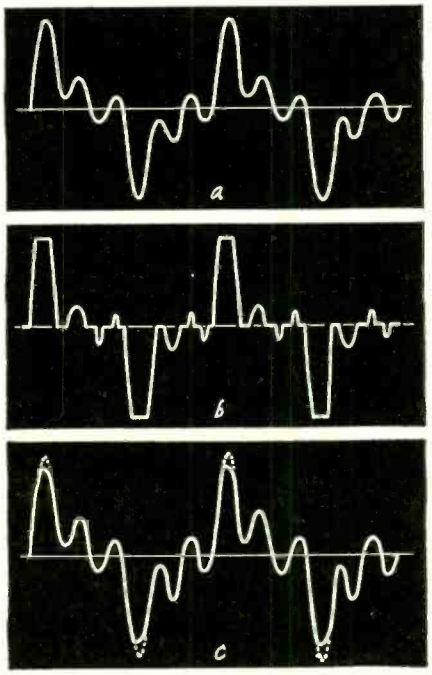


Fig. 5—Comparison of fixed-bias and self-bias amplifiers on a composite wave: a—input waveform, undistorted; b—output waveform just beyond distortion point, fixed bias; c—output waveform just beyond distortion point, self-bias (dotted portions indicate main distortion).

However, this kind of circuit has become unpopular due to the difficulty in applying feedback over an amplifier with two transformers in it. The alternative of direct coupling is difficult because it involves us in supply troubles. The supply voltage of the drive stage also has to provide the fixed bias for the output stage (Fig. 7). However, if the voltages of such an amplifier can be satisfactorily stabilized, the amplifier can then use overall negative feedback and will give the maximum rated output of the fixed-bias arrangement without the tendency to drastic distortion we have discussed.

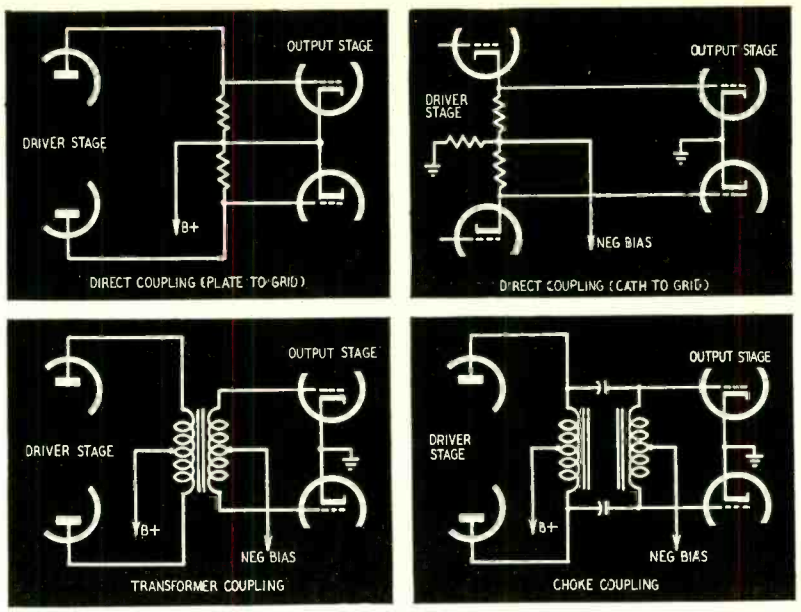


Fig. 6—Types of coupling that avoid "slide-back" effect of fixed-bias circuits.

Transformer and choke-coupling methods were quite popular in amplifiers a little before feedback came so much to the fore. In those days I remember class-B amplifiers without feedback which had a very acceptable output waveform. One of these delivered 250 watts audio, using a pair of transmitting triodes for output tubes with only 100 watts dissipation each. Both driver and output transformer needed very careful design and were costly to produce, but not too costly when the large output is considered. The distortion right up to the maximum of 250 watts was well within 5% (this without any feedback, because feedback was not applied in those days).

Contrary to some belief on the subject this kind of amplifier does not prove at all critical of loading. Any load value, higher than the nominal resistance which absorbed 250 watts at maximum output, would give a satisfactory output waveform. If load resistance was doubled, the power it received would be approximately halved but the waveform would be just as good.

The principal reason why such a circuit would not be used today is that it is not practical to apply feedback over such an amplifier, with its two transformers. It is not impossible to reduce distortion considerably by applying feedback from the driver stage to some earlier point in the amplifier, thus still using only one transformer in the feedback network (Fig. 8). This could serve to minimize the distortion caused by grid current loading in the drive stage. This may be "heresy" but it's an idea we have not seen tried.

However, this approach could not be expected to get the distortion figure down to the fraction of 1% that is popular for modern amplifiers. But it is not impossible that such an amplifier might *sound* even better than some of the modern amplifiers due to a more satisfactory overload characteristic.

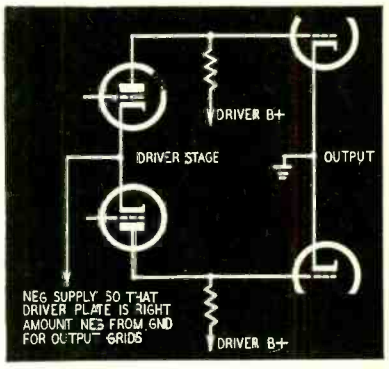


Fig. 7—The problem of direct coupling is the number of extra power supplies needed and obtaining the right bias for the output tubes.

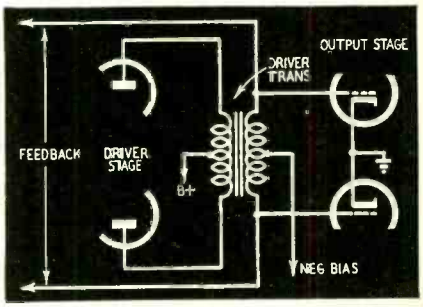
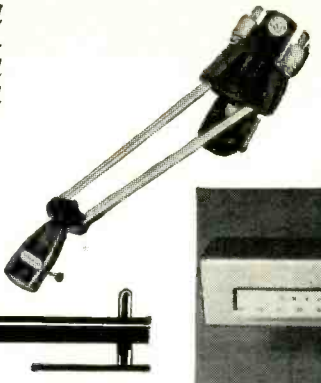


Fig. 8—Possible approach to improved amplifier design using transformer coupling from driver stage and feedback taken from driver transformer.

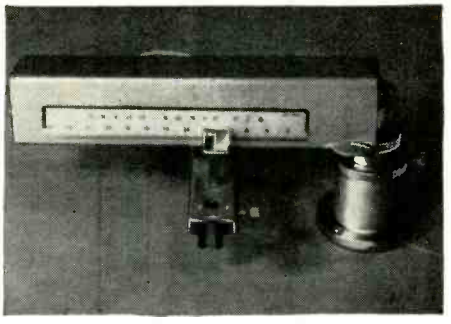
Reasons have been given why standard test signals, such as a pure sine wave at steady intensity or the kind of waveform delivered by an intermodulation test set, do not represent the behavior of the amplifier on audio program material. What we have discussed in this article reaffirms this inadequacy from another angle and emphasizes the importance of trying the amplifier out on actual program material before concluding that the engineering test means we have a better amplifier. END

HI-FI PICKUP ARMS

Part III—Radial and linkage arms which provide perfect tracking all the way across the record



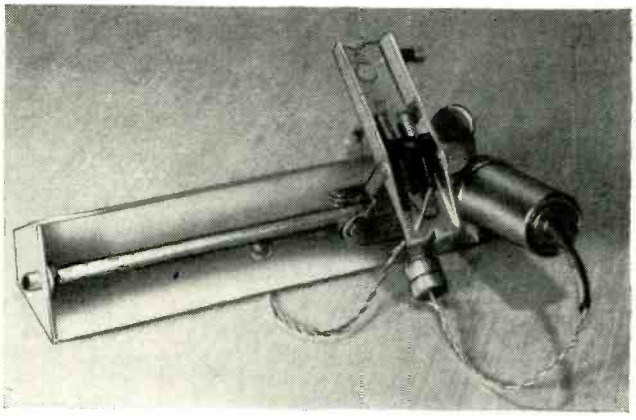
ESL/BJ "Super 90" tangential arm.



By JULIAN D. HIRSCH

CONVENTIONAL pickup arms always have to compromise with the problem of tracking error. All records are cut with a cutter that moves along a screw placed along a radius of the disc. Thus it at all times moves at a right angle to the movement of the record beneath it. As the cutting stylus, in response to an audio signal, moves from side to side in the groove it is also moving along the record's radius. Ideally, the pickup stylus should also always move along the disc's radius. This requires a pickup arm that keeps the stylus at a right angle to the record's radius.

Unfortunately, an arm pivoted at a single point outside the maximum record radius describes an arc as the stylus follows the record grooves from outside to inside. If a straight arm is used, the pickup axis is exactly tangent to the record grooves at only one point. The angle between the pickup axis and a line tangent to the record groove is called the tracking error. Tracking error introduces second-harmonic distortion into the output. Under some conditions this distortion can become as large as 10% or more.



(Above) Ortho-Sonic V/4 radial pickup arm.

Fig. 2 — Underside view of the Ortho-Sonic V/4 radial arm.

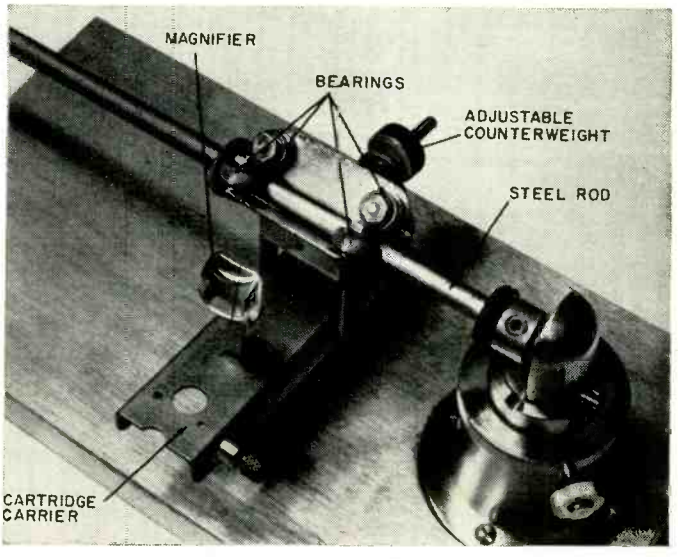


Fig. 3 — Detailed view of roller assembly of the Ortho-Sonic V/4.

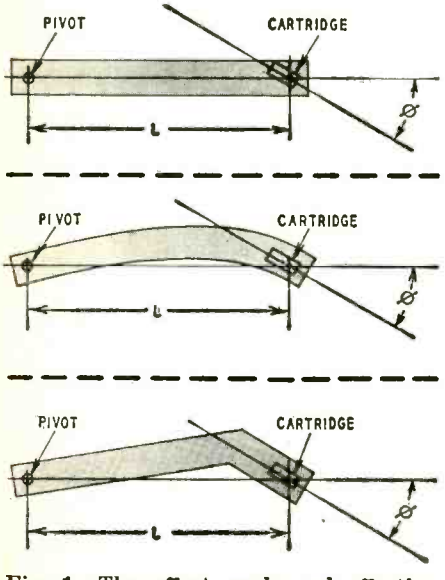
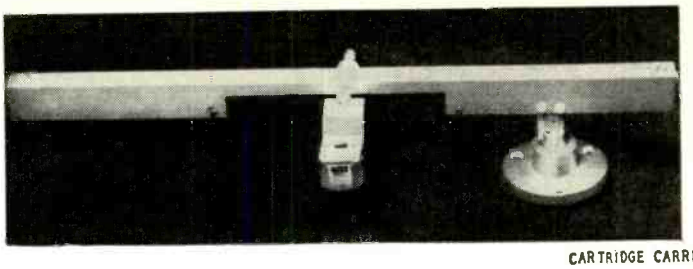


Fig. 1—The offset angle and effective length of different shaped arms.

Tracking error is minimized by carefully coordinating arm length, the distance from the arm's horizontal pivot to the turntable center and the offset angle of the cartridge. (See "Record Tracking" by Norman H. Crowhurst, RADIO-ELECTRONICS, October, 1957.) Fig. 1 shows the effective arm length and offset angle for several types of arm designs. It is important to realize that the offset angle is *not* the angle which a bent portion of the arm may make with the main body of the arm and is completely unrelated to the physical shape of the arm.

The two most common approaches to eliminating tracking error involve either a system of mechanical linkages which keep the cartridge tangent to the groove as it travels across the record, or a *radial* arm in which the cartridge actually moves along a radius of the record. A number of designs of both types have appeared in the past, but



Audio Specialties AS-30.

most have proven unworkable for one reason or another. There are only two radial arms and one linkage type arm available today. These are described in this article.

ESL/BJ Super 90

A few years ago, the original BJ arm was introduced in this country. An English design, it consisted of a cartridge shell mounted on the ends of two cylindrical rods. These rods were pivoted at both ends. As the cartridge traveled across the record, the shell was rotated to maintain tangency. It was claimed that tracking error over the surface of a 12-inch record did not exceed 1°.

This arm had a few drawbacks from the viewpoint of the American hi-fi enthusiast. It did not have a removable cartridge shell. Tracking force was adjusted by adding wedge-shaped lead plates to the rear of the arm. There was also some difficulty in keeping bearing friction down while maintaining freedom of motion. The problem was complicated by the fact that four bearings (needle type) were involved in the lateral motion of the arms.

Recently a much improved version of the BJ arm, called the Super 90, has been distributed in this country by Electro-Sonic Laboratories. It includes two plug-in heads which accommodate virtually all cartridges. A novel calibrated mounting pedestal permits instant selection of correct stylus overhang when different cartridges are used. Two sliding counterweights replace the lead plates and permit a continuous stylus-force adjustment over a 40-gram range. The four lateral pivots now employ self-lubricating ball bearings. The ESL/BJ Super 90 arm is available in two sizes—for 12-inch and 16-inch records.

The ESL/BJ Super 90 arm is shown in the photos. An unusual characteristic of this arm is that its lateral mass is less than its vertical mass. In the horizontal plane, only the cartridge shell and the two aluminum tubular arms are free to move. The rear portion of the arm, containing the counterweights, remains fixed and rotates only vertically. The manufacturer states that the tubular arm sections, being of unequal length, have different resonant frequencies and tend to cancel effects of arm resonance.

Since four bearings are used instead of one, lateral friction will be somewhat higher than in conventional arm design. However, the manufacturer states that lateral friction, referred to the stylus, does not exceed 1 gram. This is somewhat greater than the friction of several of the better conventional arms, but does not impair performance of the arm or cartridge if tracking forces greater than 4 or 5 grams are used. The arm is not laterally balanced and the turntable motorboard must be carefully leveled.

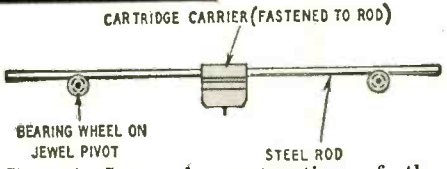


Fig. 4—Internal construction of the Audio Specialties AS-30 arm.

Ortho-Sonic V/4

The Ortho-Sonic V/4 arm, shown in the photos, was the first commercially successful radial arm to appear on the American hi-fi scene. It consists of a highly polished steel rod on which the carriage containing the cartridge is free to roll. Fig. 2 shows the underside of the Ortho-Sonic V/4 arm. The carriage rolls on four low-friction ball bearings, arranged in two V-shaped pairs. Fig. 3 is a cross-section sketch showing how the ball bearings and carriage ride on the rod.

The cartridge carriage is simple and universal. Any standard cartridge can be used. Two spring-loaded contacts make the electrical connections to the cartridge without soldering. This carriage accommodates turnover cartridges as well as single-play types. Protruding from its rear is a threaded rod on which two adjustable counterweights are mounted.

The radial rod is covered by a metal case which protects it from dust and accidental scratches. The case may be rotated slightly by grasping it near the mounting pedestal, raising the stylus from the record surface. This also releases the detent which holds the arm firmly in playing position and allows the arm to be swung clear of the record. Adjustable stops, provided on the rod, limit the cartridge's travel to the extent required for playing 12-inch records (or 16-inch records in the 16-inch version of this arm).

Operation is simple and foolproof. With the cartridge slide at the pedestal end, the arm is swung into place over the record. At the correct position, it hits a mechanical stop. At this point, rotating the arm case counterclockwise lowers the stylus gently to the record and engages the detent, which prevents moving or dislodging the arm while it is in playing position.

At any time while playing a record, the arm case may be rotated to lift the cartridge from the record without disturbing its position. When it is lowered to the record surface, it will usually return to the same groove that it left. This feature can be very handy if you are called to the telephone or otherwise interrupted while playing a record. The arm case has a calibrated scale, and a magnifying lens is mounted on the cartridge carriage. This permits cuing to a previously selected portion of a record.

Installation of the Ortho-Sonic V/4 is very simple, since there are no critical mounting distances or overhangs to observe. The pedestal may be mounted at any point around the circumference of the turntable, close enough for the cartridge slide to cover the usable surface of a 12-inch disc. By loosening a thumbscrew the entire arm can be rotated so the cartridge stylus travels along a record radius, and the mechanical stop and detent are correctly positioned. Once this position is determined and the arm height is set for the turntable, the thumbscrew locks the assembly. The arm must be leveled so it is parallel to the turntable surface.

The lateral friction of the Ortho-Sonic V/4 arm is about 1 gram. As with the BJ arm, this does not offer any tracking difficulty if a stylus force of at least 4 grams is used. When properly installed, the arm has zero tracking error. Of equal interest to the user is its universal solderless cartridge mounting system, its simple and foolproof operation and the ability to pause during the playing of a record and return to the same place without a trial-and-error process. This arm is also virtually immune to jarring and vibration.

Audio Specialties AS-30

The photos show the Audio Specialties AS-30 radial arm. In this design, a steel rod is fastened rigidly to the cartridge holder. The rod rides on two grooved wheels, similar in appearance to small pulleys. These turn on jewel bearings having very low friction. The entire rod moves with the cartridge as it travels across the record. Fig. 4 is

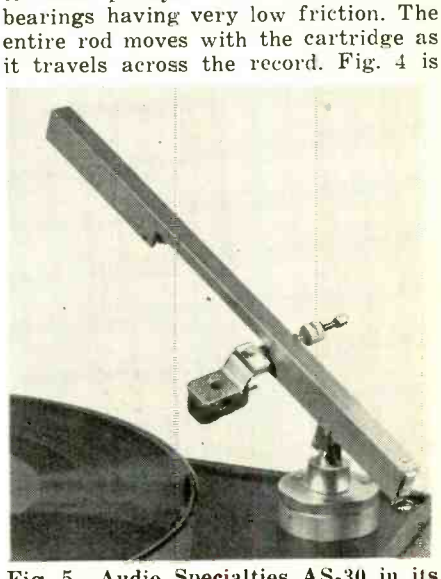


Fig. 5—Audio Specialties AS-30 in its off the record position.

a sketch showing the internal construction of the Audio Specialties AS-30 arm.

Fig. 5 shows the arm in its off-record position. The mounting pedestal is designed to hold the arm structure up at approximately a 30° angle except when in playing position. The arm contains built-in stops which locate the cartridge properly for entering the lead-in groove of a 12-inch record.

In use, the arm is rotated until it is along a record radius. Then it is pressed down into a position parallel to the record surface. The pedestal is designed so the arm cannot be lowered until it is in the correct position and, when down, cannot be moved. The cartridge stylus automatically and gently enters the lead-in groove as the arm is lowered. At the end of the record, the arm is lifted and swung aside. The cartridge slides down to its starting position when this is done.

Like the Ortho-Sonic, the Audio Specialties arm, when properly installed, has zero tracking error. Installation is simple, though its location relative to the turntable is fixed by the requirements of the built-in cartridge positioning stop. A mounting template is provided. The arm's height is adjustable to accommodate various turntables. Stylus force is varied by two knurled counterweights, which can be seen protruding from the rear of the cartridge carriage. This arm will accept almost any type of cartridge, but it must be screwed in place and soldered to the cartridge connection clips.

The manufacturer states that a vertical tracking force of 2.5–3.5 grams should be satisfactory with most cartridges. It is also relatively insensitive to the effects of shock and jarring. END

Hi-Fi Rules

Charles Nichols, director of engineering of Hoffman Electronics Corp., at the recent Hoffman dealer–distributor convention at Las Vegas, listed the following *minimum* requirements for high-fidelity equipment:

1. Sufficient power output—15 watts or more.
2. Low distortion. Less than 2% at 10 watts.
3. Wide frequency response. At least 40–15,000 cycles, ±2 db.
4. Bass and treble controls. Minimum of 15-db boost and rolloff.
5. True contour loudness control.
6. At least two speakers or one coaxial speaker.
7. No discernible hum at low volume.
8. Presence.
9. Ceramic or reluctance cartridge.
10. Turntable or record changer with four speeds, intermix automatic turnoff and no rumble.
11. Tuner input jack or tuner itself if it is a combination.
12. No interaction between the changer and tone chamber.

TONE CONTROL through positive and negative feedback

By A. V. J. MARTIN

A COMPLEX tone-control circuit combined with positive and negative feedback is found in some deluxe French Sonneclair receivers and is shown in Fig. 1.

The feedback voltage is taken from the output transformer's secondary and is applied to the grid of the audio preamp (V1). Two bridged-T circuits are inserted in the feedback loop. The first has a maximum attenuation around 3,700 cycles, so that feedback is reduced at this frequency. This provides treble boost.

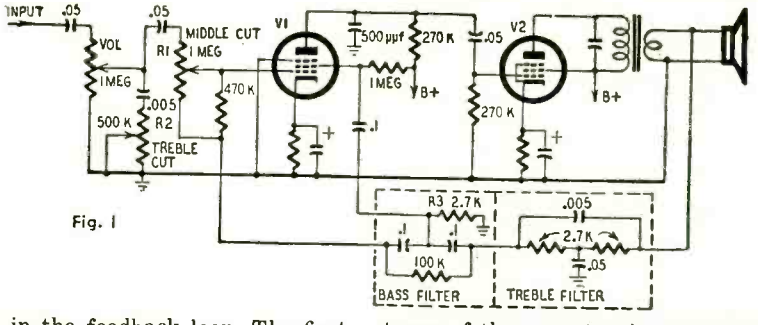


Fig. 1

The second has its maximum attenuation at about 100 cycles and insures bass boost.

The total effect of the two bridged-T networks is then a bass and treble boost. The amount of boost is adjusted by potentiometer R1, which feeds a variable amount of feedback voltage to the first grid. R1 is then justly called MIDDLE CUT.

At the input, high frequencies can be more or less short-circuited to ground through a .005-μf capacitor and potentiometer R2, accordingly labeled TREBLE CUT.

Finally, the voltage appearing across resistor R3 in the low-frequency bridged-T circuit is maximum at low frequencies. As it is applied to the preamp's screen grid, it provides positive feedback at low frequencies, and hence some additional bass boost, independent of the potentiometer's settings.

Another similar feedback circuit that provides tone control is shown in Fig. 2. This circuit is also found in some *Sonneclair* receivers.

The push-pull output tubes are driven by a self-balancing phase inverter. Resistor R1, common to the two grid returns of the output pair, does the trick. The feedback loop runs from the voice coil of the speaker to the preamplifier's grid. It includes two bridged-T filters. One has a fixed point of maximum attenuation in the vicinity of 100 cycles. It reduces the feedback ratio for low frequencies, thus providing bass boost.

The other can be adjusted by a three-position switch to have a maximum attenuation of 5,200, 3,700 or 1,600 cycles. It decreases the amount of feedback for high frequencies and provides treble boost. The switch position determines the shape of the response curve at the upper end of the audio spectrum.

Potentiometer R3 applies part of the feedback voltage to the input grid and fixes the amount of bass and treble boost. Potentiometer R4 is the conventional TREBLE-CUT control.

The voltage appearing across resistor R2 in the low-frequency T filter is maximum at low frequencies. It is applied to the screen grid of the preamp, providing bass boost by positive feedback. Amount of feedback is constant. END

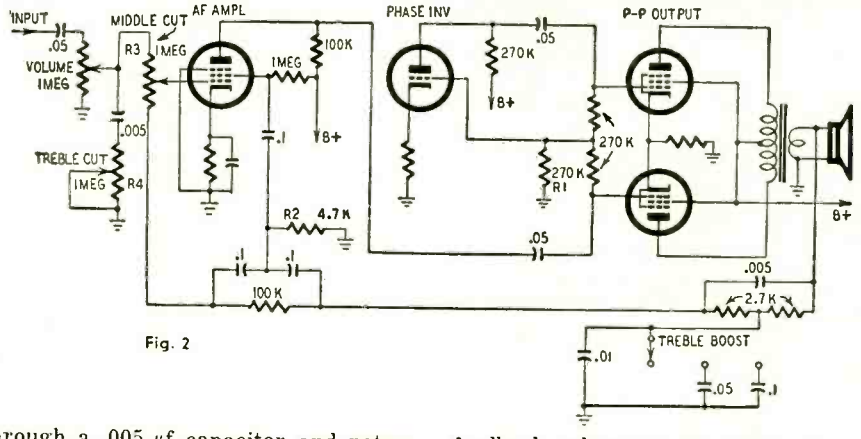


Fig. 2

COVER FEATURE

Printed-Circuit Switches Simplify Kit Construction

30-watt hi-fi preamplifier–amplifier incorporates a number of other interesting features

THE front cover of this issue shows a conventional printed-circuit board. Mounted on the board is a new development in rotary switches—a printed-circuit switch. The switch blades and rotor are standard but, instead of lugs for soldering connecting wires, each switch wafer is riveted to a phenolic sheet. Printed connections run from the rivets to a row of pins protruding from the bottom of the sheet. The pins are inserted into matching holes in the printed-circuit board (see front cover). The board is turned over and the pins soldered into the printed wiring pattern. That's all! This type of switch cuts assembly time drastically and eliminates the chance for errors in wiring the switch.

The switch and board are part of the preamplifier section of Allied Radio's new 30-watt high-fidelity amplifier–preamplifier Knight-Kit, which has several novel design features. Two of the switches are used in this kit although only one is shown—half-inserted in the printed-circuit board. One functions as the input selector–equalizer. The other is the high-frequency rolloff selector for the phono preamp.

The amplifier has three printed-circuit boards in addition to the printed switches. All tubes except the 5881 push-pull outputs and the GZ34 rectifier are mounted on these boards. Their use greatly simplifies assembly and insures that the finished job will perform with minimum deviation from design specifications.

Circuitry

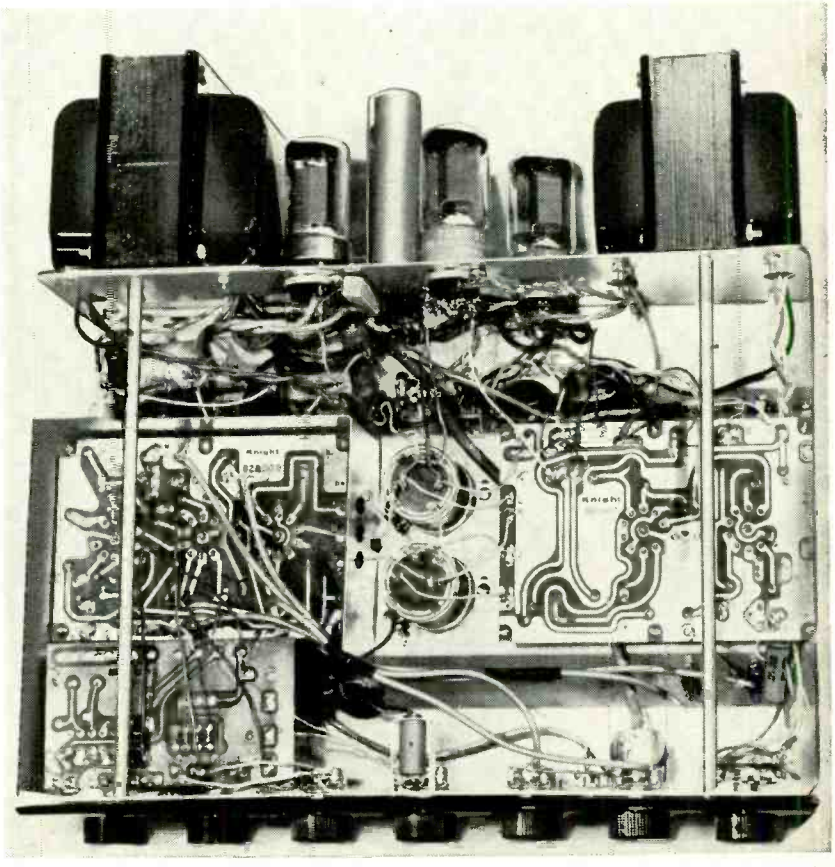
The power amplifier is a standard Ultra-Linear Williamson. The output stage uses a pair of 5881's which are similar (except for maximum ratings) to 6L6-GB's. They are driven by an ECC82/12AU7 in push-pull. The input–phase-splitter stage uses another ECC82/12AU7.

The power amplifier is preceded by a four-stage (two ECC82/12AU7's) preamplifier of fairly standard design, incorporating bass, treble, loudness, and level controls. Its input selector can switch in five input sources: tape, tuner, microphone, phono and auxiliary. In the phono position, an additional two-stage low-level equalizing preamp (a low-noise 12AY7) is switched in, for use with low-level magnetic cartridges or tape heads. The phono position of the input selector is actually five positions, each one providing a different low-frequency crossover equalization setting. A separate control switch gives four high-frequency rolloffs for the phono preamp. There are four low-level phono-input jacks GENERAL ELECTRIC, PICKERING, CERAMIC (for phono cartridges) and TAPE HEAD (for tape players having no preamp).

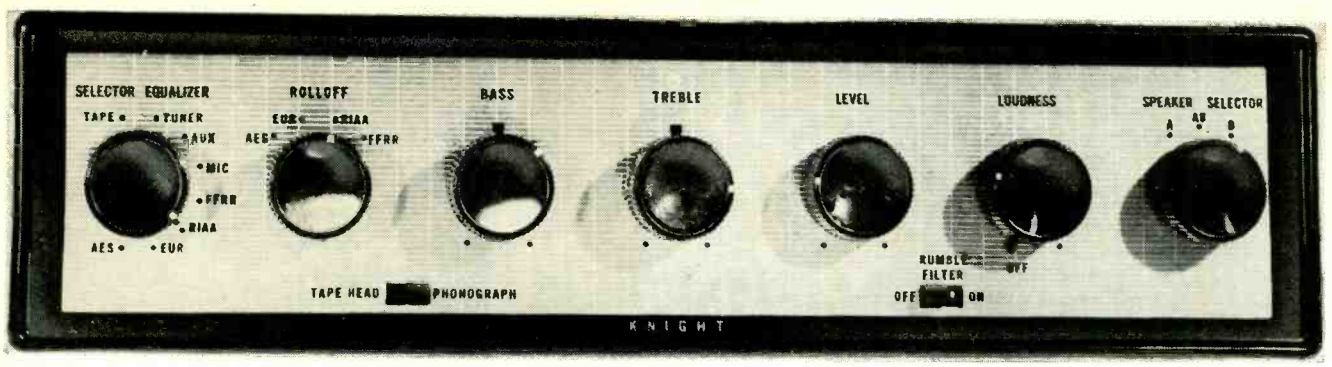
Design Features

A number of interesting circuit refinements are included in this amplifier:

The preamp's tube heaters (V1, V2 and V3) are supplied with filtered dc taken from the cathodes of the 5881 output tubes (V6 and V7). Additional filtering is furnished by an R-C network R1-C1. A 30,000-ohm resistor R2



Unusual construction reveals wiring in top view. Note the three printed-circuit boards.



Front panel of the 30-watt unit has an array of 9 controls.

connected from one end of the dc heater supply to 500 volts dc stabilizes the heater voltages against changes in cathode voltage on V6 and V7.

A metering jack is wired in the cathode circuits of the 5881's along with a dpdt switch which connects the metering jack in series with one 5881 cathode at a time. A bias-balance control permits quick adjustment of cathode currents for perfect dc balance.

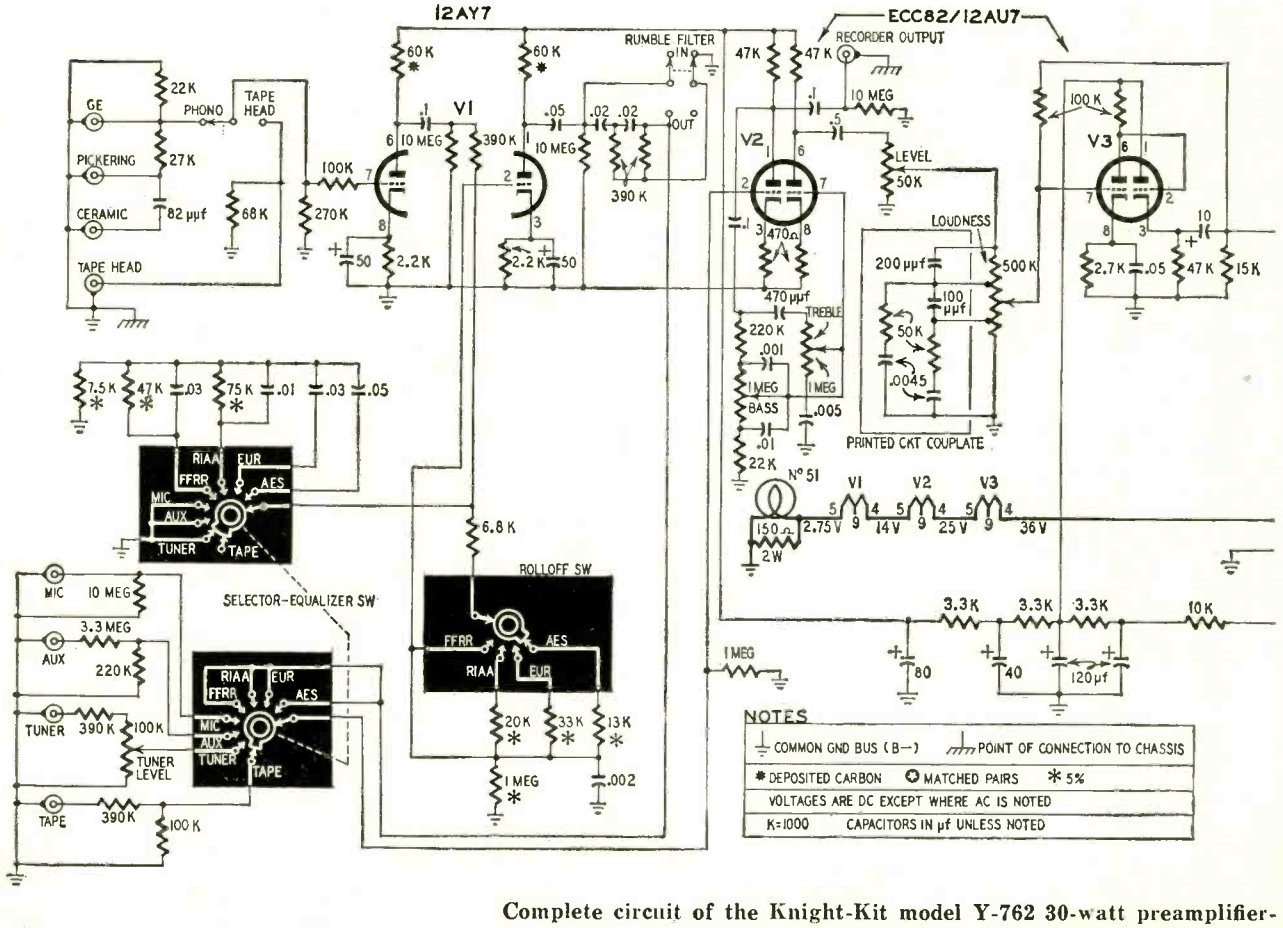
Positive and negative variable damping is provided by R3, R4 and R5. R6 and C2 restrict its effects to low frequencies where variable damping is most desirable. At one end of the rotation of potentiometer R3 (the damping control), S1 closes, cutting off the variable-damping circuit.

Dual speaker output terminals and a three-position speaker selector switch permit the user to connect two speakers or speaker systems (8 or 16 ohms each) at the same time for instantaneous A–B comparisons. The third position of the switch parallels the speakers for simultaneous operation. In this position the amplifier's output impedance is automatically cut in half for proper matching to the parallel speakers.

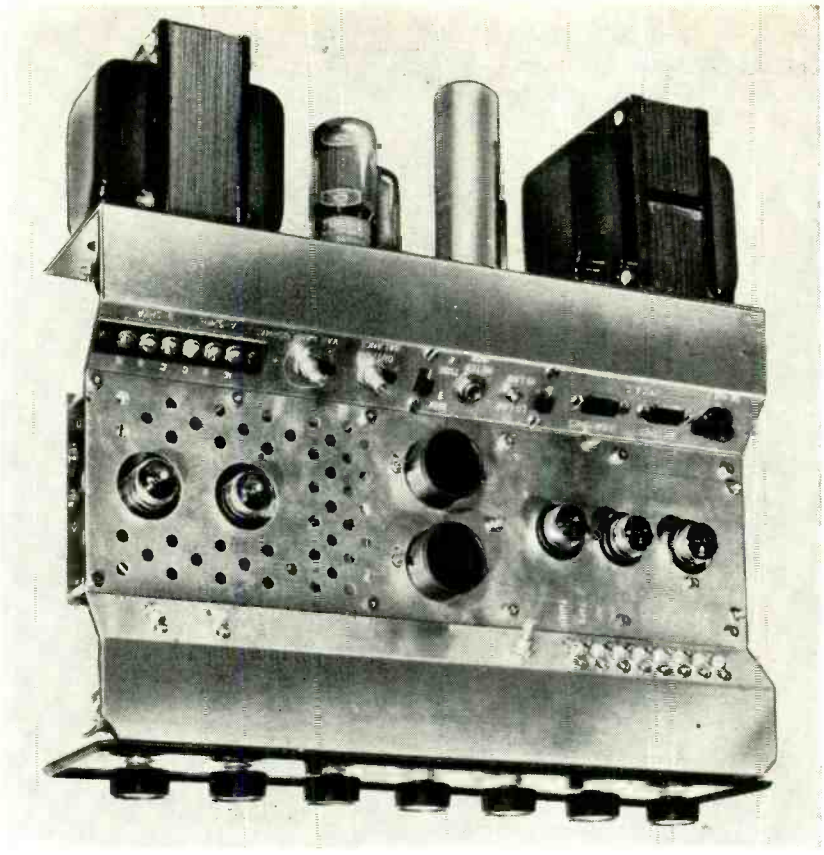
A rumble filter is inserted at the phono preamp's output. It is a simple two-step R-C type filter which can be switched in or out.

The high-voltage rectifier is an English type GZ34, similar in some respects to our 5V4, but with greater current-handling capacity and lower internal voltage drop. Being a heater type tube, its slow warmup prevents high-voltage surges when the amplifier is turned on.

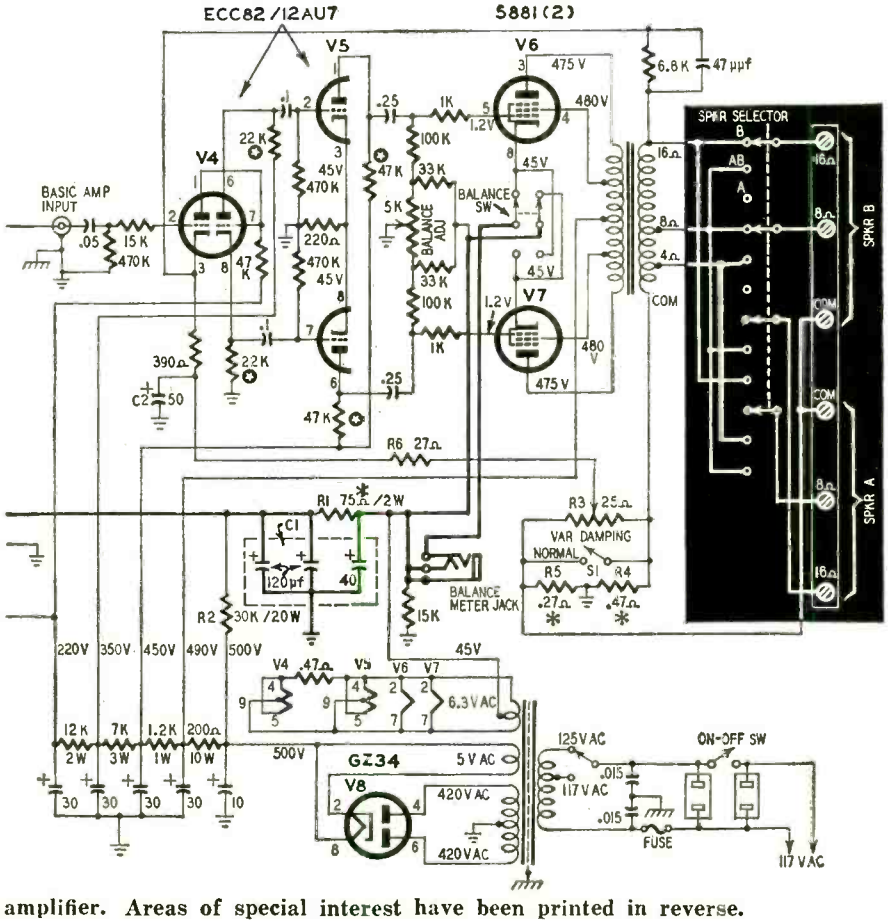
One of your editors constructed the kit with no difficulty. The printed boards speeded assembly. Values of each part are printed on the boards at the point where they are to be installed, reducing chances of mistakes. Instructions are complete and accurate. END



Complete circuit of the Knight-Kit model Y-762 30-watt preamplifier-



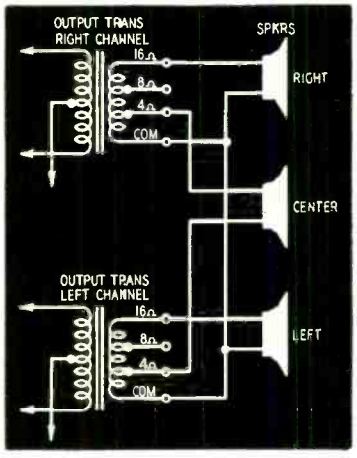
Underchassis view shows upside-down construction. Input jacks and output terminals are reached through a slot in the bottom of the unit's case.



amplifier. Areas of special interest have been printed in reverse.

3-CHANNEL EFFECT WITH 2 STEREO CHANNELS

LISTENING to two-channel stereo reproduction, we may notice an apparent gap in the space between the two speakers. This is particularly true when the speakers are an appreciable distance apart and we sense that a soloist or vocalist is at center stage. In a paper delivered before the Audio Engineering Society (Oct. 8–12, 1957), Paul W. Klipsch discussed a method of achieving apparent three-channel stereo with conventional twin-track



equipment. An amplifier and speaker system is provided for a third (center) channel. This center channel is fed a half-and-half mixture of the signals fed to the amplifiers for the right- and left-hand channels.

An appendix to the paper, just received, describes a simplified twin-track three-channel stereo system that eliminates the amplifier for the center channel. Mixing is provided by tapped output transformers on the amplifiers for the outside channels and connecting the center speaker as shown in the diagram.

The 16-ohm speakers for the outside channels are matched to taps on their respective amplifiers. The center speaker is connected between the 4-ohm transformer taps to receive half the voltage applied to the outside speakers. With this connection, the level of the center speaker is 6 db down with respect to the outside channels. For more dramatic effects, as for demonstrations and at audio shows, the center speaker can be connected across the 8-ohm taps so its output is only 3 db down with respect to the others.

An experiment was tried with four speakers, the second one tapped to 8 and 4 ohms, and the third tapped to 4 and 8. With the spacing involved there was no discernable improvement over the three-channel setup, but this could be advantageous where the speaker array exceeds 30 or 40 feet.

Automatic Fine Tuning Is Here

By SOL LIBES*

Just turn to the channel you want and the fine tuning takes care of itself

AUTOMATIC fine tuning is featured in Westinghouse's Custom line of TV receivers for 1958. Automatic fine tuning (let's call it aft for short) means that fine tuning is entirely automatic and electronically performed. The receiver is always tuned to receive the best picture and sound.

Aft is accomplished by the closed-loop system shown in Fig. 1. A few new circuits have been added to the receiver to provide aft action. A reactance circuit has been placed across the tuner oscillator and acts as a variable capacitive reactance to control oscillator frequency. The amount of capacitive reactance is determined by the developed correction current of the aft control circuit, loading the reactance circuit. This current is proportional to the amplitude of the 4.5-mc sound carrier and the average dc voltage at the video detector.

If we draw a curve of oscillator frequency with respect to aft correction current, it appears as the solid curve in Fig. 2. At the largest correction current, the oscillator frequency is lowest, and, as the correction current is decreased, the oscillator frequency increases. *The current I_o is required to keep the oscillator on its correct frequency (F_o).* This current is measured with the oscillator on its correct frequency (whether in manual or aft operation).

If the oscillator frequency goes up (curve shown in dashed lines), a larger correction current is required to bring it to its correct frequency (F_o). The opposite is true if the oscillator frequency drops (shown in dotted lines).

Fig. 3-a is the receiver's overall if response curve. To meet the requirements of the aft system, it differs slightly from the standard television receiver's if response curve. The sound carrier is not down in the notch, but rather riding up the curve. However, it is far enough down on the curve (37 db) so that no visible or audible beats are created. The notch in the response curve is now at 40.8 mc and greatly attenuated (60 db).

*Technical Editor, Service Dept., Television-Radio Div., Westinghouse Electric Corp.

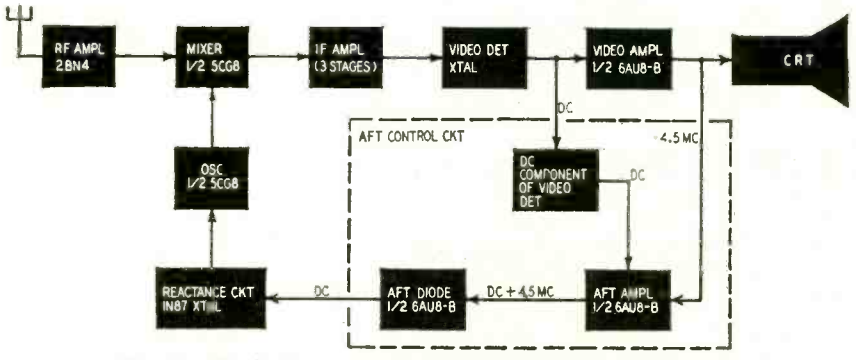


Fig. 1—Block diagram of the closed loop aft system.

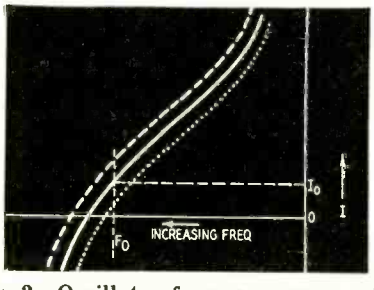


Fig. 2—Oscillator frequency curve with respect to aft correction current.

Creating a notch in the if passband at 40.8 mc has a twofold purpose: First, it keeps the sound out of the notch so that it rides up and down the slope of the curve only. If it were to ride in and out of the notch, erroneous aft voltage would be developed. The second purpose is to make the slope of the curve steeper so a greater voltage is created as the sound carrier frequency changes.

As oscillator frequency varies, the sound carrier rides up and down the curve with a resultant increase and decrease in the amplitude of the 4.5-mc beat at the video detector. A curve of the amplitude of the 4.5-mc signal developed is shown in Fig. 3-b.

The 4.5-mc signal is the result of the beat between the sound and picture carriers. Thus as the oscillator frequency increases, the sound carrier moves up the curve and the 4.5-mc signal's amplitude increases. However, when the sound carrier reaches the top of the response curve (42.75 mc), the picture carrier is down in the notch on the high end of the curve (47.25-mc trap). Now, two things happen: First, the picture carrier is so greatly attenuated that no beat occurs at the video detector and the 4.5-mc signal

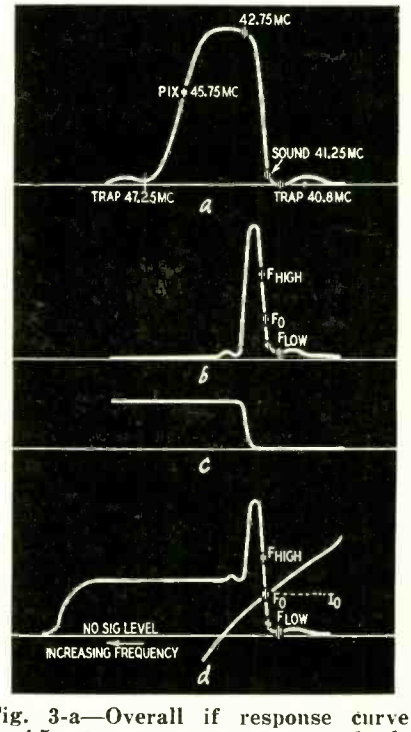


Fig. 3-a—Overall if response curve; b—4.5-mc response; c—average dc developed at video detector; d—response of aft system with aft correction current curve intersecting it.

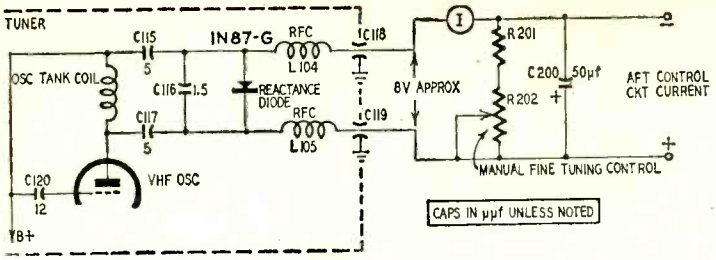


Fig. 4—The basic reactance circuit.

drops to zero. Second, the average dc voltage developed at the video detector increases sharply (shown in Fig. 3-c), due to the large amplitude of CW sound carrier signal now present.

A change in oscillator frequency (fine tuning) can now be represented in terms of the 4.5-mc signal's amplitude and average dc voltage developed at the video detector. These two signals are added and coupled to the aft amplifier (this signal can be represented by curve 3-d). The signal is then rectified by the aft diode and a correction current developed, which controls the capacitive reactance across the oscillator tank circuit and the oscillator frequency.

The aft correction-current curve is superimposed on the aft system's response curve (Fig. 3-d). The curves intersect at only one point. This is the equilibrium point—where the current required and that supplied are equal—that the aft system searches for as it drifts between the limits of F_{high} and F_{low} on the response curve. At this point all conditions are met and the circuit locks in. This represents the correct oscillator frequency. This is true because, if the oscillator should drift, the 4.5-mc signal changes in amplitude with a resultant change in correction current and capacitive reactance across the oscillator, returning the oscillator to its correct frequency.

The reactance circuit

The reactance circuit is shown in Fig. 4. Capacitors C117 and C115 and a germanium diode are connected across the tuner oscillator's tank circuit. On positive half-cycles of the oscillator signal (positive at C115 with respect to C117) the diode conducts and capacitors C117 and C115 are charged. On the negative half-cycles the diode does not conduct and the capacitors discharge through resistor R201 and control R202. If the resistance is high, the network's time constant is long and the capacitors cannot discharge. On the other hand, if the resistance is low, the capacitors will discharge.

When these capacitors charge and discharge, they are effectively a capacitance across the oscillator tank, thereby lowering the oscillator's frequency. When they are not permitted to discharge, they are an open circuit with no capacitance effect on the oscillator. The oscillator then remains at its high tuned frequency. As the setting of R202 is varied, the amount of charge and discharge of capacitors C117 and C115 is controlled and the oscillator frequency shifts 1–3 mc.

The reactance circuit is connected across the oscillator tank to increase the aft range. The cathode of the crystal is isolated from B-plus by capacitor C115, with C116 acting to limit the shift of the oscillator frequency. Since the circuitry external to the tuner has only direct current flowing through it and any rf current in it would only load down (detune) the oscillator further, the networks composed of L105–C119 and L104–C118 block the flow of rf currents. The anode of the diode is also rf hot and therefore also requires this network. Capacitor C200 slows down the rate of change of the aft correction voltage for better control action.

When R202 is at maximum resistance (aft position), in the absence of the aft correction current, as measured at I, very little current flows in the reactance circuit. When aft correction current flows, the reactance circuit is loaded, lowering the effective resistance across the reactance circuit and decreasing the oscillator frequency (see Fig. 2).

Aft amplifier and diode

The aft circuitry is shown in Fig. 5. The circuit contains four switches and one control. Switches S201-a and S201-b are ganged with R202. When R202 is in its maximum counterclockwise position, the control will be at maximum resistance (causing highest oscillator frequency), S201-b is closed and S201-a open, putting the aft system into operation.

When R202 is rotated away from its maximum counterclockwise position, S201-b is opened and S201-a closed. Under these conditions the aft system does not function and the oscillator frequency is manually controlled by R202.

Let us first examine the operation of the circuits in the aft position. With no signal received (tuner completely off channel), a positive bias (approxi-

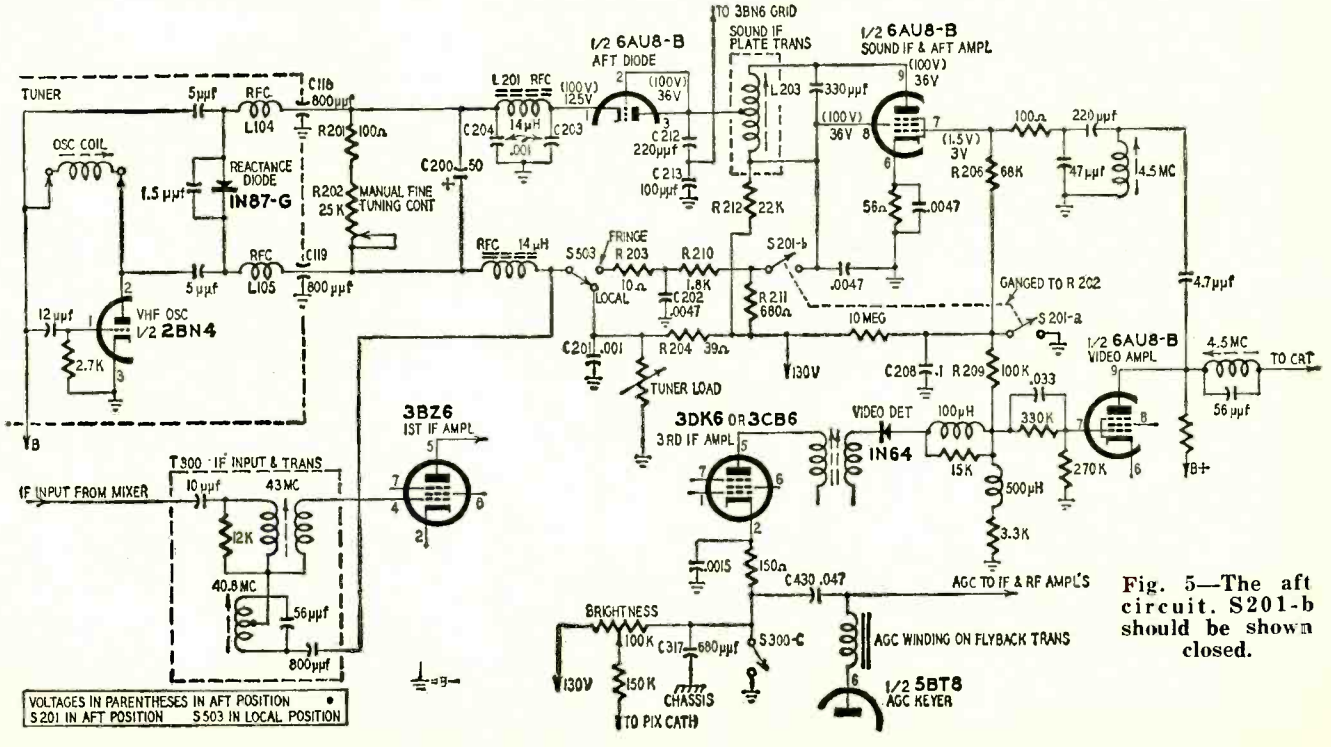


Fig. 5—The aft circuit. S201-b should be shown closed.

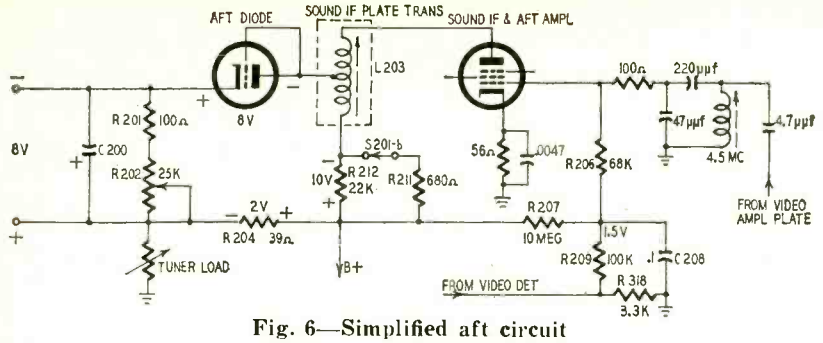


Fig. 6—Simplified aft circuit

mately 1.5 volts) exists on the grid of the aft amplifier, causing it to conduct heavily with a large voltage drop (about 10 volts) across resistor R211. This is better shown in the simplified drawing in Fig. 6. A small voltage drop (2 volts of opposite polarity) exists across resistor R204. The voltages across R212 and R204 are bucking and producing a net voltage of 8 (between the plate of the aft diode and the arm of R202) and the reactance circuit produces 8 volts across its terminals due to the rectification of the oscillator voltage. Therefore, the aft diode has zero potential across it. The diode does not conduct and is effectively an open circuit across the reactance circuit. (These voltages are approximate and are used for purposes of illustration.)

Now let's select a station and observe the circuit's action. The tuner oscillator is normally tuned high in frequency, thus the if sound carrier rides high on the if response curve (at approximately 42.75 mc) and the picture carrier is all the way down in the notch and greatly attenuated. No 4.5-mc beat occurs at the output of the video detector and no 4.5-mc signal is coupled to the aft amplifier.

However, when the sound carrier is high up on the if response curve, the CW signal at the video detector causes a marked increase in the developed average dc. The dc voltage at the detector (negative) rises to approximately 6–8 volts. This negative potential causes the grid voltage on the aft amplifier to go negative, effectively cutting it off. With the aft amplifier cut off, only a very small voltage drop—approximately 2 volts—occurs across plate load resistor R211.

The aft diode now has an 8-volt potential appearing across it, with the positive potential on its plate. The diode is now biased in a forward direction and conducts. The path of current flow is from the negative terminal of the reactance circuit of the tuner, through the aft diode, L203, R211, R204 and back to the positive terminal of the reactance circuit. The current lowers the effective resistance across the reactance circuit, lowering the oscillator frequency.

The lower oscillator frequency causes the sound carrier to move down the curve and the picture carrier to move up the curve. A 4.5-mc beat is developed at the video carrier and the developed average dc decreases because of the decrease in the sound carrier's amplitude. The aft amplifier now comes out of cutoff.

The 4.5-mc signal is amplified by the video amplifier (10 db of gain), amplified by the aft amplifier (40 db of gain) and then rectified by the aft diode, producing a dc flow in the reactance circuit and lowering the effective resistance across the circuit and further lowering the oscillator frequency.

The oscillator frequency continues to be lowered, in this manner, until the sound and picture carriers are at their correct positions on the if response curve. At this point the current in the reactance circuit is at the value I_o (as shown in Fig. 3-d). This point is the natural equilibrium point of the aft system, being at the intersection of the control-voltage and correction-current curves.

If the oscillator should drift high in frequency, the 4.5-mc signal would increase in amplitude, producing greater current in the reactance circuit and lowering the oscillator frequency. If the oscillator should drift low in frequency, the 4.5-mc signal would decrease in amplitude and the current in the reactance circuit would decrease, increasing the oscillator frequency.

Resistors R209 and R206 couple the dc component of the video detector to the aft amplifier. Capacitor C208 filters any variations in the signal.

The 4.5-mc signal to the 3BN6 audio detector is obtained at the junction of capacitors C212 and C213. These capacitors serve as a capacitance voltage divider to divide the 4.5-mc signal to a suitable level for the 3BN6.

The aft diode is formed by connecting the grid and plate of the triode section of a 6AU8B together. Components C204, C203 and L201 in the cathode circuit of the aft diode filter out any 4.5-mc and harmonic signals present in the output of the aft diode.

When a channel is selected and the aft circuit first goes into operation, the keyed age circuit develops little negative age voltage due to its relatively long time constant, allowing the if and rf amplifiers to operate at maximum gain momentarily. This effect produces an erroneous sound carrier amplitude and excessive 4.5-mc signal as far as the aft system is concerned. To prevent this from happening, the third if cathode and the ground side of capacitor C430 are opened by S300-c. This capacitor assumes a negative charge during the time when S300-c is open. When S300-c is closed, this charge is dumped into the age line and momentarily lowers the gain of the if and rf amplifiers at the time the channel is being switched in. In addition, the last if amplifier's cathode circuit to ground is opened by S300-c, stopping the operation of the tube. S300-c is opened when the programming is rotated from channel to channel. Although not shown in Fig. 6, the brightness control is opened by S300-c, blanking the C-R tube screen.

Fringe operation

Aft operation on fringe signals is improved by moving S503 to FRINGE. This switch is activated by a small plastic slide on the programming wheel and is individually set for each channel. Thus the aft system can be set for fringe operation on selected channels and for normal operation of others.

Fringe signal can be defined as a very weak signal. The age has boosted the receiver's gain to its maximum, but the signal is so weak that noise appears in the picture. The practice in fringe areas is to adjust the fine tuning so the picture carrier is moved up on top of the curve with sound moved further down into the notch. The fine picture detail is cut down, but the

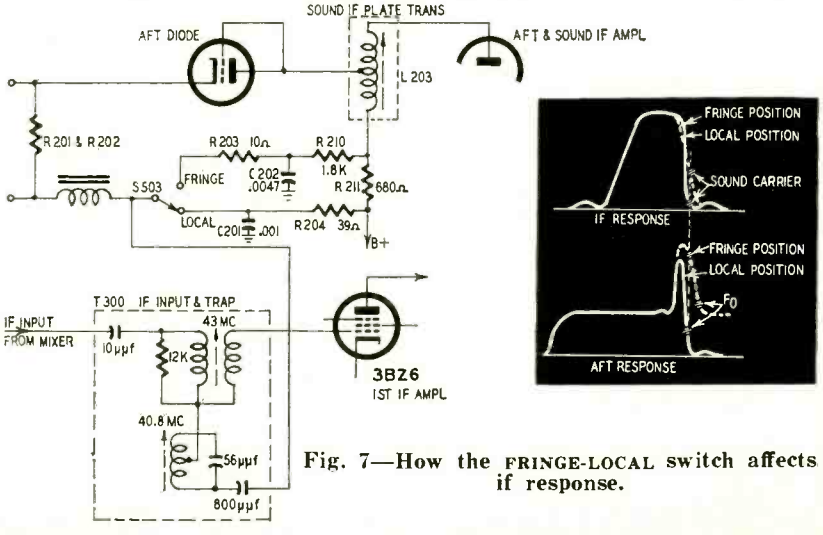


Fig. 7—How the FRINGE-LOCAL switch affects if response.

amount of snow in the picture is considerably lessened and a considerably better overall picture results.

This effect—namely moving the picture up the curve a little—is accomplished automatically in the aft system by changing the shape of the if response curve and the resulting 4.5-mc curve. When S503 is in the FRINGE position, the trap at 40.8 mc is taken out and the slope of the curve is more gradual, with the sound carrier moving higher up on the curve. The shape of the aft response curve changes with the result that the aft equilibrium point is now at a higher frequency, causing the picture carrier to move up the curve (which is what we want in fringe areas to overcome noise in the picture).

The trap at 40.8 mc is a bifilar T trap which attenuates the signal 60 db. This trap is part of T300 (see Fig. 7). One side of this trap is connected to S503. In the LOCAL position, the trap is connected to ground through capacitor C201. In the FRINGE position, the trap is connected to ground through a 10-ohm resistor, R203, and capacitor C202. The insertion of the 10-ohm resistor disables the trap, raising the if response curve.

In the FRINGE position resistors R204 and R211 are no longer in the aft diode circuit. The bucking voltage is removed from the aft circuit, moving the locked-in correction current (I_o) to a lower frequency. Resistor R210 (1,800 ohms) limits the amount of correction current applied to the reactance circuit, raising the amplitude of the curve and preventing the oscillator from locking in too low in frequency.

Manual operation

In an ultra-fringe signal area it may be found advantageous to tune the receiver manually. Likewise, in the case of high interference, where it may be possible to detune the picture and eliminate a beat in the picture (with some deterioration in the picture of course), manual fine tuning is an asset. Therefore a fine-tuning switch–fine-tuning control is placed on the front control panel of the receiver. R202 is the manual fine tuning control. When it is in its maximum counterclockwise position, it is at maximum resistance (oscillator high in frequency). When the control is rotated away from its maximum counterclockwise position, the aft system is disabled by S201-a and S201-b (ganged to control R202) and the resistance of control R202 controls the oscillator frequency.

In MANUAL operation switch S201-a is closed and the aft amplifier grid resistor R206 is returned to ground, causing grid leak action and making the pentode operate as a limiter. S201-b is opened so plate voltage is now dropped through resistor R212 only (higher resistance), dropping the plate action. The tube now is functioning as a 4.5-mc sound limiter and the aft diode is cut off because of a large voltage drop across R212. END

Radio Paging System Causes TVI

By JOSEPH A. LENTON

THE television technician now has a relatively new source of TVI to contend with—the shortwave radio paging systems now used in several large cities. This system operates for professional people and others who desire to maintain contact with their offices at all times. See "V.H.F. Paging Calls Subscriber to Phone" on page 74 of the October 1951 issue. Each subscriber carries a small portable receiver. A central transmitter broadcasts his code number whenever his office wishes to contact him. If, for instance, a doctor is on the golf course and an emergency arises, his office contacts the transmitter and his code number is broadcast repeatedly. He listens to his pocket receiver from time to time and, when he hears his code number, calls his office by ordinary telephone. The call is then cancelled by his office.

One frequency allocated for these systems is 43.58 mc. Since most TV receiver manufacturers now use an if centering approximately on 44 mc it is easy to see that interference problems may arise in an area near such a transmitter. This interference makes itself evident by a varying herringbone pattern superimposed on the TV picture, in severe cases tending to give what can be seen of the picture a negative appearance. Often the code numbers can also be heard in the background of the audio.

If radiation from the paging systems enters a TV receiver only through the antenna, it can usually be trapped out to a certain degree before it reaches the tuner or if system. A high-pass filter designed to bypass to ground the frequencies from 40 to 45 mc is required. Drake and several other manufacturers make a filter that will serve the purpose. When installing such a trap it should be well grounded to the chassis as close to the tuner as possible so that the lead between trap and tuner may be kept very short. The lead from the outside antenna connects to the trap's other set of terminals.

Trapping by itself is successful only where the bulk of the interference enters the receiver via the antenna system. Where the interfering signal is strong enough to radiate directly into the chassis itself more drastic measures must also be taken. Screening the entire rf, if and video sections of the chassis with fine mesh screen such as copper or aluminum window screen grounded every inch or so to chassis will help. Careful alignment of tuner and if stages, with a little steepening of the low-frequency side of the response curve also helps. This is usually not noticable and is less objectionable than the interference would be.

This interference is usually more detrimental in a uhf area as the construction of many uhf single-conversion tuners allows the interference to pass into the if strip more readily than will vhf units. Receivers with overcoupled if stages are affected worse than stagger-tuned systems. Double-conversion uhf systems, in which the uhf tuner reduces the TV signal to low-channel vhf which is again reduced by the vhf tuner to the intermediate frequency, tend to attenuate the interference more than the single-conversion systems.

In a very strong interference area it is sometimes impossible to eliminate all of the interference. However, by carefully applying the aforementioned methods, a usable picture can be obtained in practically all cases. END

TV Service Clinic

conducted by

ROBERT G. MIDDLETON
TELEVISION CONSULTANT

THE rustler who was to be hanged was asked if he had any last words. "Yes," he replied, "I would just like to say a few words on behalf of the great State of Texas." And thereby hangs a tale which shall not be repeated here.

Instead, we shall make with a few words on the subject of *sync buzz*, after which we fondly trust the subject can be decently buried.

Because *sync buzz* is a repeater—a habitual criminal, more dastardly than a rustler—it keeps turning up like a bad penny.

Actually, there are two basic types of buzz:

1. True sync buzz, caused by modulation of the 4.5-mc intercarrier sound signal by the vertical sync pulse.
2. Sweep buzz, caused by coupling of the vertical sweep voltage into the receiver's sound circuits.

Sweep buzz can be checked by pulling the vertical output (and sometimes the vertical oscillator) tube. If the buzz stops, it is being caused by cross-coupling of the vertical circuits with the sound circuits. This is usually due to bad electrolytics.

However, the most usual cause of buzz is modulation of the intercarrier sound signal by the vertical sync pulse. This can be caused by a number of operating faults.

Sync-buzz causes

When the 4.5-mc sound signal is passed through the video amplifier, overload of the video tube causes the undesired modulation. Grid bias must be correct, and the plate voltage must be high enough to avoid overload.

Agc trouble which causes overload in the if amplifier often results in sync buzz. Find the agc fault and cure the buzz.

Misalignment (of if or rf circuits) will cause sync buzz, when the sound carrier appears higher than 10% on the overall response curve.

Bad impedance mismatches of lead-in to rf tuner may cause sync buzz—the overall response curve is affected by impedance mismatches.

Some other common situations may cause sync buzz. For example, misadjustment of the local-oscillator slug can sometimes cause buzz, even when alignment is OK.

Similarly, misalignment of the ratio-detector transformer can cause buzz. If the charging capacitor (usually an electrolytic) at the output of the ratio detector becomes defective, sync buzz is a certainty.

Sync buzz can be caused by regeneration, too. This is another angle on misalignment, because regeneration makes the response curve go to pieces.

You can see sync buzz on a scope. Use a detector probe and check the intercarrier sound signal at the 4.5-mc driver or at the input to the ratio detector. If you use a dc scope, you can check the percentage modulation of the 4.5-mc sound signal by the vertical sync pulse.

The buzz pulse looks something like a horizontal sync pulse. This is because the probe strips off the equalizing pulses and fills in the serrations on the vertical sync pulse.

Snow and fuzz

An Admiral 20Y4LS chassis has a picture which becomes snowy and fuzzy after running a while. Line voltage runs between 130 and 135 here. Could this be causing the trouble?—I. O. F., Bussey, Iowa

Your line voltage is above usual tolerance. The chances are very great that this is the basic trouble. The symptoms you note are doubtless due to overheating and breakdown in one or more electrolytic capacitors. Localize the capacitor(s) causing the trouble by touching their cases after the set has been operating a while. The hot ones are breaking down. The best practice is to install an automatic line-voltage regulating transformer. To obtain best regulating action, the transformer must be properly rated for the receiver.

Curved raster lines

A Packard Bell 24ST2 came into the shop with raster lines straight in the center of the screen, but curved at the top and bottom. I replaced the deflection yoke, but this had no effect on the curvature. I will appreciate any information on this problem.—H. D., Riverside, Calif.

Many yoke and picture-tube combinations show more or less bending of the raster lines. This is better known as pincushion effect. It is corrected quite easily with the use of anti-pincushion magnets. Mount the brackets for the magnets with the poles 3 or 4 inches forward of the yoke. Carefully adjust the spacing between the magnets and the picture tube to obtain straight raster lines.

Metal to glass

What electrical changes should be made when replacing a 16GP4 metal picture tube with a glass 16RP4 in an Emerson 674, series B?—J. A. S., Los Angeles, Calif.

Both are 70° tubes with electrical characteristics close enough that no circuit changes are required. The problem is a mechanical one. This conversion has been made satisfactorily by numerous shops.

Video bend

The set is a Philco 52-T1804. It runs OK for about an hour, and then the picture starts to lean at the top. The bending spreads from top to bottom till straight lines look like S curves. I have changed tubes, shunted filter capacitors, etc. Any help will be appreciated.—F. E., Holly Pond, Ala.

There is not enough data to tie the picture bending down to one receiver section. However, this sounds suspiciously like borderline age or sync-separator trouble. It would be advisable to check the age action first. Put a vtvm on the age line at pin 1 of the first video if amplifier. Put another vtvm on the tuner age line at the junction of the .01-μf age filter capacitor and the 6,800- (or 4,700-) ohm grid resistor for the 6CB6 rf amplifier. Watch the indications as the trouble develops. If the reading on one or both of the vtvm's falls, look for leaky delay capacitors or grid emission in controlled tubes, plus the usual resistance checks. However, if age circuits are not causing the trouble, voltage and waveform checks should be made in the first and second sync separators and the horizontal afc circuit. Leaky coupling capacitors are ready suspects here.

Yoke breakdown

An RCA KCS47A has come in with shorting in the horizontal yoke winding. I have replaced the yoke twice. Using a variable isolation transformer, set for 95 volts on the line, the plate of the 6W4 is about 300 volts, but the cathode has risen past 500 volts. More line voltage skyrockets the cathode voltage past 700, but the plate never exceeds 375. Can you throw some light on this trouble?—R. W., Bethel Park, Pa.

The breakdown in the horizontal yoke windings results from abnormally high peak voltages in the horizontal deflection system. These excessive peaks

are probably caused by strong feedback at ultrasonic frequency. This oscillation can be checked by using a scope and high-voltage capacitance-divider probe from the high side of the yoke to chassis. The usual cause of this trouble is marginal decoupling capacitors in the horizontal oscillator and sweep section. Check these for capacitance and power factor, and replace those that are not up to par. This will most likely clear up the difficulty.

Out-of-phase picture

An RCA KCS40A came into the shop with a bad case of out-of-phase picture, bent picture and cogwheel edges, and now the vertical hold is becoming unstable. The only improvement obtained was by shunting a .05-μf capacitor from the cathode of the sync separator to ground. However, this leaves phasing ghosts and unstable operation.—G. O., Oakland, Calif.

Past experience with these symptoms has indicated that a thorough check of all electrolytic capacitors should be made before going farther. This kind of trouble is generally caused by feedback among various receiver sections. This is partially confirmed by the fact that you can improve the situation by increasing the capacitance from the cathode of the sync separator to ground. In a case of this kind, it is not advisable to merely shunt suspected electrolytics with new capacitors, but to measure capacitance and power factor.

70° to 90°

What are the problems in replacing a 24BP4 picture tube with a 24DP4A in a Hoffman Mark IV. I have a Packard Bell kit No. 98465 flyback and No. 29590 yoke.—H. J. Tracy, Calif.

This is a conversion that is not considered practical. The 24BP4 is a 70° round metal tube, while the 24DP4A is a 90° glass rectangular. It is twice as heavy, but this is only a minor point compared with the required change of yoke and flyback. Shops that have attempted this conversion have found that the extensive butchering, which *must be done* to the cabinet is strictly a losing proposition.

Excessive width

An Olympic DX-214 has excessive horizontal width. The width control is not open, but there is an overscan of about 2 inches. The focus control seems ineffective. Can the resistor in the screen of the output tube be replaced with a higher value to reduce the width?—J. R., St. Petersburg, Fla.

Excessive width probably results from a fall in the value of high voltage. A 21-inch tube should be operating at about 15 kv. If you measure a lower voltage, the high-voltage power supply should be checked first. Sometimes the 1-megohm resistor in series with the high-voltage lead increases in value. Low accelerating voltage would be confirmed by the action of the focus control. The screen resistor in the output circuit can be increased in value, but this would be a nonstandard repair which does not correct the basic trouble.

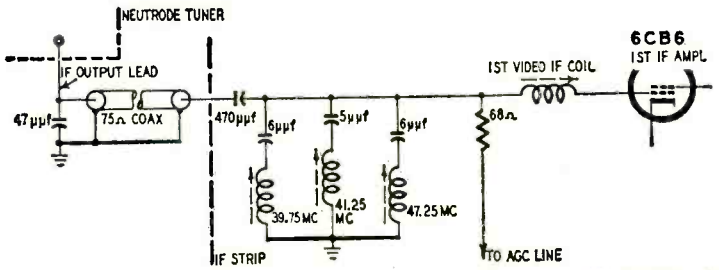
New yoke?

Can you suggest a replacement yoke for a Freed Eisemann model 121 TV? —J. C. R., Takoma Park, Md.

Reference to some older listings indicates that the Merit MDF-70 yoke replaces the Freed Eisemann 83-669, used in the model 121.

Tuner change

How can a Standard Coil Neutrode tuner be adapted to a Zenith model 20H20—E. A. M., Plaza del Rey, Calif.



Coupling output from Neutrode tuner to first if stage of Zenith 20H20.

The problem is largely a mechanical one. An improvised bracket arrangement is needed to mount the Neutrode tuner. The receiver has a 6.3-volt heater supply, so you will need the 6BN4 and 6CG8 tube lineup in the tuner. The agc line used in the receiver is suitable for tuner bias. However, the B-supply must be cut from 250 to 125 volts. A series resistor should be inserted in the B-plus line to the tuner—determine the right value by experiment. The if output from the Neutrode tuner requires a little attention. As shown in the diagram, a 47-μμf capacitor is shunted from the if output lead to the tuner chassis. A 75-ohm coax lead is run from the 47-μμf capacitor to the 470-μμf capacitor in the first if stage. Make your if connections as shown in the illustration. After installing the Neutrode tuner, use a good sweep and marker generator to align the if system properly, so you get full benefit of the conversion.

Pix overload

A Silvertone chassis No. 528.263 has symptoms of agc trouble. However I cannot find anything wrong with it. What else could cause overload symptoms?—V. A. MacR., Franklin. N.Y.

This letter was turned over to the Sears-Roebuck service department, whose reply follows:

Dear Mr. MacR.:

Bob Middleton of RADIO-ELECTRONICS Service Clinic has forwarded me your letter. In spite of the statement that you have checked the agc circuit and can find nothing wrong with it, it is our feeling that the difficulty you are having must originate in the agc circuit. This receiver uses a keyed agc system in which a 6AU6 tube, V12 on the tube layout chart, is the keyer tube. There is also a 4-μf 50-volt agc filter capacitor. Our recommendation is to check the tube first and then the agc filter capacitor. In fact, rather than attempting to check the capacitor, it should be replaced since some difficulties which occur, such as high internal resistance are difficult to detect.

If replacing the capacitor does not solve the problem, you should check to determine whether the keyer tube is receiving pulse voltage at its plate. This is pin 5 and can be checked only with a scope. At this point, you should have 540 volts peak to peak with the scope operating at a 7,875-cycle sweep frequency.

There is one other possibility, and that is the horizontal output transformer. It can cause the difficulty you are having if the agc keyer winding has leakage to the primary. This is checked by disconnecting terminals A and G on the transformer and testing with an ohmmeter between either of the terminals and the transformer's primary winding. If the resistance reading is not more than 1 megohm, the transformer should be replaced.

Yours very truly,

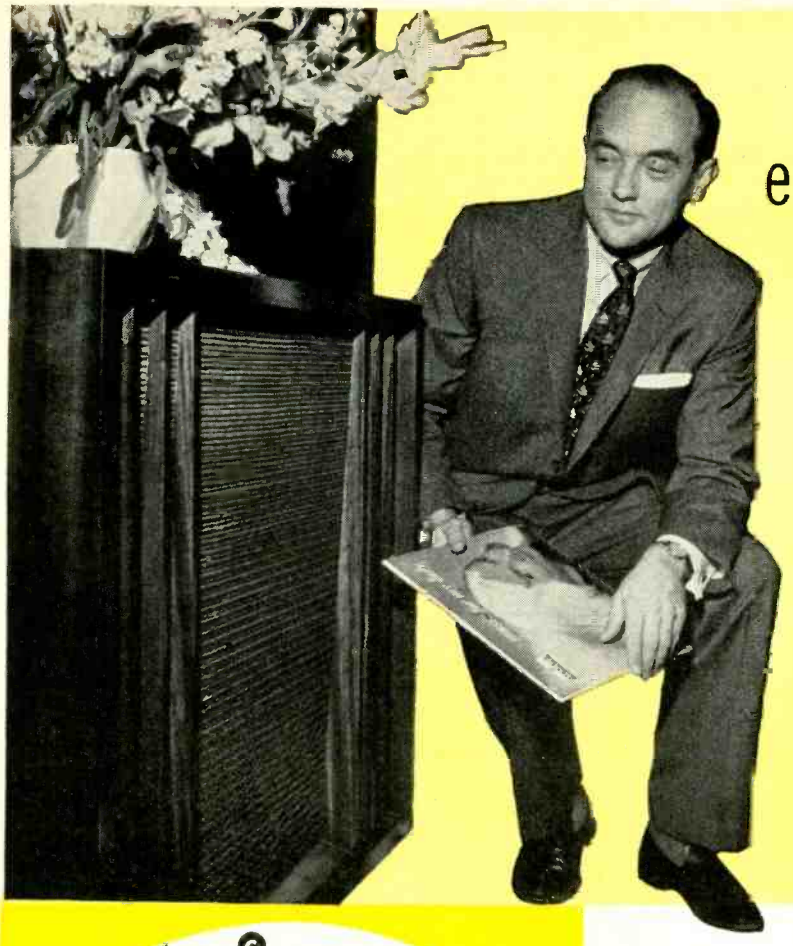
F. A. BEAVER

Service Engineer
Sears, Roebuck & Co.

Vertical bars

I have been working on a 16-inch Emerson, model 677 series B. The set has dark vertical bars at the left side of the picture. I checked the anti-ringing capacitors and found one open. However, I am still having trouble.—C. J. S., Fairborn, Ohio

It sounds as though you are on the right track as far as you have gone. As a further step, try a trimmer capacitor of suitable range instead of a fixed capacitor in each of the anti-ringing circuits. Adjust the trimmers carefully for minimum intensity of the bars. In some cases, further improvement can be made by connecting a resistor in series with the trimmer. It should not have a very high value, but the best value can be found only by trial. Ringing is sometimes picked up by the signal lead to the picture tube. To check this possibility, connect a 0.1-μf capacitor from the signal lead terminal to chassis. If the bars disappear, reroute the lead out of the strong fields which are causing the pickup. In particular, keep the lead away from the high-voltage cage. END



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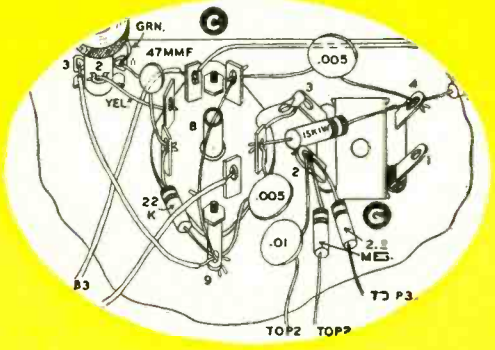
FRANK PERKINS

Composer and arranger Frank Perkins listens attentively to his Decca hi-fi album "Music For My Lady" as its beautiful sounds are recreated with Heath high fidelity equipment. Music is a very important part of Frank's life, since his background includes composing and arranging musical scores for motion pictures, and for music publishers. Songs he has written include "Stars Fell on Alabama", "Emaline", "The Scat Song", "The Way I Feel Tonight", "After All These Years", and "Turn Back The Clock". Frank Perkins has discovered the beauty of Heath Hi-Fi sound . . . and the fun of "do-it-yourself" Heathkit construction. So, why don't you!



You'll get plenty of these detailed pictorial diagrams in your Heathkit construction manual to show where each and every wire and part is to be placed. Everything you do is spelled out in pictures so you can't go wrong. That's what makes it such fun!

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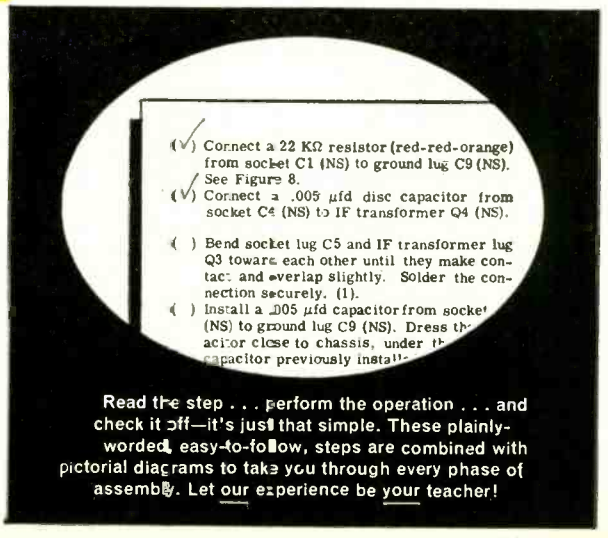

Read the step . . . perform the operation . . . and check it off—it's just that simple. These plainly-worded, easy-to-follow, steps are combined with pictorial diagrams to take you through every phase of assembly. Let our experience be your teacher!

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The Heath Time Payment Plan was designed for your convenience. Now, you can order the kits of your choice, and pay for them in small monthly installments. Write for full details.

HEATHKIT EXTRA PERFORMANCE 70-WATT AMPLIFIER KIT

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

MODEL W-6M

$109.95

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

HEATHKIT HIGH FIDELITY FM TUNER KIT

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

MODEL FM-3A

$25.95 (with cabinet)

HEATHKIT BROADBAND AM TUNER KIT

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

MODEL BC-1A

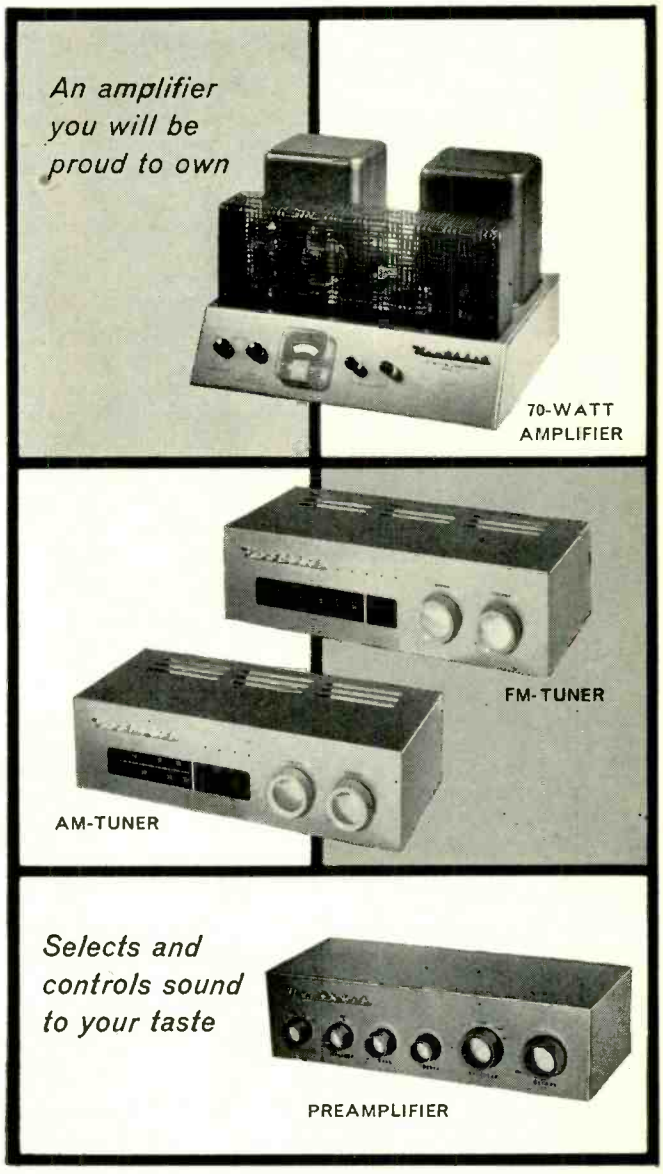
$25.95 (with cabinet)

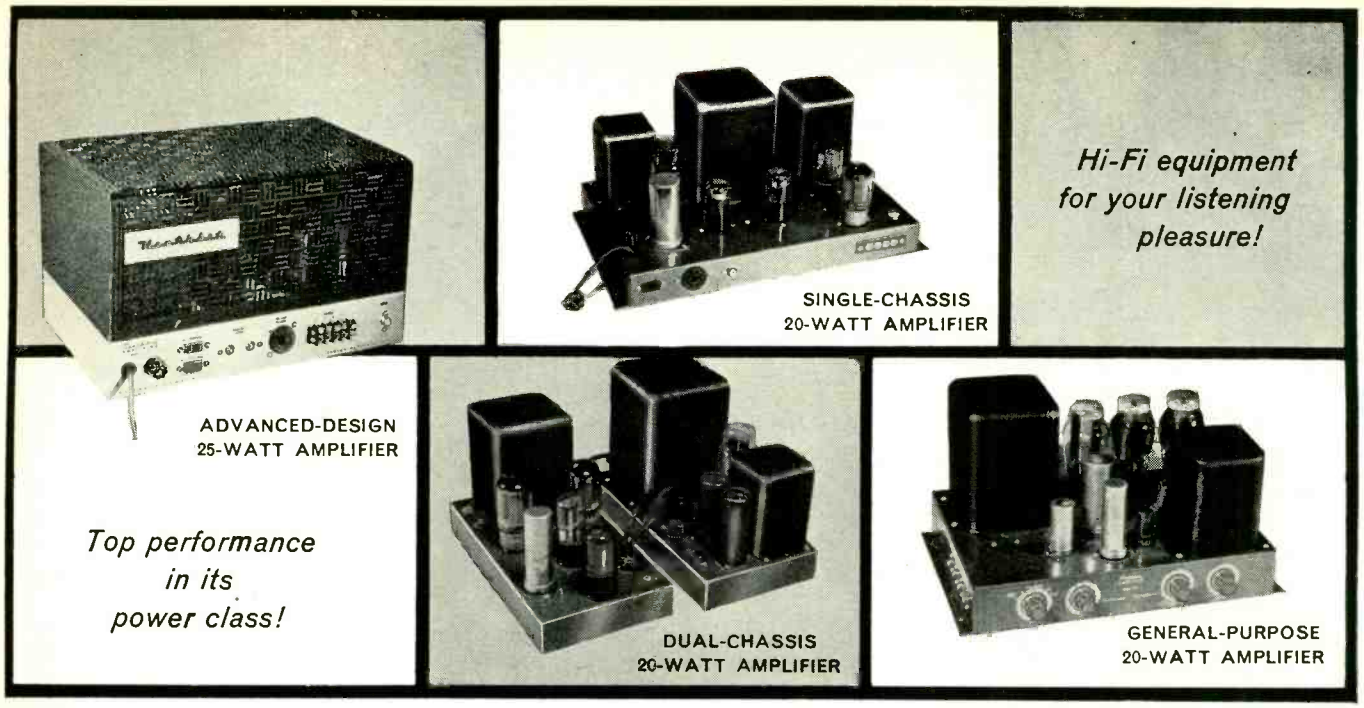
HEATHKIT MASTER CONTROL PREAMPLIFIER KIT

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

MODEL WA-P2

$19.75 (with cabinet)





HEATHKIT ADVANCED-DESIGN 25-WATT HIGH FIDELITY AMPLIFIER KIT

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

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

MODEL W-5M
$59.75

HEATHKIT SINGLE-CHASSIS 20-WATT HIGH FIDELITY AMPLIFIER KIT

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

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

MODEL W4-AM
$39.75

HEATHKIT DUAL-CHASSIS 20-WATT HIGH FIDELITY AMPLIFIER KIT

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

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

MODEL W-3AM
$49.75

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

MODEL A-9C
$35.50

HEATHKIT "BASIC RANGE" HI-FI SPEAKER SYSTEM KIT

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

MODEL SS-1
$39.95

HEATHKIT "RANGE EXTENDING" HI-FI SPEAKER SYSTEM KIT

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

MODEL SS-1B
$99.95

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HEATHKIT SINE-SQUARE GENERATOR

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

MODEL AG-10
$49.95

HEATHKIT AUDIO ANALYZER KIT

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

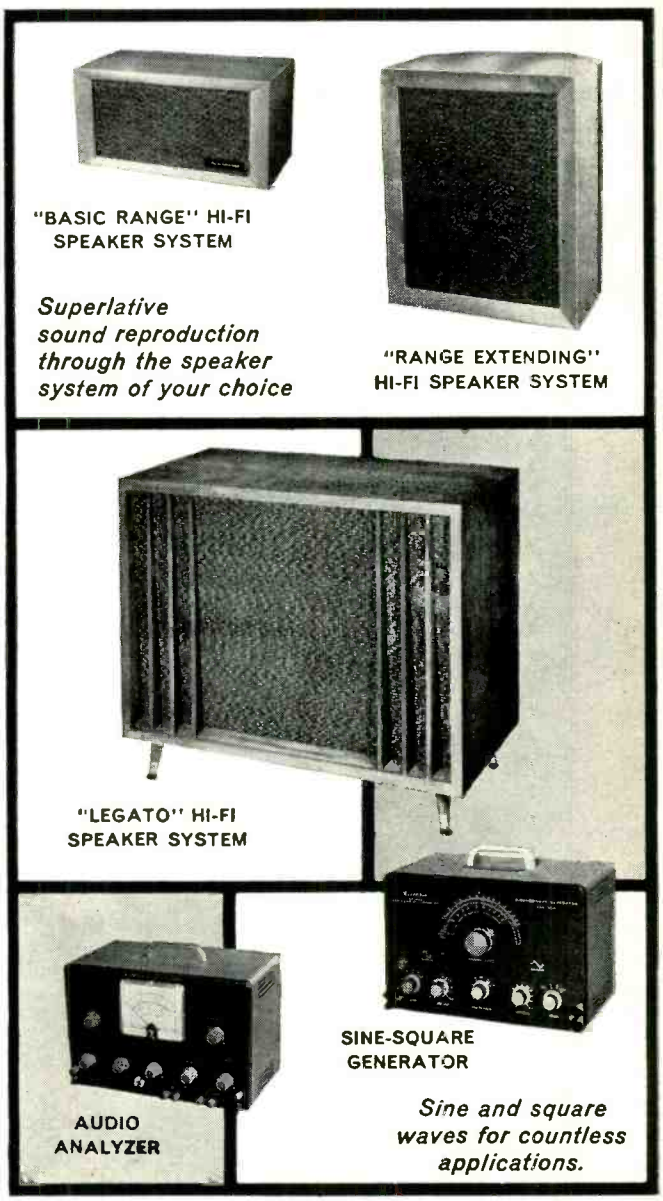
MODEL AA-1
$49.95

HEATHKIT "LEGATO" HIGH FIDELITY SPEAKER SYSTEM KIT

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

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

MODEL HH-1-C
MODEL HH-1-CM
$325.00
EACH



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HEATHKIT "GENERAL PURPOSE" 5" OSCILLOSCOPE KIT

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

MODEL OM-2
$42.50

HEATHKIT AUDIO WATTMETER KIT

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

MODEL AW-1
$29.50

HEATHKIT AUDIO SIGNAL GENERATOR KIT

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

MODEL AG-9A
$34.50

HEATHKIT HARMONIC DISTORTION METER KIT

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

MODEL HD-1
$49.50

Heathkits...

By DAYSTROM

are well known for their high quality and reliability.

HEATHKIT AUDIO VTVM KIT

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

MODEL AV-3
$29.95

HEATHKIT COLOR BAR AND DOT GENERATOR

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

MODEL CD-1
$59.95

Heathkits...

By DAYSTROM

are guaranteed to meet or exceed advertised specifications

HEATHKIT TV ALIGNMENT GENERATOR KIT

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

MODEL TS-4A
$49.50

HEATHKIT "EXTRA DUTY" 5" OSCILLOSCOPE KIT

This fine oscilloscope compares favorably to other scopes costing twice its price. It contains the extra performance so necessary for monochrome and color-TV servicing. Features push-pull horizontal and vertical output amplifiers, a 5UP1 CRT, built in peak-to-peak calibration source, a fully compensated 3-position step-type input attenuator, retrace blanking, phasing control, and provision for Z-axis modulation. Vertical amplifier frequency response is within +1.5 and −5 db from 3 CPS to 5 MC. Response at 3.58 MC down only 2.2 db. Sensitivity is 0.025 volts RMS/inch at 1 kc. Sweep generator covers 20 CPS to 500 kc in five steps, five times the usual sweep obtained in other scopes through the use of the patented Heath sweep circuit. Etched-metal circuit boards reduce assembly time and minimize errors in assembly, and more importantly, permit a level of circuit stability never before achieved in an oscilloscope of this type. Shpg. Wt. 21 lbs.

MODEL O-11
$69.50

HEATHKIT ELECTRONIC SWITCH KIT

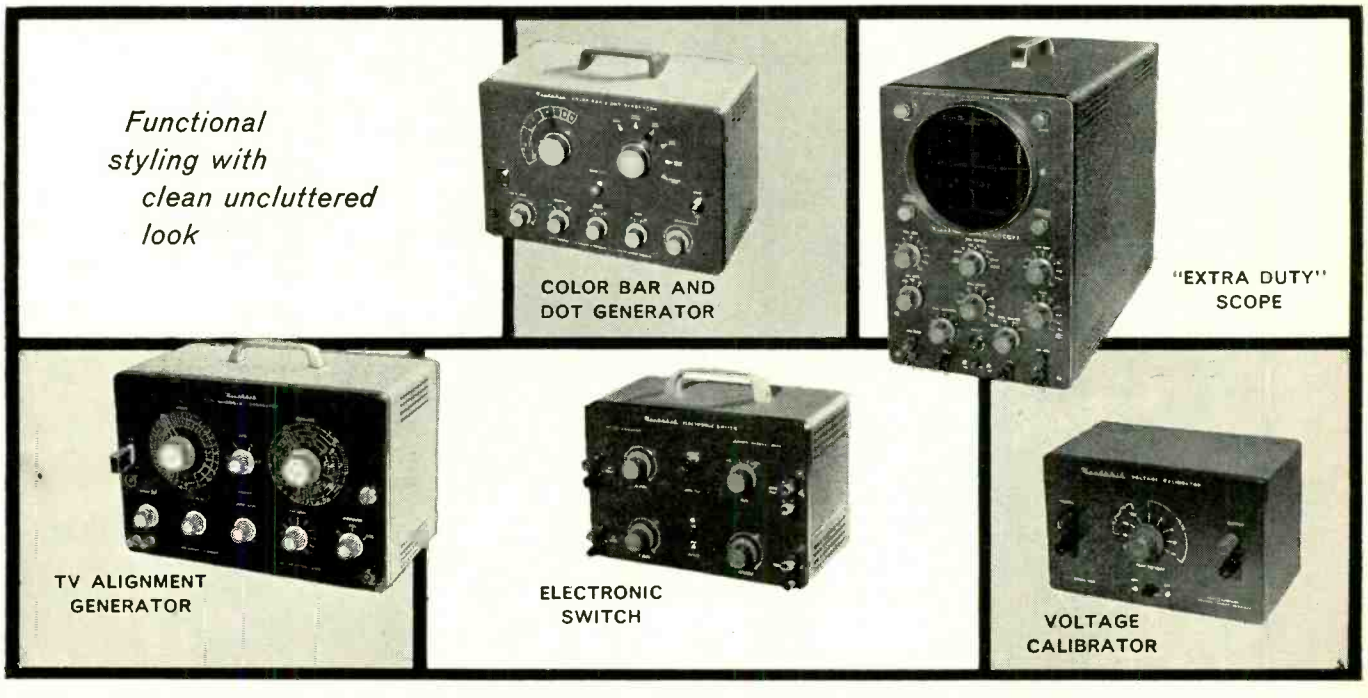
A valuable accessory for any oscilloscope owner. It allows simultaneous oscilloscope observation of two signals by producing both signals, alternately, at its output. Four switching rates. Provides gain for input signals. Frequency response ±1 db, 0 to 100 kc. A sync output is provided to control and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

MODEL S-3
$21.95

HEATHKIT VOLTAGE CALIBRATOR KIT

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

MODEL VC-3
$12.50



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

HEATHKIT TUBE CHECKER KIT

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

MODEL TC-2

$29.50

HEATHKIT HANDITESTER KIT

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

MODEL M-1

$17.95

HEATHKIT PICTURE TUBE CHECKER KIT

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

MODEL CC-1

$24.95

HEATHKIT ETCHED-CIRCUIT VTVM KIT

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

MODEL V7-A

$24.50

Heathkits...

By DAYSTROM

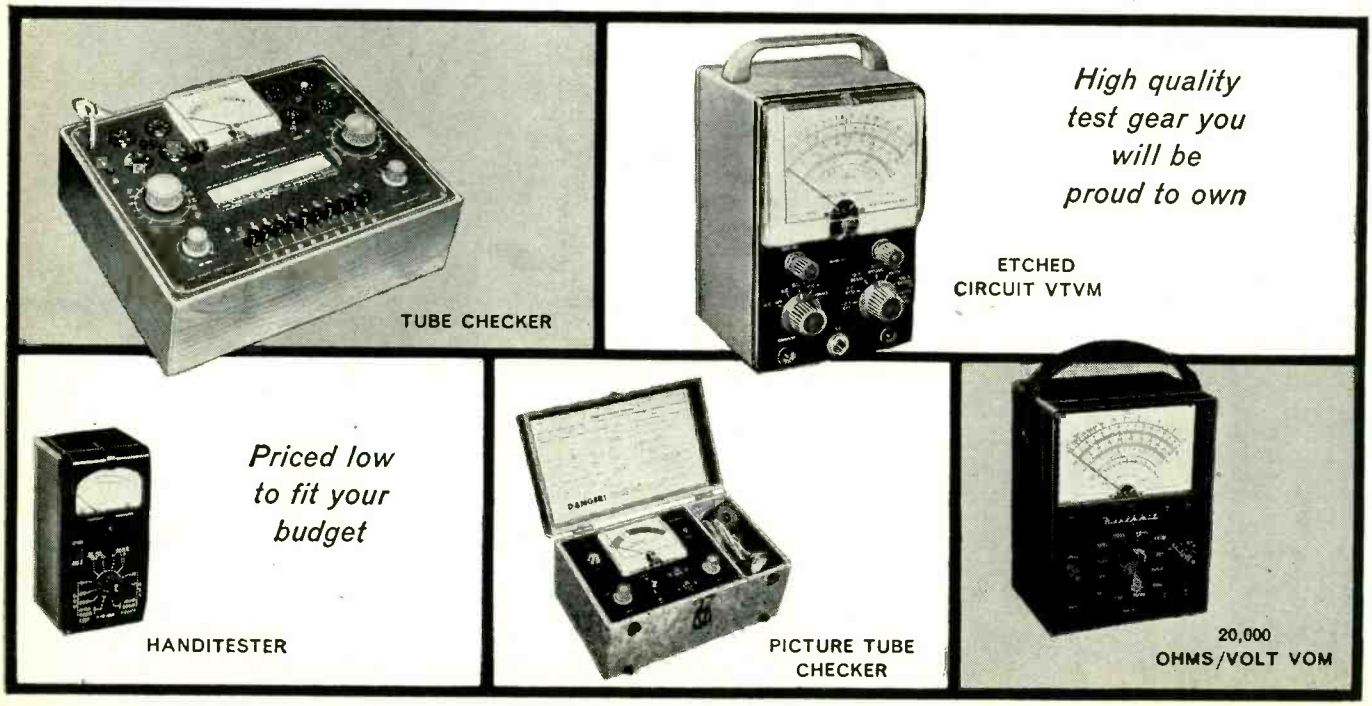
let you fill your exact needs from a wide variety of instruments

HEATHKIT 20,000 OHMS/VOLT VOM KIT

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

MODEL MM-1

$29.95



HEATHKIT RF SIGNAL GENERATOR KIT

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

MODEL SG-8

$19.50

HEATHKIT LABORATORY RF GENERATOR KIT

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

MODEL LG-1

$48.95

HEATHKIT DIRECT-READING CAPACITY METER KIT

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

MODEL CM-1

$29.50

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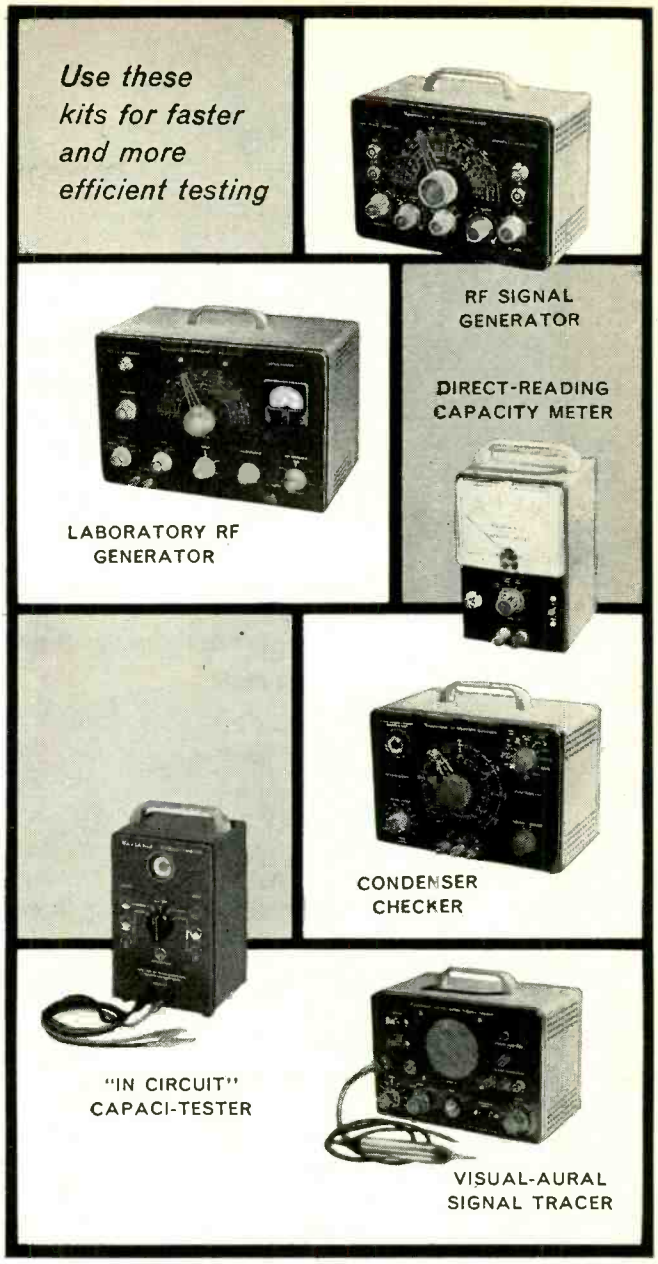
are educational
as well as functional

HEATHKIT "IN-CIRCUIT" CAPACI-TESTER KIT

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

MODEL CT-1

$7.95



HEATHKIT CONDENSER CHECKER KIT

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

MODEL C-3

$19.50

HEATHKIT VISUAL-AURAL SIGNAL TRACER KIT

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

MODEL T-3

$23.50

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

HEATHKIT IMPEDANCE BRIDGE KIT

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

MODEL IB-2A

$59.50

HEATHKIT "LOW RIPPLE" BATTERY ELIMINATOR KIT

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

MODEL BE-5

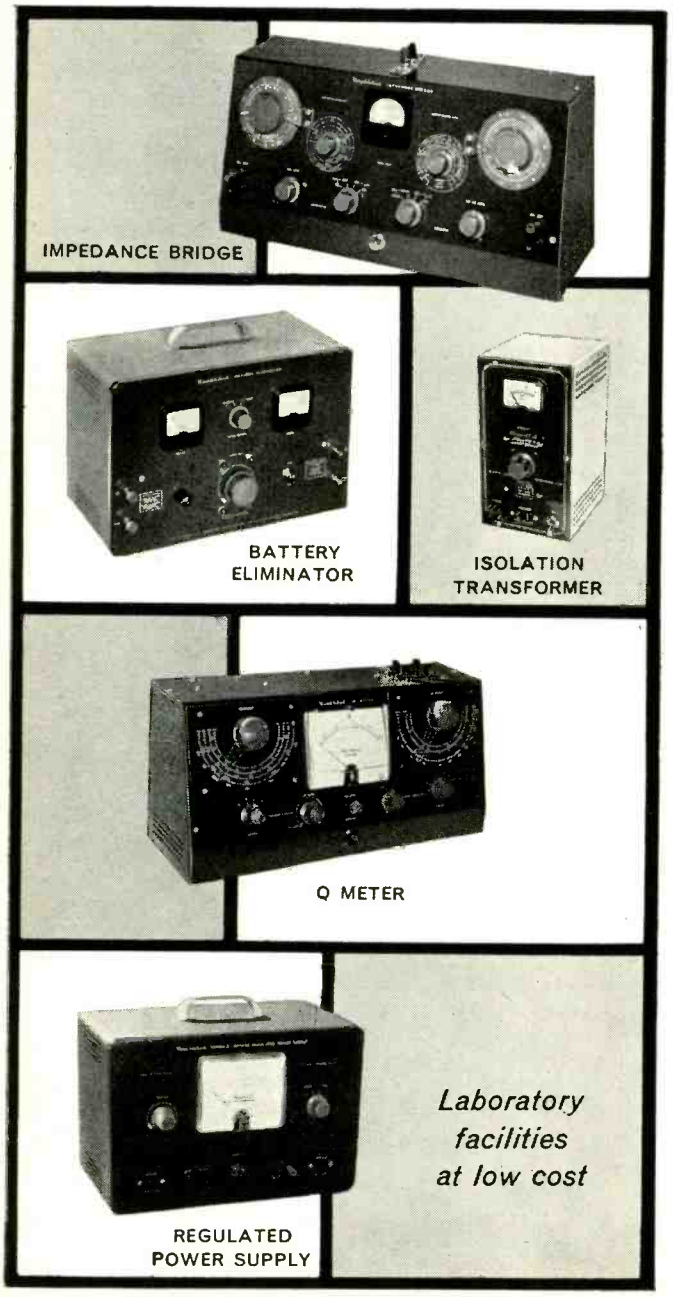
$39.95

HEATHKIT ISOLATION TRANSFORMER KIT

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

MODEL IT-1

$16.50



Heathkits...

By DAYSTROM

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

HEATHKIT "Q" METER KIT

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

MODEL QM-1

$44.50

HEATHKIT REGULATED POWER SUPPLY KIT

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

MODEL PS-3

$35.50

Terrific values in amateur equipment!

DX-100 TRANSMITTER

DX-20 TRANSMITTER

DX-40 TRANSMITTER

HEATHKIT DX-20 CW TRANSMITTER KIT

The Heathkit model DX-20 "straight-CW" transmitter features high efficiency at low cost. It uses a single 6DQ6A tube in the final amplifier stage for plate power input of 50 watts. A 6CL6 serves as crystal oscillator, with a 5U4GB rectifier. It is an ideal transmitter for the novice, as well as the advanced-class CW operator. Single-knob band switching is featured to cover 80, 40, 20, 15, 11 and 10 meters. Pi network output circuit matches various antenna impedances between 50 and 1000 ohms and reduces harmonic output. Top-quality parts are featured throughout, including "potted" transformers, etc., for long life. It has been given full "TVI" treatment. Access into the cabinet for crystal changing is provided by a removable metal pull-out plug on the left end of the cabinet. Very easy to build from the complete step-by-step instructions supplied, even if you have never built electronic equipment before. If you appreciate a good, clean signal on the CW bands, this is the transmitter for you! Shpg. Wt. 18 lbs.

MODEL DX-20

$35.95

Heathkits...

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are designed by licensed ham-engineers, especially for you

HEATHKIT DX-40 PHONE AND CW TRANSMITTER KIT

A most remarkable power package for the price, the new DX-40 provides both phone and CW facilities for operation on 80, 40, 20, 15, 11 and 10 meters. A single 6146 tube is used in the final amplifier stage to provide full 75 watt plate power input on CW, or control carrier modulation peaks up to 60 watts for phone operation. Modulator and power supplies are built right in and single knob bandswitching is combined with a pi network output circuit for complete operating convenience. The tight fitting cabinet presents a most attractive appearance, and is designed for complete shielding to minimize TVI. A 4-position switch provides convenient selection of three different crystals or a jack for external VFO. The crystals are reached through access door at rear of cabinet. You can build this rig yourself and be proud to show it off to your fellow hams. Get your DX-40 now for many hours of operating enjoyment. Shpg. Wt. 25 lbs.

MODEL DX-40

$64.95

HEATHKIT DX-100 PHONE AND CW TRANSMITTER KIT

Listen to any ham band between 160 meters and 10 meters and note how many DX-100 transmitters you hear! The number of these fine rigs now on the air testifies to the enthusiasm with which it has been accepted by the amateur fraternity. No other transmitter in this power class combines high quality and real economy so effectively. The DX-100 features a built in VFO, modulator and power supplies, complete shielding to minimize TVI, and pi network output coupling to match impedances from approximately 50 to 600 ohms. Its RF output is in excess of 100 watts on phone and 120 watts on CW, for a clean strong signal on all the ham bands from 10 to 160 meters. Single-knob band switching and illuminated VFO dial and meter face add real operating convenience. RF output stage uses a pair of 6146 tubes in parallel, modulated by a pair of 1625's. High quality components are used throughout, such as "potted" transformers, silver-plated or solid coin silver switch terminals, aluminum heat-dissipating caps on the final tubes, copper plated chassis, etc. This transmitter was designed exclusively for easy step-by-step assembly. Shpg. Wt. 107 lbs.

MODEL DX-100

$189.50

FUNCTIONAL DESIGN . . .

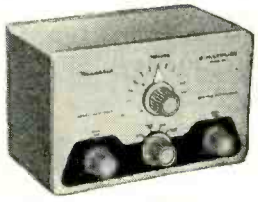
The transmitters described on this page were designed for the ham, by hams who know what features are desirable and needed. This assures you of the best possible performance and convenience, and adds much to your enjoyment in the ham shack.

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

Automatically turns off transmitter and gives visual signal

"AUTOMATIC" CONELRAD ALARM

GRID DIP METER



"Q" MULTIPLIER

COMMUNICATIONS-TYPE RECEIVER

An ideal receiver for the beginning ham or short wave listener

HEATHKIT "AUTOMATIC" CONELRAD ALARM KIT

This conelrad alarm works with any radio receiver; AC-DC-transformer operated—or battery powered, so long as the receiver has AVC. Fully complies with FCC regulations for amateurs. When the monitored station goes off the air, the CA-1 automatically cuts the AC power to your transmitter, and lights a red indicator. A manual "reset" button reactivates the transmitter. Incorporates a heavy-duty six-ampere relay, a thyratron tube to activate the relay, and its own built-in power supply. A neon lamp shows that the alarm is working, by indicating the presence of B+ in the alarm circuit. Simple to install and connect. Your transmitter plugs into an AC receptacle on the CA-1, and a cable connects to the AVC circuit of a nearby receiver. A built-in sensitivity control allows adjustment to various AVC levels. Receiver volume control can be turned up or down, without affecting alarm operation. Build a Heathkit CA-1 in one evening and comply with FCC regulations now! Shpg. Wt. 4 lbs.

MODEL CA-1
$13.95

HEATHKIT "Q" MULTIPLIER KIT

The Heathkit Q Multiplier functions with any AM receiver having an IF frequency between 450 and 460 KC, that is not "AC-DC" type. It derives its power from the receiver, and needs only 6.3 volts AC at 300 ma (or 12 VAC at 150 ma) and 150 to 250 volts DC at 2 ma. Simple to connect with cable and plugs supplied. Adds additional selectivity for separating signals, or will reject one signal and eliminate heterodyne. A tremendous help on crowded phone and CW bands. Effective Q of 4000 for sharp "peak" or "null". Tunes any signal within IF band pass without changing the main receiver tuning dial. A convenient tuning knob on the front panel with vernier reduction between the tuning knob and the tuning capacitor gives added flexibility in operation. Uses a 12AX7 tube, and special high-Q shielded coils. Instructions for connecting to the receiver and operation are provided in the construction manual. A worthwhile addition to any communications, or broadcast receiver. It may also be used with a receiver which already has a crystal filter to obtain two simultaneous functions, such as peaking the desired signal with the crystal filter and nulling an adjacent signal with the Q Multiplier. Shpg. Wt. 3 lbs.

MODEL QF-1
$9.95

HEATHKIT GRID DIP METER KIT

A grid dip meter is basically an RF oscillator for determining the frequency of other oscillators, or of tuned circuits. Extremely useful in locating parasitics, neutralizing, identifying harmonics, coil winding, etc. Features continuous frequency coverage from 2 mc to 250 mc, with a complete set of prewound coils, and a 500 ua panel meter. Front panel has a sensitivity control for the meter, and a phone jack for listening to the "zero-beat." Will also double as an absorption-type wave meter. Shpg. Wt. 4 lbs.

Low Frequency Coil Kit: Two extra plug-in coils to extend frequency coverage down to 350 kc. Shpg. Wt. 1 lb. No. 341-A. $3.00

MODEL GD-1B
$21.95

HEATHKIT ALL-BAND COMMUNICATIONS-TYPE RECEIVER KIT

This communications-receiver covers 550 kc to 30 mc in four bands, and provides good sensitivity, selectivity, and fine image rejection. Ham bands are clearly marked on an illuminated dial scale. Features a transformer-type power supply—electrical band spread—antenna trimmer—headphone jack—automatic gain control and beat frequency oscillator. Accessory sockets are provided on the rear of the chassis for using the Heathkit model QF-1, Q Multiplier. Accessory socket is handy, also, for operating other devices that require plate and filament potentials. Will supply +250 VDC at 15 ma and 12.6 VAC at 300 ma. Ideal for the beginning ham or short wave listener. Shpg. Wt. 12 lbs.

Cabinet: Fabric covered cabinet with aluminum panel as shown. Part no. 91-15A. Shpg. Wt. 5 lbs. $4.95.

MODEL AR-3
$29.95
(Less cabinet)

Heathkits...

By DAYSTROM

are outstanding in performance and dollar value

HEATHKIT REFLECTED POWER METER KIT

The Heathkit reflected power meter, model AM-2, makes an excellent instrument for checking the match of the antenna transmission system, by measuring the forward and reflected power or standing wave ratio. The AM-2 is designed to handle a peak power of well over 1 kilowatt of energy and may be left in the antenna system feed line at all times. Band coverage is 160 meters through 2 meters. Input and output impedances for 50 or 75 ohm lines. No external power required for operation. Meter indicates percentage forward and reflected power, and standing wave ratio from 1:1 to 6:1. Another application for the AM-2 is matching impedances between exciters or R.F. sources and grounded grid amplifiers. Power losses between transmitter output and antenna tuner may be very easily computed by inserting the AM-2 in the line connecting the two. No insertion loss is introduced into the feeder system, due to the fact that the AM-2 is a portion of coaxial line in series with the feeder system and no internal connections are actually made to the line. Complete circuit description and operation instructions are provided in the manual. Cabinet size is 7-3/8" x 4-1/16" x 4-5/8". Can be conveniently located at operating position. Shpg. Wt. 3 lbs.

MODEL AM-2

$15.95

HEATHKIT VARIABLE FREQUENCY OSCILLATOR KIT

Enjoy the convenience and flexibility of VFO operation by obtaining the Heathkit model VF-1 Variable Frequency Oscillator. Covers 160-80-40-20-15-11 and 10 meters with three basic oscillator frequencies. Better than 10 volt average RF output on fundamentals. Plenty of output to drive most modern transmitters. It features voltage regulation for frequency stability. Dial is illuminated for easy reading. Vernier reduction is used between the main tuning knob and the tuning condenser. Requires a power source of only 250 volts DC at 15 to 20 miliamperes and 6.3 volts AC at 0.45 amperes. Extra features include copper-plated chassis, ceramic coil forms, extensive shielding, etc. High quality parts throughout. VFO operation allows you to move out from under interference and select a portion of the band you want to use without having to be tied down to only two or three frequencies through use of crystals. "Zero in" on the other fellow's signal and return his CQ on his own frequency! Crystals are not cheap, and it takes quite a number of them to give anything even approaching comprehensive coverage of all bands. Why hesitate? The model VF-1 with its low price and high quality will add more operating enjoyment to your ham activities. Shpg. Wt. 7 lbs.

MODEL VF-1

$19.50

Heathkits...

By DAYSTROM

are the answer for your electronics hobby.

HEATHKIT BALUN COIL KIT

The Heathkit Balun Coil Kit model B-1 is a convenient transmitter accessory, which has the capability of matching unbalanced coax lines, used on most modern transmitters, to balance lines of either 75 or 300 ohms impedance. Design of the bifilar wound balun coils will enable transmitters with unbalanced output to operate into balanced transmission line, such as used with dipoles, folded dipoles, or any balanced antenna system. The balun coil set can be used with transmitters and receivers without adjustment over the frequency range of 80 through 10 meters, and will easily handle power inputs up to 250 watts. Cabinet size is 9" square by 5" deep and it may be located any distance from the transmitter or from the antenna. Completely enclosed for outdoor installation. Shpg. Wt. 4 lbs.

MODEL B-1

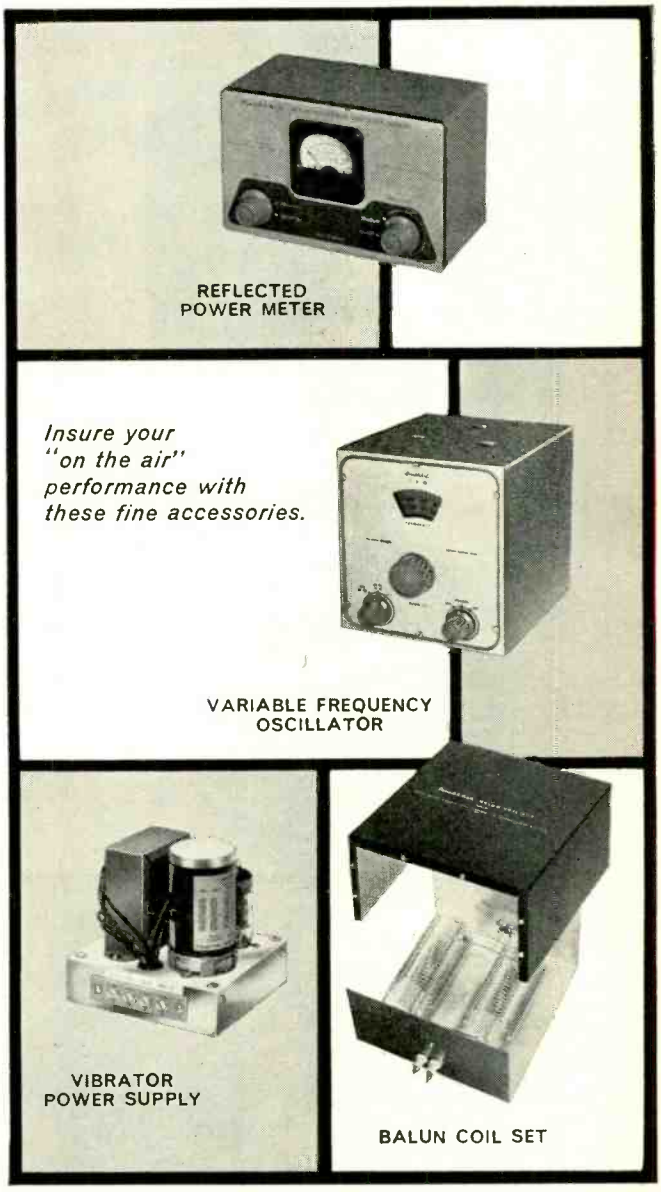
$8.95

HEATHKIT 6 OR 12 VOLT VIBRATOR POWER SUPPLY KITS

These little power supply kits are ideal for all portable applications with 6 volt or 12 volt batteries, when you are operating electronic equipment away from power lines. By replacing the power supplies of receivers, small public address systems, or even miniature transmitters with these units, they can be used with conventional 6 or 12 volt batteries. Use in boats, automobiles, light aircraft, or any field application. Each unit provides 260 volts DC output at up to 60 miliamperes. More than one power supply of the same model may be connected in parallel for increased current capacity at the same output voltage. Everything is provided in the kit, including a vibrator transformer, a vibrator, 6X4 or 12X4 rectifier, and the necessary buffer capacitor, hash filter, and output filter capacitor. Shpg. Wt. 4 lbs.

6 VOLT MODEL VP-1-6
12 VOLT MODEL VP-1-12

$7.95 Each



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HEATHKIT ELECTRONIC IGNITION ANALYZER KIT

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

MODEL IA-1
$59.95

HEATHKIT PROFESSIONAL RADIATION COUNTER KIT

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

MODEL RC-1
$79.95

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

HEATHKIT ENLARGER TIMER KIT

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

MODEL ET-1
$11.50

HEATHKIT BATTERY TESTER KIT

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

MODEL BT-1
$8.50

HEATHKIT CRYSTAL RADIO KIT

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

MODEL CR-1
$7.95

Heathkits...

By DAYSTROM

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

HEATHKIT TRANSISTOR PORTABLE RADIO KIT

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

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

HEATHKIT BROADCAST BAND RADIO KIT

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

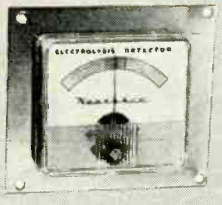
Cabinet: Fabric covered cabinet with aluminum panel as shown. Shpg. Wt. 5 lbs. Part no. 91-9A. $4.95.

MODEL BR-2
$18.95
(Less cabinet)

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

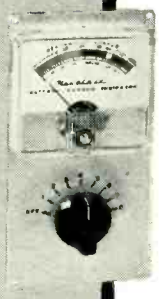
protects against possible explosion and fire from undetected fuel vapor

FUEL VAPOR DETECTOR



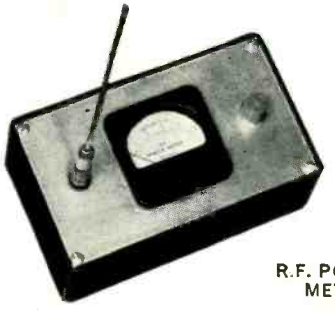
detects electrolysis currents which cause deterioration of underwater metal fittings on your boat

ELECTROLYSIS DETECTOR



indicates condition and charge of batteries for safe cruising

BATTERY CHARGE INDICATOR



R.F. POWER METER

HEATHKIT FUEL VAPOR DETECTOR KIT

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

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

HEATHKIT BATTERY CHARGE INDICATOR KIT

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

MODEL CI-1
$16.95

HEATHKIT ELECTROLYSIS DETECTOR KIT

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

MODEL ED-1
$9.95

HEATHKIT RF POWER METER KIT

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

MODEL PM-1
$14.95

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now offer you completely modern marine equipment with outstanding design features

HEATHKIT TRANSISTOR RADIO DIRECTION FINDER KIT

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

MODEL DF-1

$54.95

use it for a radio-compass or as a portable radio

TRANSISTOR RADIO DIRECTION FINDER

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By DAYSTROM

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Pioneer in "do-it-yourself" electronics

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

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THE COMPLEAT TV REPAIRMAN

It's back to the suburban garden for better TV servicing

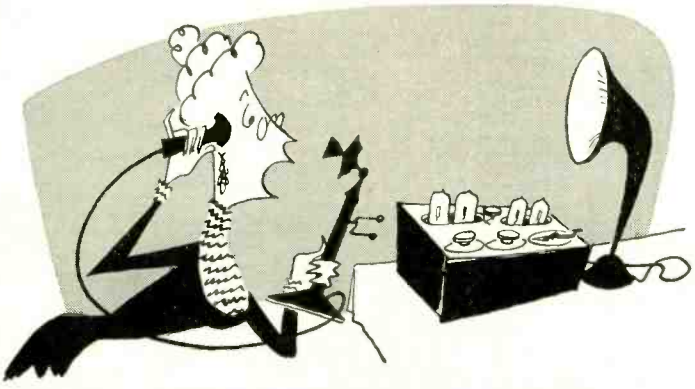
By H. A. HIGHSTONE

IN 25 years of electronic repairing—first radios and later TV sets—you inevitably run into a lot of odd customers and weird situations. There was, for instance, that Radiola-IIIA owner who decided I must be more than a little off my trolley. Right out of a clear sky this nice old lady phoned the service manager I'd said that her ground was poor and she with some of the best garden soil in town! . . . And that young radioman of yours had better stick to his trade and stop passing opinions on matters agricultural . . . Yes, m'am . . . Oh yes, indeed . . . No m'am . . .

Well anyway, just recently I suddenly realized that during the past 2 years I had found use for such unlikely items as garden hose, a common rake and a rubber-tired wheelbarrow in my activities as a TV repairman. Of course those who live anywhere near an ocean know the answer to the hose: the sight of a TV fixer or owner up on a roof flushing salt spray off an antenna and lead-in is common. Inlanders would be surprised at the way this method often melts snow out of a seaside TV receiver. (Try it some time—it might be just as useful in some of those smoky inland cities.)

The wheelbarrow and the rake, though—you wouldn't guess them in a month of Sundays. It's no gag either; absolutely no double-talk involved. A 16-inch Motorola and an inquisitive owner started the chain of events leading to the rake. The sound went out (a 6J5 heater had opened); the owner got out his *Fix-Your-Own-TV* manual, took the back off his box, bumped against the picture-tube socket and broke the neck off the tube a couple of inches south of the base. The thing just went hiss, informatively; no other developments. I suppose it all depends on the kind of life you've been in the habit of living.

I routinely removed the two pieces of the defunct tube, set them behind my shop bench, unpacked a new 16RP4 and steered its base into the deflection yoke. That's as far as I got because that picture-tube base wouldn't go through the yoke! I gouged the plastic insulation a couple of times and nearly got the tube stuck before I gave up. The tube base definitely wasn't oversize. The trouble grew exclusively out of the fact that the yoke had been a tight squeeze to begin with and had subsequently gotten out of round for some mad reason or other. The idea of the rake occurred to me an hour or so later, just as I'd decided to join the Foreign Legion—a resolution arrived at by every active TV repairman every once in a while.



". . . and that young radioman of yours . . ."

The rake, luckily, was a nice new one with the handle still smooth and polished. The bulge at the bottom of the handle—also luckily—was slightly larger than the outside diameter of a picture-tube base. After liberal applications of petroleum jelly, I jammed the yoke (earlier removed from the chassis) as far down the rake handle as it would go; at irregular intervals over a period of 8 hours I jammed it still farther. Eventually, the yoke went past the tube base with 2/1000 (or possibly 3/1000) inch to spare, but that's all you need. There in a nutshell, pardner, is the technique used in fixing TV sets with a garden rake.

". . . I jammed the yoke as far down the rake handle as it would go."

Even the panel of *Twenty Questions* couldn't figure out the story behind the wheelbarrow. This one started with the vertical blocking oscillator transformer in an RCA 16-incher several years back. The primary winding opened and (exactly as it states in the *Home TV Fixers Encyclopedia)* failure of the vertical sweep system was indicated by a thin horizontal line of light across the face of the picture tube. (I really like those home-fixer books; many is the dollar I've raked into my worn till as a result of someone being encouraged to tinker by the 50c book he bought at the drugstore. Of course, a few rubber checks have also been raked into the same till from the same general source, but suppose we skip that part of the story.)

Well, several years ago, if you remember that far back, a defective part could be a serious matter. This was the era of the Big Shortage, when you were advised to "write for prices on critical tubes and parts." "Critical" meant nearly everything, including vertical blocking oscillator transformers. Three weeks' delivery—maybe—was the best offer after a week of trying; meanwhile the customer, characteristically, was jumping up and down, hollering for his set. In desperation, I finally decided to rewind the accursed contraption. Yeah, rewind it—the open primary, next to the core, was No. 39 according to my ciphering while the secondary was No. 42. Get No. 42 in a strong light, against a white surface and if you have about 10–10 vision you can sometimes actually see it, but mostly you depend upon your sense of touch and it had better be a keen one.

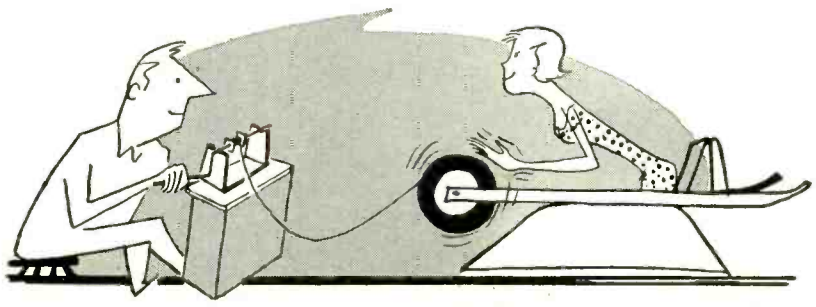
It was at this point I learned that you don't simply pull No. 42 enameled off a spool as you do with wire you can see. I wasted a couple of hours, broke the wire 40 or 50 times and wound up with a head as big as a bale of hay before I discovered the supply spool must be rotated as the coil is wound; rotated steadily and just fast enough to prevent any loops forming on the floor, because loops develop into kinks.

A rubber-tired wheelbarrow, an obliging neighbor and a wife are required. The wheelbarrow is borrowed from the neighbor; it is turned upside down in your shop and an adequate amount of No. 42 wound on the 16-inch tire.

The good wife then acts as a motor to rotate the wheel and to keep the loop between wheelbarrow and winding bobbin a foot or so above the floor. The big wheel turns smoothly and steadily on its ball bearings and solid base and has just the right amount of inertia for this particular job. And if in the end you wind up with only 85% of the original turns on the bobbin, a vertical blocking oscillator works just the same as before. Mine did, anyway.

And now, just as an added free attraction, I shall tell all you kind people who have read this far what I plan to do if ever I get to be Dictator. I plan to use still another garden implement—a pick to be exact—to improve the general tone of the TV industry.

Specifically, I am going to use the handle of that pick to beat the heads of people who make ac–dc TV sets with parts arranged three layers deep, some of the tubes in practically inaccessible locations in pint-sized chassis and with numerous specialized components which a repairman is often 3 or 4 weeks getting. END



By ROBERT G. MIDDLETON
TELEVISION CONSULTANT

Fuzz runs into some hair-splitting convergence controls on the latest crop of color TV receivers and Red tells him how they work

controls, controls, controls

YOU'RE goosy as a hop-frog this morning," Bess remarked as she poured Fuzzball's coffee. "Any little thing and you get the jerks."

"Fuzz had a hard jolt from a TV set an hour ago," Red explained. "His nerves are half-shot."

"That's right," Fuzz agreed. "I got to remember that you don't play around in the high-voltage cage of a color set, like you do in a black-and-white."

"You better know it," Red replied.

"There's something else throws me on some of these color sets, besides the high voltage," Fuzz complained.

"Like what, for instance?"

"Well, this rig I worked on yesterday had a new lever on the yoke like I never saw before. What's the pitch?"

Red wrinkled his forehead for a moment. "Oh, yeah, I know what you mean. That's a blue lateral size switch."

"Jumping Jupiter," moaned Fuzz. "Another blue convergence control?"

"You ought to be glad," Red replied. "It lets you do a better convergence job."

"OK, fill me in," said Fuzz, with a resigned gesture.

"Did you see a small coil right on top of the blue lateral corrector?"

"Yop. Couldn't figure that one at all."

"Well, that's the blue lateral-size coil," Red explained.

"What does it do?"

"That coil corrects the width of the blue raster."

"So the blue lateral-size switch would adjust the current in the coil, to change the width of the blue raster?" asked Fuzz.

"You are 100% right, my boy," Red replied. "I swear I don't know how you do it."

Bess put in her two cents' worth, as she refilled Red's cup. "He ain't even as smart as he looks. He cheats by going to night school. Ask him," Bess challenged.

"That right, Fuzz?" asked Red, opening his eyes wide.

"I hate to admit it," said Fuzz, "but I signed up for that new color TV course at the trade school."

"That's great, Fuzz," Red reassured him. "Just between us girls, we're never too old to learn. Keep it up."

A puzzled look crossed Fuzzball's face. "But tell me," he asked, "how do you adjust the blue lateral size switch. It just don't make sense to me."

"Makes lots of sense, when you know how," Red replied. "You got to have the know-how before the can-do. That switch has six positions."

"You're telling me," replied Fuzz, shaking his head.

"Here, let me show you," said Red, drawing a sketch on a napkin (Fig. 1).

"There's the horizontal yoke balancer we kicked around yesterday," Fuzzball observed.

"Correct," Red replied. "Now, in this model, the yoke balancer is center-tapped. The current to the yoke flows through the size coil, unless you switch it out of the circuit."

"The second position of the size switch would cut out the size coil entirely," Fuzz suggested.

"Right. Now, in the first position, the yoke current causes a reverse magnetic field in the size coil—the size of the blue raster is narrowed a little."

"I see the whole deal, now," Fuzz announced. "If the switch is put on the third tap, the blue raster widens out. It will widen out still more on the fourth tap."

"You're hot as a firecracker, today," Red complimented him. "Maybe you ought to have a 20,000-volt shock treatment every morning."

"What did you say, Red? I can't hear you," said Fuzz slyly.

Bess shrugged her shoulders and shook her head slowly.

"OK, wise guy," Red replied. "Let's get back in this world for a change. Can you see how to adjust the switch now?"

"I reckon you would use it along with the yoke balancer while you're bringing in the blue dots at the left and right edges of the screen," Fuzz guessed.

"That's the general idea," Red replied.

"Let's chew some warmed-over cabbage a minute," Fuzzball suggested.

"Like what?"

"Well, we've just been talking about the horizontal yoke balancer again. Reminds me that you said yesterday some of these new sets have a vertical yoke balancer, too."

"You remember right."

"Well, tell me then, how is a vertical yoke balancer hooked up?"

Red reached for another napkin and drew a sketch (Fig. 2). "The vertical yoke balancer is a pot," he explained.

"I see now," Fuzz announced. "That 2-ohm pot throws a little more current into one coil or the other."

"It don't do nothing else," Red agreed.

"But why are the yoke coils connected in parallel in these color sets?" demanded Fuzzball. "Black-and-white sets

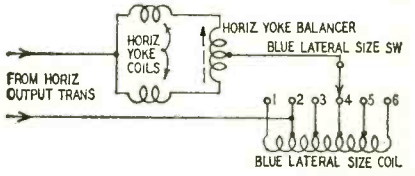


Fig. 1—The blue raster is smallest when the size switch is at its first tap, largest at the sixth tap.

connect yoke coils in series."

"For many years," Red explained academically, "we have known that more accurate scanning is obtained with parallel coils. But the efficiency is lower."

"After fighting dynamic convergence the last few days, I'll vote for parallel coils all right," Fuzzball said fervently.

"Riddle me another one," Red suggested.

"You asked for it," Fuzzball replied. "What's them little crank handles on the top and bottom of the yoke for?"

"Oh, yeah, them little gizmos," said Red. "Them's keystone correctors."

"Come again?"

"Just like I said. You adjust them to

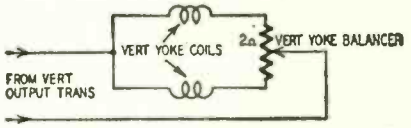


Fig. 2—The vertical yoke balancer is a 2-ohm potentiometer.

make the raster the same width at the top and the bottom of the screen."

"They get down to pretty fine points on some of these color sets, don't they?" Fuzz asked.

"But definitely," Red agreed. "With set owners as fussy and critical as they are these days, what are you gonna do?"

"I can't argue," Fuzzball replied. "It's easy to criticize and it's the best thing that a lot of our customers do."

"They put us between the devil and the deep blue sea," Red agreed. "If you don't split hairs for most of them, they complain that we didn't do a good job. Then they turn right around and bitch about the cost of receivers."

"Them's my sentiments," Fuzzball agreed. "I can see where the keystone correctors would give a little closer adjustment on horizontal convergence."

"Right you are," Red replied. "You can make the red and green raster widths exactly equal by fiddling with the keystone correctors."

Fuzzball started to count on his fingers and hesitated as he came to his last finger. "Take off your shoes," Bess suggested. "Then you can count to 20."

Red grinned. "I never saw Fuzzball barefoot. Maybe he can count to 22 that way."

"I'll buy that," Bess agreed, nodding her head.

"Oh tish and tosh," Fuzzball snapped. "You talk like a bunch of old women."

"What're you counting up?" asked Red.

"Just trying to figure up the number of convergence controls I got to battle in these new receivers."

"Remember one thing, though," Red advised.

"What's that?"

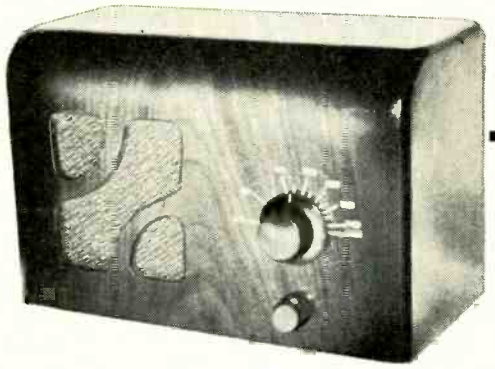
"In some of these new receivers the red and green coils on the convergence yoke aren't hooked up separate."

"No?"

"No! The red and green dynamic convergence windings are connected in parallel."

TABLETOP TRANSISTOR RADIO

Though not intended as a hi-fi set, this 7-transistor receiver is very easy to listen to

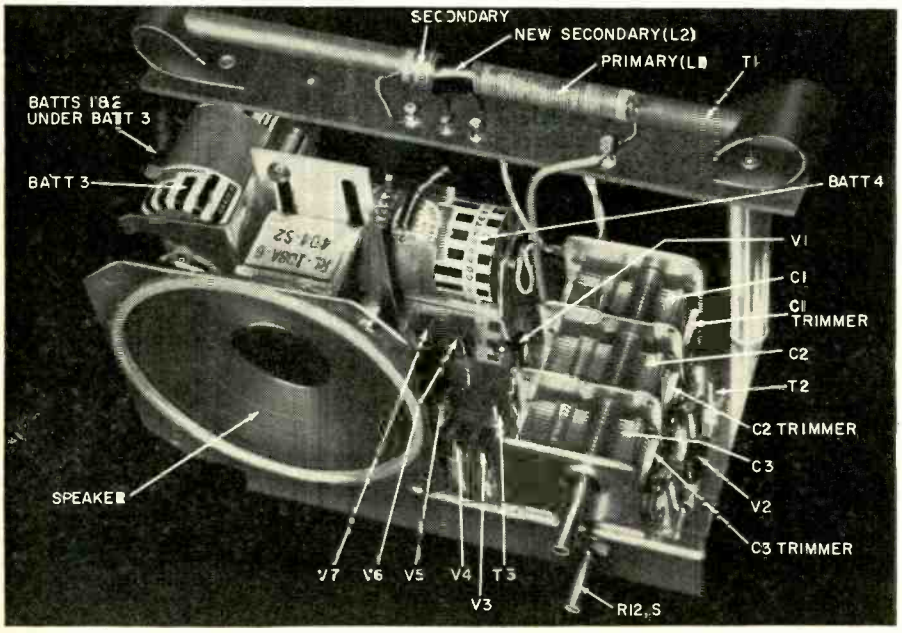


In its polished wood cabinet, the finished unit presents an attractive appearance.

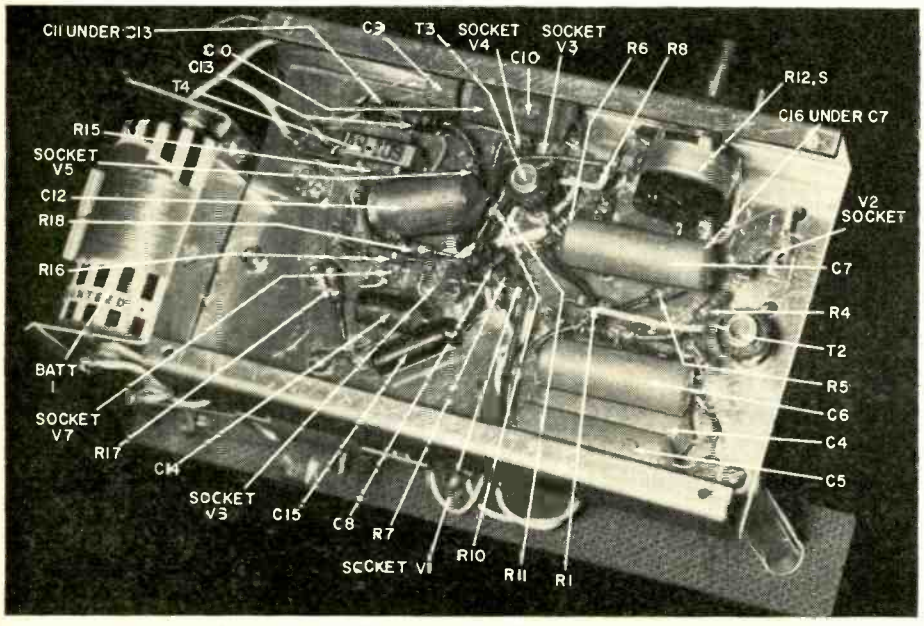
By JAMES E. PUGH, JR.

IF you have hesitated to build a full-sized transistor radio because of the complicated circuitry and alignment of a superheterodyne, this trf receiver may be just what you have been looking for. It is easy to build and adjust.

While a trf receiver does not have as great sensitivity and selectivity as a superhet with an equal number of stages, entirely satisfactory performance is possible. Trf circuitry is simpler and, since all tuned circuits resonate at the same frequency, alignment is easier and better tracking over the tuning range is possible. Reception is not marred by images or by pickup at the intermediate frequency, both of which can be annoying in inexpensive superhets. And from the other listener's viewpoint, it does not radiate interference.



Top chassis arrangement. Note the antenna mounting.



Under the chassis. No attempt at miniaturization has been made.

Circuit details

The receiver has two stages of trf amplification and a class-B detector to provide good sensitivity and selectivity. This is followed by three audio stages —the last being a class-B output stage driving a 4-inch PM speaker. (See Figure 1.) Two extras are included: a simple avc system, and negative feedback in the driver and output stages for improved tone.

The first three transistors (V1, V2 and V3) are the rf type (Raytheon 2N112's) with an alpha cutoff frequency of 5 mc. Both V1 and V2 are connected as grounded-base amplifiers. The grounded-base circuit is used because its frequency response is much better than that of the grounded-emitter circuit; it has sufficient isolation between its input and output circuits to make neutralization unnecessary.

Fewer parts are used because the neutralization capacitors and tapped coils are not required; alignment is simple since tracking of the three tuned circuits (L1–C1, L3–C2, L5–C3) is the only adjustment needed, and because the output impedance of the grounded-base amplifier is much higher than that of the grounded-emitter.

The input impedance of the grounded-base circuit is less than that of the grounded-emitter but this is no disadvantage because both require impedance matching.

Of course, the grounded-base circuit does not have *all* the advantages. The

7-pin 98¢ Twin $1.15 9-pin 98¢

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Printed-Circuit, Straight Tip 65¢

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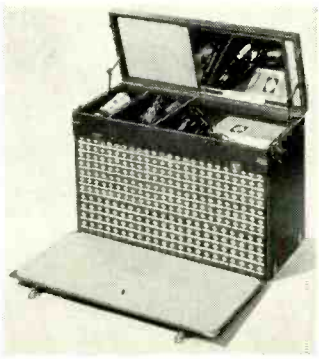
And as you well know, a service-dealer has two major things to sell: his time and know-how. Because CBS tools save precious time, it is not surprising that over 2.5 million have been sold. Service-dealers, engineers and technicians use them habitually. The Soldering Aid, for example, has become a standard.

Many of the tools grew out of a CBS contest. All are time-tested, painstakingly developed and manufactured to give you helpful, foolproof tools. Their quality is tops, yet they are priced most economically.

Order the tools you still need from your CBS Tube distributor — particularly the new Printed-Circuit Soldering Aids. Ask to see the bigger yet handier new Tube-and-Tool Caddy. Or write today for CBS Tool Catalog, PA-6.

Let *all* the CBS tools help make *your* work easier, faster, more profitable.



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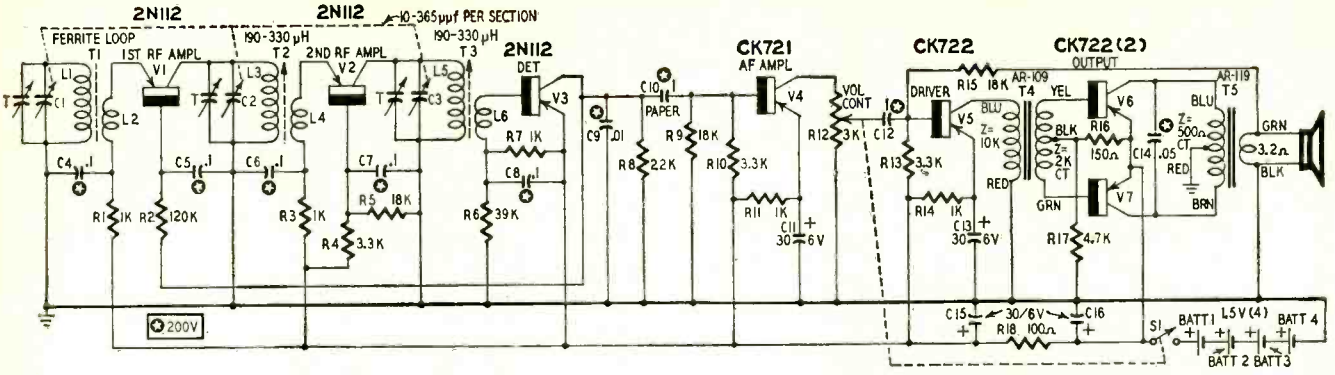


R1, 3, 7, 11, 14—1,000 ohms
R2—120,000 ohms
R4, 10, 13—3,300 ohms
R5, 9, 15—18,000 ohms
R6—39,000 ohms
R8—22,000 ohms
R12—pot, 3,000 ohms, with spst switch
R16—150 ohms
R17—4,700 ohms
R18—100 ohms
All resistors ½-watt 10%
C1, 2, 3—3-gang variable capacitor, 10-365-μμf per section with trimmers (Allied 60 H 726 or equivalent)
C4, 5, 6, 7, 8—0.1 μf, 200 volts
C9—.01 μf, 200 volts
C10, 12—1.0 μf, 200 volts
C11, 13, 15, 16—30 μf, 6 volts, miniature electrolytic
C14—.05 μf, 200 volts
BATT1, 2, 3, 4—type D flashlight cells
S1—spst on R12
T1—ferrite antenna (Miller type 2000 or equivalent), new secondary added (see text)
T2, 3—adjustable rf coils, 190-330 μh (Miller 4513 or equivalent) with secondaries added (see text). No. 32 enameled wire for T2 and T3
T4—Driver transformer: primary, 10,000 ohms; secondary, 2,000 ohms, ct (Argonne AR-109 or equivalent). (The catalog erroneously lists this transformer without a center tap)
T5—output transformer: primary, 500 ohms, ct; secondary, 3.2 ohms (Argonne AR-119)
V1, 2, 3—2N112
V4—CK721
V5, 6, 7—CK722
Speaker, 4-inch PM; 3.2-ohm voice coil
Chassis, 1 x 6⅛ x 4 inches, open end
Battery holder for 1 type D cell (Austin Craft 1D or Acme No. 11)
Battery holder for 3 type D cells (Austin Craft 3D or Acme No. 28)
Cabinet, wood, 8 5/16 x 5 7/16 x 4¼-inch inside dimensions (Allied 98 S 932 or equivalent)
Knobs
Transistor sockets, 3 pins (3)
Transistor sockets, 5 pins (5)
Miscellaneous hardware

Fig. 1—Circuit of the tabletop receiver.

grounded-emitter circuit does have an important one—the well-known greater gain per stage.

Loop antenna T1 is a high-Q ferrite-rod type that has been modified slightly to accommodate the grounded-base circuit. The sharp tuning properties of this coil, combined with the medium Q of T2 and T3, provides a good degree of selectivity. The primaries of these transformers (L1, L3 and L5) are ready-wound and secondaries L2, L4 and L6 are homemade.

The class-B detector

Detector V3 is a class-B type. Compared with conventional diode detectors, it has the advantage of providing gain and, since it is biased nearly to cutoff, its current needs are extremely small. Avc action is obtained by applying the positive dc voltage developed across the collector load resistor (R8) to V1's base, through R2.

This voltage becomes more positive with an increase in signal level and is in the right direction to decrease V1's gain with an increase in signal. A series resistor is used for obtaining base bias for V1 instead of a voltage divider because a divider makes the base voltage nearly immovable and thus unresponsive to avc voltage.

The audio section is conventional in most respects. If you plan to use the

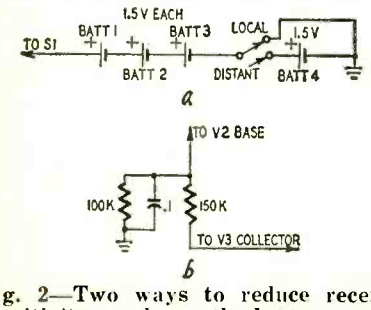


Fig. 2—Two ways to reduce receiver sensitivity: a—lower the battery supply voltage; b—alter the age circuit.

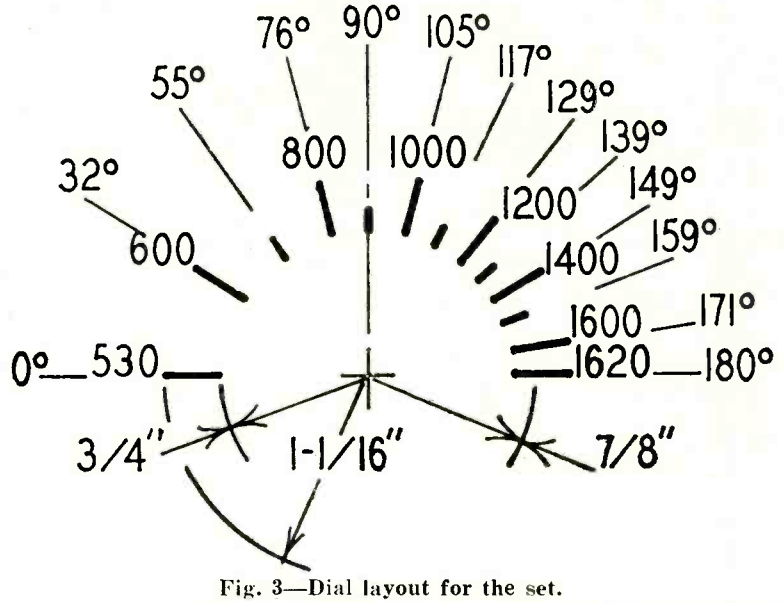


Fig. 3—Dial layout for the set.

receiver where most stations are within 25 to 30 miles, the first audio stage can be eliminated. If this stage is eliminated, delete R8, R9, R10, R11, C10, C11 and V4. Change potentiometer R12 to 25,000 ohms and connect it in the collector circuit to replace R8. A CK721 can be used for V5 without requiring any change in the value of any parts.

(We tested this receiver in a strong-signal area and discovered that its gain and sensitivity were much too high. To provide satisfactory operation, two modifications were tried. Both worked successfully and are shown in Fig. 2.

The first consists of placing a spdt switch between BATT3 and BATT4 as shown in Fig. 2-a. When the switch is in the LOCAL position, only 4.5 volts is applied to the radio with a resultant decrease in sensitivity and gain. The DISTANT–LOCAL switch can be mounted on the front panel.

The other possibility is to change the avc circuit as shown in Fig. 2-b. To do this, remove resistor R4. Replace resistor R5 with a 150,000-ohm unit and connect as in Fig. 2-a. Then to finish up, place a 100,000-ohm resistor across C7. Of course, in a weak-signal area no changes are necessary.—*Editor)*

Construction techniques

All components are mounted on a 1 x 6⅛ x 4-inch open-end aluminum chassis to fit one of the smallest wooden cabinets available. The cabinet's inside dimensions are 8 5/16 x 5 7/16 x 4¼ inches. Plenty of space is available for all parts and no attempt is made to miniaturize other than to use inexpensive transistor transformers, small low-voltage electrolytics and small rf inductors for T2 and T3.

The first construction step should be to determine the best location for all parts. Layout is not critical but care

should be taken in locating the antenna, batteries and speaker because clearance between them and the case is tight.

The antenna's fiber mounting strip is too long to fit in the cabinet and is shortened to 8⅜ inches by cutting an equal length off each end. Four terminal lugs are mounted on this strip as shown in the top-chassis photo. Those shown are USECO type 1300T terminals (available at Newark Electric Co., Chicago, and the Radio Shack, Boston) but 4-40 x ¼-inch machine screws with solder lugs under their heads are satisfactory. Solder lugs are used on the under side of the three left terminals in either case.

The antenna is mounted flush with the back of the chassis. Do not use metal supports and mount it as far from the speaker and battery holder as possible, as nearby metal will lower the antenna's Q.

The right end of the antenna is mounted on a 3 5/16-inch length of ½-inch-diameter polystyrene or bakelite rod. The upper end of the rod is tapped for a 4-40 x ½-inch screw and the lower end is threaded for a 6-32 x ½-inch screw. The left end of the antenna is mounted on a 1⅞-inch length of ½-inch-diameter insulator rod. One end of this rod is threaded for an 8-32 x ½-inch screw for mounting in the outer slot in the speaker mounting bracket. The antenna is fastened to this rod with a 4-40 x ½-inch screw ⅝ inch from the outer end of the rod.

The existing antenna tap is not used and is taped down with a narrow strip of vinyl plastic tape. The new secondary (L2) is 7 turns of No. 20 insulated wire wound in either direction on the lower end of primary L1. The ends of this winding are soldered to the two inner terminal lugs and the coil is fastened down with polystyrene coil dope. The lower end of L1 is connected to a ground lug mounted on the tuning capacitor's frame and the hot end is connected to C1's stator with a length of spaghetti-covered No. 16 bus wire. All wires from L1 should be as short as possible.

A ¼ x ¼ x 2-inch section is cut from the bend in the chassis directly under the speaker to permit mounting closer to the chassis. This opening can be seen in the upper left corner of the underchassis photo. The speaker mounting bracket is fastened with its left edge flush with the left edge of the chassis. Transformer T5 is mounted under the magnet frame (directly above T4) and the separation here will be about 3/32 inch.

The three-section battery holder is mounted with two angle brackets. One can be seen on the left side of the chassis. The other is mounted on top of the chassis, under one of the screws used to fasten the speaker mounting bracket. The single battery holder mounts on top of the chassis with the battery clip flush with the back edge of the chassis. Allow about 5/32 inch between the end of this box and the

RADIO

bottom of the three-section box for clearance for the end terminal. The negative terminal is connected to a solder lug on the tuning capacitor's frame.

Tuning capacitor and volume-control shafts are centered between the outer edge of the cabinet and the speaker opening. The front capacitor-mounting screw is a 6-32 flat head in a countersunk hole to allow room for mounting the volume control.

The transistor sockets require 5/32 x 11/32-inch mounting holes. These holes are made by first marking the outline with a scriber and then carefully drilling three ⅛-inch holes inside the outline. Use a 5/32-inch round file to bring the hole to size and square the corners with a jeweler's or ignition file. After the sockets are mounted, a drop of red paint or nail polish on both sides of the chassis to identify the collector. This is helpful when placing the transistors in the sockets and when making connections to the sockets.

Sockets for V1, V2 and V3, and transformers T2 and T3 are positioned so that the tuning capacitor stators can be used to connect the collector of V1 to coil L2 and the collector of V2 to L5. This layout permits using short leads in the rf section.

Transistor V1 is located close to the center of the chassis. A short length of hookup wire connects its collector to C2's stator through a ⅛-inch hole in the chassis. Below the solder lug on the opposite end of C2's stator is another hole through which another short wire connecting C2 to L3 is run.

Transistor V2 is directly above T2 and the secondary (L4), seven turns of No. 32 enameled wire wound on the outer surface of L3, is connected to its emitter. Its collector is connected to C3's stator. Secondary L6 is 15 turns of No. 32 wire wound on the outer surface of L5. The hot end of L6 is connected to V3's base.

The lugs on the transistor sockets are very small and, where convenient, it is best to solder only one wire to each lug. Where several parts connect to the same lug, tie points can be used for the neatest arrangement. Or for the most compact arrangement all of the parts can be soldered together with a single wire connected to the lug.

A good mechanical connection is sometimes difficult to make so, when using these transistor sockets, it is important to make a good solder joint. Cut the transistor leads to ¼ inch with a pair of diagonals. Use the diagonals with the cutting edge parallel to the long side of the transistor. This makes the end of the pin wedge-shaped and correctly oriented to help spread the spring contact in the socket.

The chassis is fastened to the case with 6-32 screws threaded into tapped holes in the bottom edge—or use self-tapping screws. Rubber feet (1½-inch diameter) are mounted on each corner of the cabinet's bottom.

The cabinet's back is made from a

piece of ⅛-inch Masonite cut about ⅛ inch smaller than the case's outside dimensions. It is fastened with small wood screws in each corner and provides excellent protection when the receiver is used as a portable.

Receiver alignment

Alignment is a simple operation and is best done with a signal generator although very good results can be obtained using only two broadcast stations of known frequency and a dc voltmeter. First make a dial on stiff cardboard as shown in Fig. 3 and fasten it temporarily to the front of the tuning capacitor frame. Connect a 0–10-volt dc meter—preferably with a 20,000-ohms-per-volt movement — from V3's collector to ground and lightly couple the output of the signal generator to the loop antenna.

Adjust C1's trimmer so that a 1620-kc signal falls at the correct point on the dial. Check that the low end resonates at about 530 kc. Now set the dial and the generator to 600 kc and adjust T2 and T3 for maximum output. Next set the dial and signal generator to 1400 kc and adjust C2 and C3 for maximum output.

Repeat these adjustments until maximum output is obtained at both 600 and 1400 kc. Check occasionally at 1620 kc to see that dial calibration is still correct.

If a signal generator is not available, it is possible to make a reasonably good alignment by using two broadcast stations of known frequency—preferably close to 600 and 1400 kc. First determine the frequency of each station and then adjust C1 until the one near 1400 kc falls at the correct dial reading. Then set the dial to the reading where the lower-frequency station should be peaked. Adjust T2 and T3 for maximum output.

Now reset the dial to read the predetermined frequency of the higher-frequency station and adjust C2 and C3 trimmers for maximum output. Repeat these adjustments until both stations are peaked at the correct dial reading. Remove the cardboard dial, put the chassis in the cabinet and the radio is ready to use.

The performance of this receiver is satisfactory for either home or portable use. It covers the broadcast band from 530 to 1620 kc with good tracking over the entire range. Its sensitivity is good enough for acceptable daytime reception of lower-power stations up to 60 miles away. Good nighttime reception of stations up to 1,000 miles away has been noted.

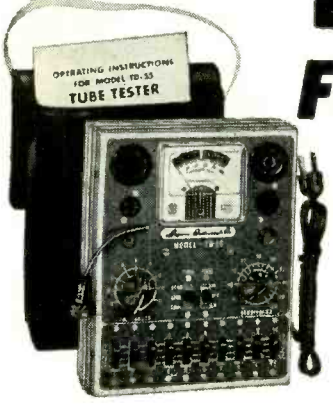
The no-signal battery drain is 6 ma, increasing to 30 ma at full output. Acceptable operation is obtained with a battery voltage as low as 4, which means that battery life should be at least 500 hours.

The overall dimensions of the case are 4½ x 9⅜ x 6 inches. The total weight, including batteries, is less than 4½ pounds END

Superior's New Model TD-55

EMISSION TYPE

New! SICO Streamlined TUBE TESTERS



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

• **You can't insert a tube in wrong socket.** Separate sockets are used, one for each type of tube base. • **"Free-point" element switching system** 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.** 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. • **Elemental switches are numbered in strict accordance with R.M.A. specification.** The 4 position fast-action snap switches are all numbered in exact accordance with the standard R.M.A. numbering system.

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

Model TD-55 comes complete with operating instructions and charts and streamlined carrying case.

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

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

Tests all magnetically deflected picture tubes from 7 inch to 30 inch types.

- Tests for quality by the well established emission method. All readings on "Good-Bad" scale.
- Tests for inter-element shorts and leakages up to 5 megohms.
- Test for open elements.

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

Comes absolutely complete — nothing else to buy. Round cornered molded bakelite case. Only ...

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STANDARD PROFESSIONAL

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- Uses the new self-cleaning Lever Action Switches for individual element testing. **All elements are numbered according to pin-number in the RMA base numbering system.**
- Model TW-11 does not use 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. Printed in large easy-to-read type.

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

EXTRAORDINARY FEATURE

SEPARATE SCALE FOR LOW-CURRENT TUBES

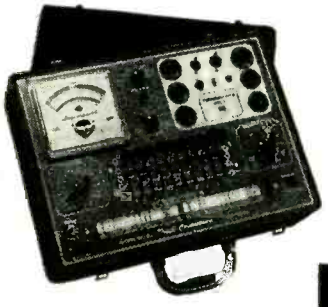
Previously, on emission-type tube testers, it has been standard practice to use one scale for all tubes. As a result, the calibration for low-current types has been restricted to a small portion of the scale. The extra scale used here greatly simplifies testing of low-current types.

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

$47.50 NET

SICO TRANS-CONDUCTANCE TUBE TESTER

The new Model TV-12



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★ **Employs improved TRANS-CONDUCTANCE circuit.** An in-phase signal is impressed on the input section of a tube and the resultant plate current change is measured. This provides the most suitable method of simulating the manner in which tubes actually operate in Radio & TV receivers, amplifiers and other circuits. Amplification factor, plate resistance and cathode emission are all correlated in one meter reading.

★ **NEW LINE VOLTAGE ADJUSTING SYSTEM.** A tapped transformer makes it possible to compensate for line voltage variations to a tolerance of better than 2%.

★ **SAFETY BUTTON**—protects both the tube under test and the instrument meter against damage due to overload or other form of improper switching.

★ **NEWLY DESIGNED FIVE POSITION LEVER SWITCH ASSEMBLY.** Permits application of separate voltages as required for both plate and grid of tube under test, resulting in improved Trans-Conductance circuit.

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A transistor can be safely and adequately tested only under dynamic conditions. The Model TV-12 will test all transistors in that approved manner, and quality is read directly on a special "transistor only" meter scale.

Model TV-12 housed in handsome rugged portable cabinet sells for only

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USE APPROVAL FORM ON NEXT PAGE

New! SICO Superior's New Model 76

IT'S A **CONDENSER BRIDGE** IT'S A **RESISTANCE BRIDGE** IT'S A **SIGNAL TESTER** IT'S A **TV ANTENNA TESTER**

✓ **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. Will also measure the power factor of all condensers from .1 to 1000 Microfarads.

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2 Ranges: 100 ohms to 50,000 ohms; 10,000 ohms to 5 megohms.

✓ **SIGNAL TRACER SECTION**
With the use of the R.F. and A.F. Probes included with the Model 76, you can make stage gain measurements, locate signal loss in R.F. and Audio stages, localize faulty stages, locate distortion and hum, etc.

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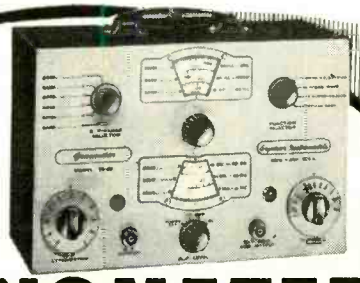

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Servicing transistor AUTO RADIOS

Part II—Transistor circuits and tube circuits are not alike. Look at these transistor audio, agc and automatic-tuning stages and see the differences

By JACK DARR

LAST month we took a close look at the first four stages of transistor auto radios—rf, mixer, oscillator and if. We also covered the precautions a pre-transistor service technician must keep in mind when working on transistor sets. Now we will continue our tour of the auto radio, this time starting with the detector.

A transistor detector is somewhat similar to the familiar diode detector, but differs in theory. The if signal is applied to the base through a stepdown transformer. The base is not supplied with forward bias, and the transistor remains cut off until voltage is applied. (see Fig. 6). Thus, the transistor conducts only on the positive half-cycles of the applied current and is cut off on the other half—standard detector action. Filtering out the remaining if pulsations from the signal is taken care of by the .05-μf capacitor shunted from emitter to ground.

The audio signal developed is applied to the manual volume control, which is connected through a 25-μf capacitor to the coupling transformer feeding the audio pream. In some circuits, especially those used in signal-seeking or search-tuner radios, additional detector isolation may be found. A crystal diode in series with the detector's base lead is often used. It is needed to avoid undue signal damping at this point, where it would possibly interfere with the normal triggering action of the tuner, causing it to stop on sidebands of strong signals.

Agc circuits

As in tube sets, some form of automatic gain control is needed to keep the output fairly constant for signal variations. A separate transistor is used as an agc amplifier and a crystal diode for the actual rectification of the signal voltages. The agc bus is almost identical with the circuit in tube sets (see Fig. 7). This circuit will introduce a very unusual feature to the pre-transistor tech—*this* agc voltage, on an *increase* in signal, goes *positive*, instead of negative as in tube sets! The higher the signal strength, the more positive the agc voltage. The positive voltage, applied to the controlled transistor's emitter, reduces the stage's gain. In some sets, a strong input signal drives the controlled stages into complete cutoff, with the only signal transfer being that due to the transistor's interelectrode capacitance. This only happens on very strong signals when it is desirable to keep the receiver sensitivity at a very low level to avoid blocking and distortion.

Another rather unusual circuit, except in some very large tube sets, is the

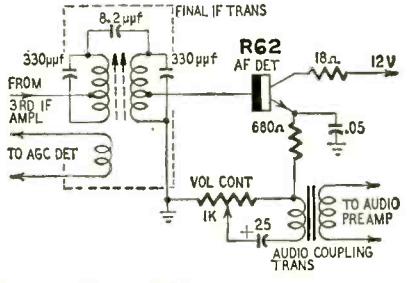

Fig. 6—Simplified circuit of a transistor, audio-detector stage.

separate agc amplifier. This raises the agc voltage to the necessary level. Emitter resistors for the controlled stages are part of the ground-return circuit for this transistor amplifier. Thus, the voltage developed is applied to these elements, controlling the gain of their respective stages. Note, in Fig. 7, the crystal diode connected in series with the agc connection to the rf amplifier. This functions by reverse conduction—the so-called Zener point, as a delay for agc voltage applied to the rf stage. The diode maintains a high resistance until agc voltage has reached a given point. Then it suddenly starts to conduct, allowing the agc voltage to reach the rf stage's emitter. This keeps the rf stage operating efficiently over a wide range of signal strength. It also keeps selectivity, image rejection and signal-to-noise ratio at a high level.

Audio stages

Whenever detector output is not sufficient to drive the output stages, a preamp is used (see Fig. 8). The one shown uses a p-n-p 2N109, which is a medium-power type with a higher current amplification than the 2N149's used in earlier stages. The usual input and output matching transformers are used. The tertiary winding shown at the bottom of the driver transformer delivers a degenerative voltage to the emitter to improve the stage's quality. The 100-ohm resistor shown in the emitter circuit is the self-bias resistor. It stabilizes the transistor against changes in emitter current caused by temperature variations. The 100-μf capacitor bypasses this resistor, preventing audio degeneration by providing a low-impedance path to ground for the af signals. A tone control is shown in the collector circuit of this stage. This is the familiar high-cut type used in many sets for years.

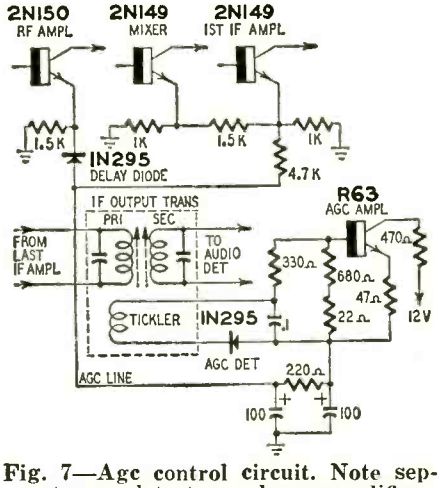

Fig. 7—Agc control circuit. Note separate agc detector and agc amplifier.

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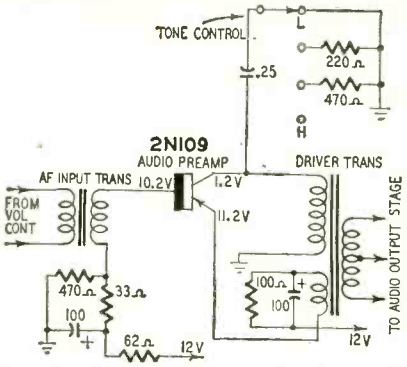


Fig. 8—Audio preamp stage, needed when detector output is insufficient to drive the audio output stage.

Fig. 9 shows a 2N173 connected in a single-ended, common-emitter output circuit. The necessary forward bias is developed across a 10-ohm resistor in the voltage-divider network. By varying the bias adjust potentiometer, forward bias is set to the proper point. This must be adjusted with a milliammeter in the collector circuit. For the values shown, a typical reading would be 900–930 ma.

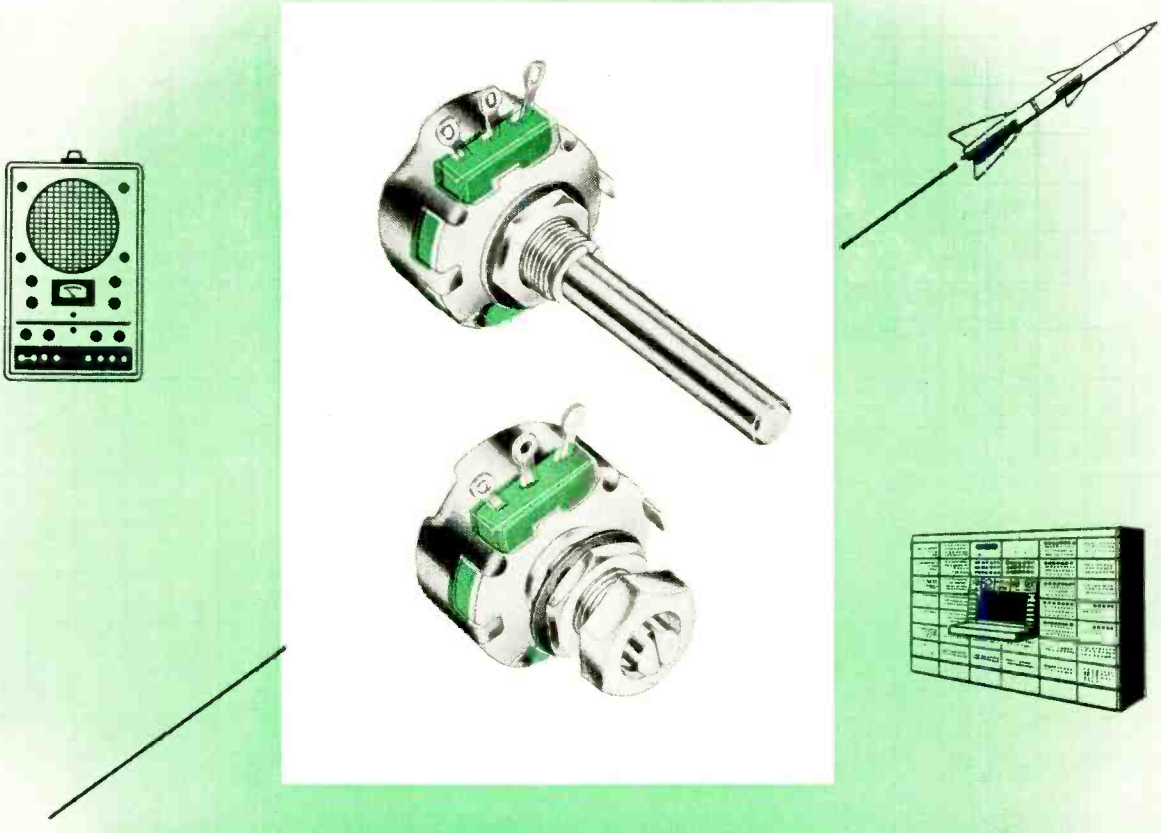
Since collector current in this circuit is nearly 1 amp and the transformer used has a dc resistance of about 1 ohm, collector voltage will be about 1. This is a handy test of whether the transistor is working. As the collector is returned directly to ground with no voltage actually applied to it, if the voltage is present, the transistor must be working! Low voltage at this point would indicate a weak transistor, low output or insufficient driving current.

The 0.47-ohm resistor stabilizes collector current and prevents thermal runaway due to transistor heating. As temperature increases during operation, the transistor's resistance drops, causing it to draw more current. This produces a change in the voltage across the 0.47-ohm resistor, which adjusts the bias and opposes the original current change.

Power transistors are always mounted tightly to a suitable chassis, which acts as a heat sink, carrying away excess heat. The power transistor's collector is connected to the case and mounting stud and must be insulated from the metal chassis. This is generally done by using a thin mica or anodized-aluminum washer between case and ground. When removing or replacing these transistors, be sure that the insulator is replaced and that it has not been damaged.

Fig. 10 shows two 2N278 power transistors in a push-pull circuit. They are connected in a common-emitter configuration to take advantage of their tremendous power gain. This circuit uses the familiar class-AB biasing, in which each transistor amplifies only during half of each cycle, just as in a tube circuit. A thermistor in the emitter circuit stabilizes the stage against troubles caused by excessive heating.

The collectors are connected to



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ground through the output transformer's primary. The center tap of this transformer is a good place to insert a milliammeter to measure collector current. In a circuit like this, total collector current should be about 100 ma for true class-AB operation. This current can be set to the correct value by varying the base voltage—a potentiometer adjustment is usually provided in the voltage-divider network.

Signal-seeking tuner

The basic action of a signal-seeking tuner is probably familiar to most technicians. A trigger tube is actuated by the set's avc voltage, as the radio is slowly tuned across the band by some mechanical arrangement. When the tuner crosses a strong station, the pulse of avc voltage applied to the grid of the trigger tube causes it to conduct. The resulting pulse of current in its plate circuit is applied to another tube and the plate current of this tube

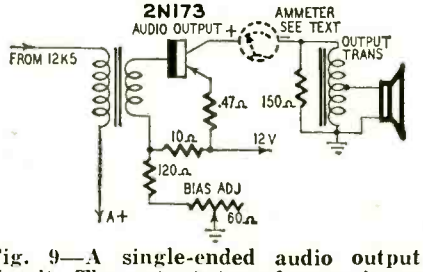

Fig. 9—A single-ended audio output circuit. The output transformer is an autotransformer.

actuates a relay, stopping the tuner on the station. A 12AU7 is used in almost all tube sets for this purpose.

Two transistors are needed to take the place of the 12AU7's twin triodes in this circuit. One of Delco's circuits uses a 2N149 transistor as the trigger, with a 2N109 as the relay control. The controlling pulse from the age line is applied to the base of the trigger transistor. A small delay voltage, also derived from the customary voltage divider, is used to prevent the transistor from triggering on the sidebands of very strong signals.

The transistor relay control acts in reverse to the tube. Instead of closing the relay, the transistor holds the relay open while the tuner is seeking. The control pulse from the trigger amplifier cancels out the base bias, the relay control transistor is cut off and the relay drops out, stopping the tuner. To restart the tuner, a starting circuit is energized, closing the relay and allowing the transistor to hold it in the energized position.

One of the quickest checks for abnormal operation of power transistors is to test for collector voltage. If this voltage is low and all other conditions seem normal, the transistor should be tested for low gain and internal leakage. This is done with an ohmmeter. Disconnect the base and emitter leads from their circuit connections, leaving the transistor bolted firmly to its heat sink. It might be a good idea to check for shorts between the transistor case and the chassis after disconnecting the output transformer's primary.

Check the ohmmeter's polarity. Most service type instruments have a positive lead to the red or ohms jack, but some differ. Set the instrument on R × 1, and *leave it there!* On this scale, only a small battery is used. Some instruments use as much as 22.5 volts on higher ranges, and this can harm transistors.

Connect the ohmmeter's *negative lead* to the collector stud and the positive lead to the emitter. A zero ohms reading, dead short, indicates a shorted transistor. If a fairly high reading is shown, the transistor is probably OK. A low ohmage reading indicates a leaky transistor or the possibility that the transistor is still too hot. Wait a few minutes and recheck.

For a final test, connect a 1,000-ohm resistor between the base and the collector stud (Fig. 11). The meter should now show a decided *decrease* in resistance, and should read less than 50 ohms. If not, the ohmmeter polarity may be wrong—recheck. If the reading is more than 50 ohms with the 1,000-ohm resistor connected, either the base lead is open or the transistor has very low gain and should be replaced.

Service in the car

Servicing transistor sets in the car offers few differences from the older sets. All possible tests should be made, including substitution of a new antenna, before pulling the chassis. The use of a low-range (0–5-amp) dc ammeter to measure current drain would be even more appropriate on these than with tube sets. Check speakers for continuity. If an open voice coil is found, replace the speaker and check output transistors for power output. They may have been damaged by running with the output transformer secondary open!

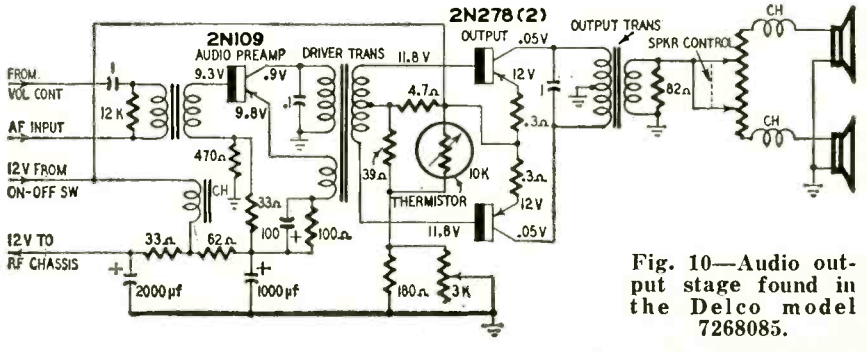

Fig. 10—Audio output stage found in the Delco model 7268085.

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In one case starting an air conditioner caused noise in the radio. This was traced to a loose connection in the wiring. It was causing large pulsations which were fed into the battery system and thence into the radio. Another case of somewhat similar noise was traced to imperfect grounding and mounting of the air-conditioner's compressor.

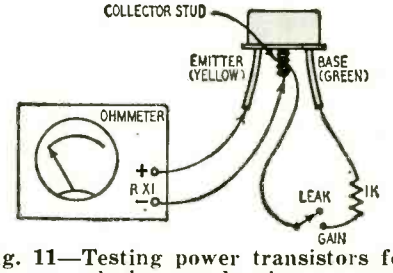

Fig. 11—Testing power transistors for leakage and gain.

When working on the bench, be careful when making tests on some of the peculiar parts found in these sets. Here, we're referring mostly to the very low-voltage high-capacitance electrolytics used in many circuits (100-μf etc.). These should be tested by substitution, at least until a good check is developed for them. Test voltages used in many commercial capacitor checkers will overload and damage perfectly good low-voltage electrolytics. Bypass capacitors also tend to have low voltage ratings. Watch out for them when making leakage tests.

One item which will keep the technician busy is getting parts which he is not accustomed to keeping in stock—the very-low-ohmage resistors, for example. It might be wise for him to lay in a few of the more common values to be ready. These are mostly standard RETMA (EIA) values, but the 0.47-, 4.7- and 39-ohm resistors are not apt to be found in the drawer of the average service shop, especially if that shop has been engaged in TV work.

In general, the new all-transistor auto sets will offer little difficulty to the technician who takes the time to study them and to become familiar with their peculiarities (to him at least). Such things as positive avc voltage, 1-volt plate (collector) voltage, and other novelties will not puzzle him if he has brought himself up to date! END

I wish to thank the service departments of the various radio manufacturers for assistance given, and to express my appreciation especially to Motorola Auto Radio Div. and to Mr. H. W. Welling of Delco, for their generous help.

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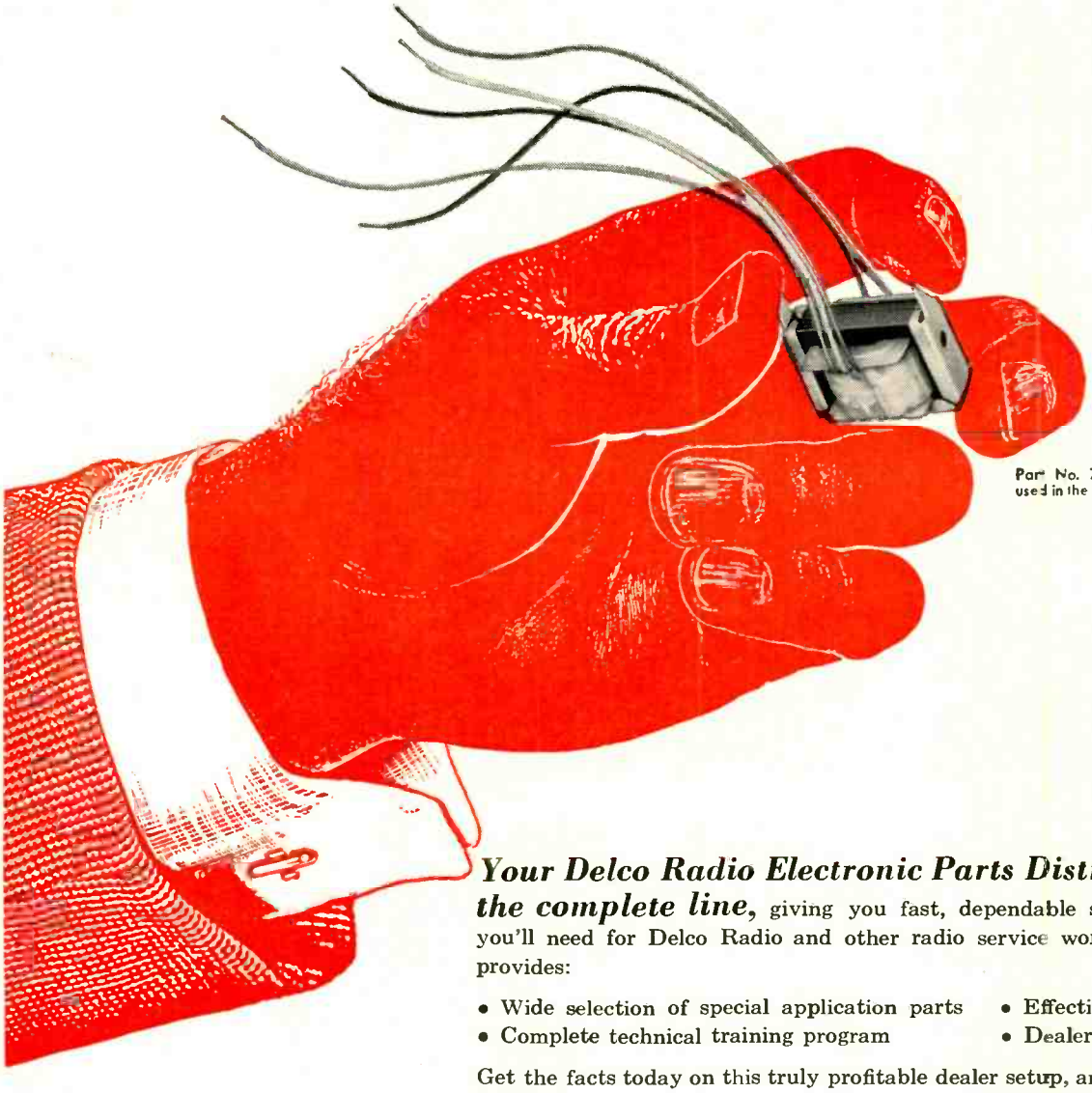

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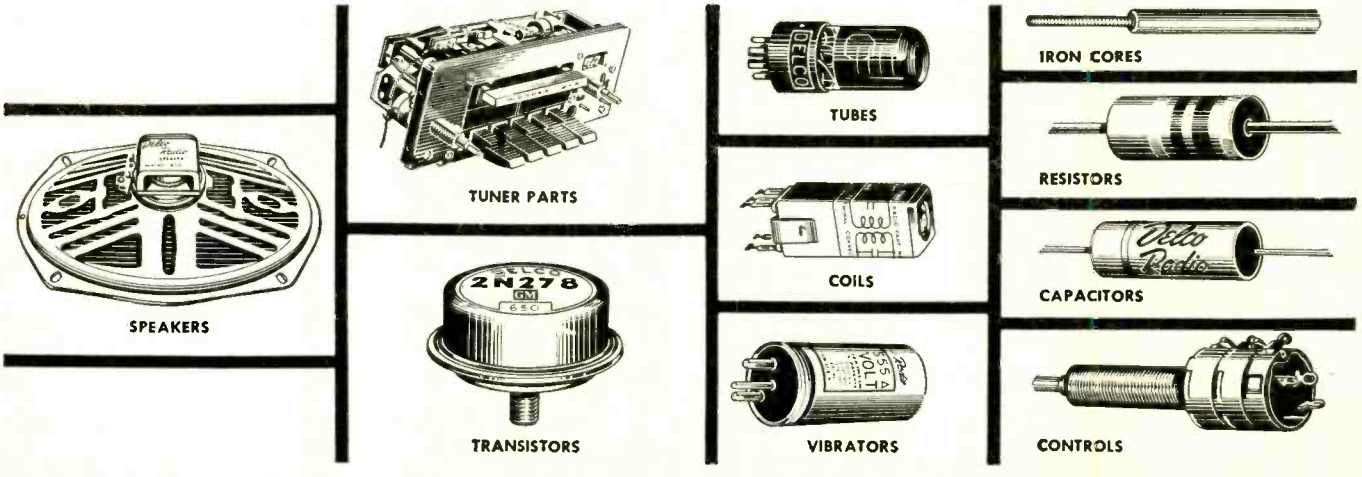
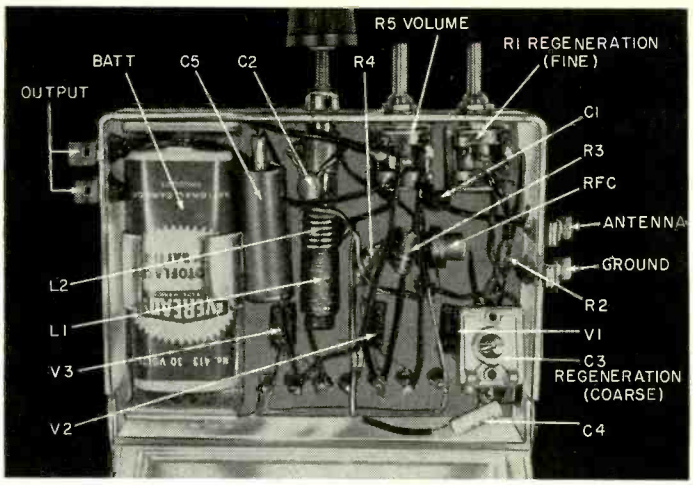
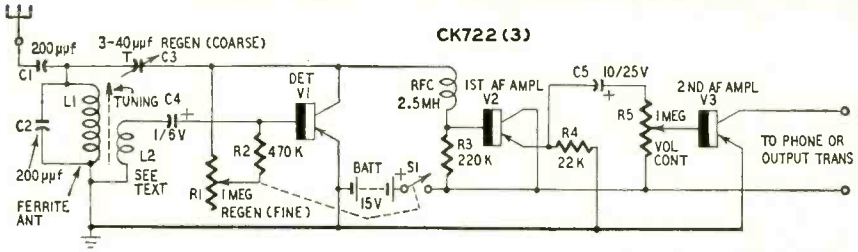


3-Transistor Regenerative Receiver

By JOSEPH CHERNOF

One-day project turns out a pocket-sized broadcast receiver that can drive a speaker





R1—pot, 1 megohm, miniature with spst switch
R2—470,000 ohms
R3—220,000 ohms
R4—22,000 ohms
R5—pot, 1 megohm, miniature
All resistors ½-watt 10% unless noted
C1, 2—200-μμf ceramics
C3-40-μμf trimmer (Miller MA-1 or equivalent)
C4—1 μf, 6 volts, miniature electrolytic
C5—10 μf, 25 volts, miniature electrolytic
L1—ferrite antenna coil, adjustable (Miller 6300 or equivalent)
L2—6 turns of insulated wire wound over L1, see text
RFC—2.5-mh choke (Miller 6302 or equivalent)
V1, 2, 3—CK722
BATT—15 volts, miniature (Eveready 411 or equivalent)
Battery holder, Austin Craft 15-volt battery case
Fahnestock clips (4)
Chassis, phenolic board to fit case
Case, 4 x 3 x 1-inch plastic box

Circuit of the regenerative receiver.

DOLLAR for dollar, the regenerative circuit is still one of the best compromises available to the experimenter who is looking for a simple, yet sensitive, detector circuit. As used in this little receiver, extremely good performance is delivered at a total cost of about $10. The CK722 makes a very smooth and sensitive regenerative detector in this circuit.

With a short external antenna and a good ground, broadcast stations are easily logged over a hundred-mile radius during the daytime, with many distant ones coming in at night. With no external antenna, local broadcasts were still received with sufficient volume to drive a small speaker. Battery drain is low—under 2 ma. The entire receiver mounts with room to spare in a 4 x 3 x 1-inch plastic box available in any dime store.

The regenerative receiver's circuit is shown in the diagram. Three CK722's are used in the unit: one as a detector and two as audio amplifiers. Where speaker operation is not desired, the second audio stage could be eliminated since the first stage alone supplies adequate headphone volume.

Referring to the circuit, C1 is the antenna-isolating capacitor and C2–L1 the input tuned circuit. The wide inductance range of L1, a Miller adjustable ferrite antenna coil, allows the coil inductance adjustment to be used for tuning across the broadcast band. Capacitor C2 centers this tuning adjustment. L2 consists of six turns of insulated wire wound over the upper portion of L1. See the photograph for details. The polyethylene insulated antenna wire supplied with the ferrite antenna coil is used for L2. The ends of L2 are twisted together several times to hold the coil in place.

Signals from L2 are coupled to V1's base through capacitor C4. A grounded-emitter circuit is used, and regeneration provided by feeding back a portion of the collector output voltage to L1 through trimmer capacitor C3. Series network R1–R2 provides vernier control of regeneration, C3 serving as coarse control. Should the detector circuit fail to oscillate, reverse L2's connections. Choke RFC1 keeps any rf in the detector output from reaching V2's base.

The first audio stage (V2) uses a grounded-collector amplifier circuit. This is the only standard type of transistor connection with the input impedance high enough so that it does not load down the detector circuit to where it would be impossible to maintain regeneration. This type of circuit is analogous to the cathode-follower circuit used in conventional vacuum-tube design. The detector output is directly coupled to V2's base, eliminating the need for interstage coupling elements. The output of V2 is coupled through a miniature capacitor (C5) and volume control R5 to the base element of V3, a grounded-emitter amplifier stage. R5 is a miniature pot, only ⅝ inch in diameter.

For headphone operation, the phones are connected directly to the output jacks. A high-impedance headset should be used since the higher the impedance of the headset, the lower the direct current drain of V3. For speaker operation, the primary of a miniature output transformer such as the Triad T-20 is connected to the output. One of the new Jensen P275-Y miniature speakers, designed specifically for transistor equipment, works very well with this receiver. The entire unit is powered by a 15-volt miniature B-battery, mounted in an Austin-Craft battery clamp, a handy gadget for holding miniature batteries. The on–off switch is ganged with REGENERATION control R1.

Initial setup is short and sweet. Once L1 and L2 are properly connected to sustain regeneration, R1 is advanced to about midway in its range. Then C3 is adjusted so the detector regenerates throughout L1's tuning range. Once this has been done, C3 is locked and R1 is used as regeneration control. It was not difficult to find a CK722 which would oscillate satisfactorily in this circuit. Since three are used in the receiver, the one that seemed to regenerate the easiest was selected as detector and the other two were used in the audio stages.

As shown in the photo, parts layout is simple and should present no problem in wiring and assembling other than the standard precautions used when working with transistors. The receiver is built up on a phenolic board which is fastened inside the plastic case. The ferrite antenna coil and volume and regeneration controls are mounted directly on the plastic case.

To permit tuning with a knob rather than by the screwdriver adjustment on L1, a bushing was made for the antenna coil adjustment screw. This was done by cutting off about ⅜ inch from the shaft of a standard volume control and drilling and then tapping the cut-off piece with a 4-40 starter tap. This bushing is then screwed down on the threaded tuning adjustment on the tuning coil until it binds. Then a standard setscrew type knob is placed over the bushing. END

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Each ALLIED KNIGHT-KIT incorporates the very latest circuitry for top-quality performance. Tried and proved professional design and the use of premium quality parts throughout help insure your building success to bring you quality results.

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- World's Finest Hi-Fi Kits
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knight-kit High Fidelity FM-AM Tuner Kit

Model Y-787
$49.95
Only $4.99 down

- Latest Time-Saving Printed Circuit Design
- Flywheel Tuning
- Automatic Frequency Control
- 2.5 μv FM Sensitivity
- True High Fidelity Response
- Beautiful Custom-Styled "Space Saver" Case

The best-looking, best-performing FM-AM tuner kit your money can buy! Carefully designed for quick, easy construction—a tuner you'll enjoy assembling and be proud to own, both for its amazing musical performance and outstanding beauty. Covers the full AM broadcast band and 88 to 108 mc FM. On FM *sensitivity is a remarkable 2.5 microvolts for 20 db of quieting;* hum and noise, –60 db; IF bandwidth, 200 kc at 50% down on curve response, ± 0.5 db, 20-20,000 cps. On AM, *sensitivity is 3 microvolts for 10 db signal-to-noise ratio;* IF bandwidth, 8 kc at 50% down on curve; response, 20-8000 cps. Outstanding features include: Inertia Flywheel Tuning for effortless, accurate tuning; Automatic Frequency Control (plus AFC disabling) to "lock-in" FM stations; printed circuit board (with most of the kit wiring already done for you) assures time-saving, error-free assembly; pre-aligned RF and IF coils; tuned RF stage on FM; drift-compensated oscillator; neon glow tuning pointer; cathode follower output; two output jacks—one for recorder, one for amplifier; rotatable built-in ferrite antenna for AM. Includes beautiful French-gray case with chrome-finished tapered feet, 4 x 13 x 8". Ideal for use with 18, 20 or 30 watt KNIGHT-KIT amplifiers. Ready for easy assembly. Shpg. wt., 12 lbs.

Model Y-787. FM-AM Tuner Kit. Net only..... **$49.95**

knight-kit 18-Watt Complete Hi-Fi Amplifier Kit

Model Y-786
$39.95
Only $3.99 down

- The Last Word in Custom Hi-Fi Styling
- Full 18 Watts with Superb Hi-Fi Specifications
- 8 Inputs for Every Desired Signal Source
- Printed Circuit Switch and Printed Circuit Boards
- Full Equalization for All Record Types

Here is a custom-styled, easy-to-build complete Hi-Fi amplifier at a price that defies comparison. Delivers full 18 watts output with wide-range, flat frequency response for true hi-fi reproduction. Features 8 inputs for every possible signal source, including NARTB equalized tape head input. At full 18 watts output, distortion is only 0.5%; uses new RCA 6973 hi-fi output tubes. Frequency response is ± 1 db, 20-30,000 cps; tape head and magnetic cartridge sensitivity, 5 microvolts for 18 watts output; hum and noise level better than 60 db below 18 watts. Output taps for 4, 8 or 16 ohm speakers. Controls: Input and Record Equalization; Bass Boost and Attenuate; Treble Boost and Attenuate; Volume. Simplest assembly is made possible through the use of an exclusive printed circuit switch and two printed circuit boards—most of the kit wiring is already done for you. With custom-styled French-gray "space-saver" case on tapered feet finished in chrome, 4 x 13 x 8". Complete with case, tubes, all parts, and step-by-step instructions, for easy, error-free assembly. Shpg. wt., 15 lbs.

Model Y-786. 18-Watt Hi-Fi Amplifier Kit. Net only..... **$39.95**

EASY TERMS TO FIT YOUR BUDGET. ALLIED KNIGHT-KITS may be purchased under our Easy Payment Plan. Your order need total only $45.00 or more—only 10% down, small monthly payments thereafter. No red tape—fast handling assured.

Our 37th Year

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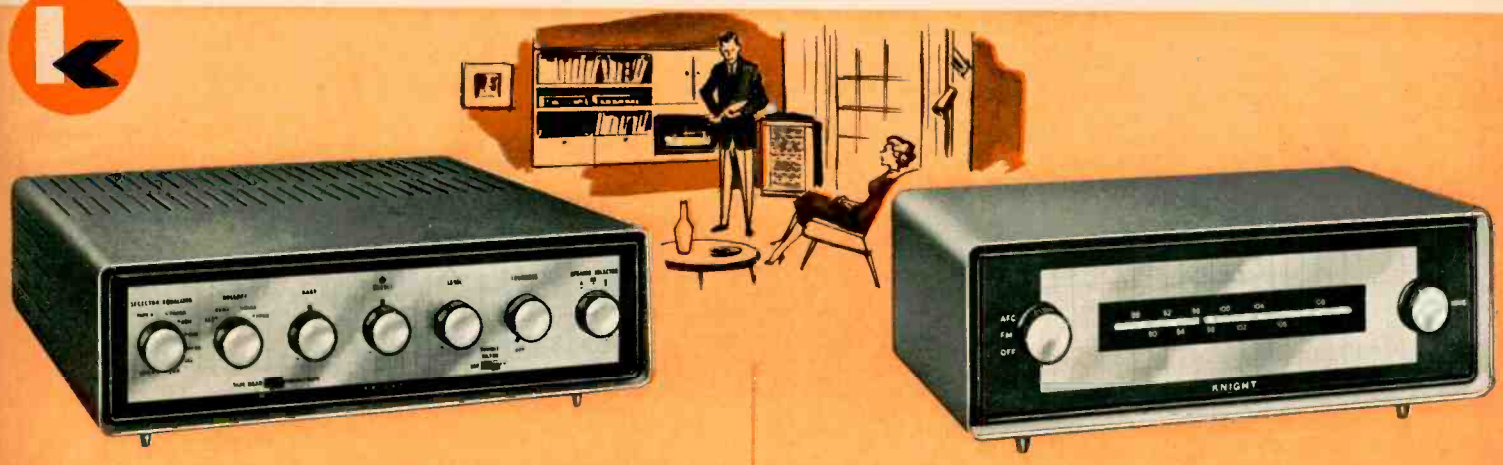


knight-kit 30-Watt Complete Hi-Fi Amplifier Kit

Model Y-762

$76.95

Only $7.69 down

- Full Equalization, ±½ db of Recommended Accuracy
- Printed Circuit Switches • Printed Circuit Boards
- 8 Inputs For Every Possible Signal Source
- Full 30 Watts Output • Custom-Styled Beauty

Comparable to the best in Hi-Fi—at far less cost! Deluxe features include: Linear-deluxe Williamson-type circuit for flawless response; equalization for all records within ½ db of recommended accuracy; 2 exclusive new printed circuit switches in preamp section (no complex wiring to do); 3 printed circuit boards for time-saving, error-free assembly; separate, continuously variable Level and Loudness controls; use of premium 12AY7 tube for low noise and hum; DC on all filaments of preamp tubes; exclusive A-AB-B speaker selector switch (use speakers of mixed impedances without mismatch). 8 inputs: Tape Head direct; G.E. and Pickering cartridges; Ceramic cartridge; Microphone; Auxiliary; Tape Preamp; Tuner (with separate Level Set control). Power amplifier response, ± ½ db, 15-100,000 cps at full 30 watt level; distortion—harmonic, 0.55% at 30 watts—IM, 0.74% at 20 watts. Separate Bass and Treble controls; rumble filter switch; variable damping. Output, 8 and 16 ohms. With smart French-gray cabinet, 4 x 15 x 15". Ready for easy, money-saving assembly. Shpg. wt., 32 lbs.

Model Y-762. 30-Watt Hi-Fi Amplifier Kit. Net only..... **$76.95**

knight-kit High Fidelity FM Tuner Kit

Model Y-751

$38.95

Only $3.89 down

- Authentic High Fidelity FM Response
- Flywheel Tuning • Automatic Frequency Control
- Printed Circuit • Pre-Adjusted Coils and IF's
- 4 Microvolt Sensitivity Guaranteed

Here is top value in creative engineering, impressive hi-fi performance and distinctive design—a tuner you'll be proud to build and own. Covers the full FM band, 88 to 108 mc. Features Automatic Frequency Control (with disabling feature) to "lock-in" stations and prevent drift; Inertia Flywheel Tuning for velvet-smooth, accurate station selection; pre-adjusted RF coils; pre-aligned IF's; cascode broad-band RF amplifier; drift-compensated oscillator; neon bulb pointer. All critical wiring is already done for you in the form of a printed circuit board—assembly is simple. Sensitivity is 4 microvolts for 20 db of quieting across entire band; output, 2 volts at 1000 microvolts input; IF bandwidth, 200 kc; response, 20-20,000 cps. with only 0.6% distortion. Output jacks for amplifier and tape recorder; cathode follower output. Ideal for use with the KNIGHT-KIT amplifiers, or any amplifier with phono-tuner switch. Features custom-styled case in French-gray, with tapered chrome-finished feet, 4 x 13 x 8". Includes all parts, tubes and step-by-step instructions for easy assembly. Shpg. wt., 12 lbs.

Model Y-751. Hi-Fi FM Tuner Kit. Net only..... **$38.95**

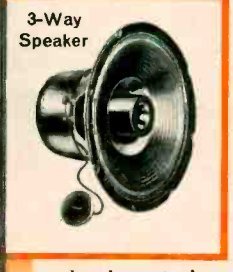
knight-kit Deluxe 3-Way Speaker System Kit

Model Y-937

$89.50

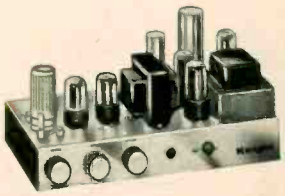
Only $8.95 down

- Pre-Finished "Quik-Craft" Corner Enclosure
- Klipsch Designed and Licensed
- Famous Knight 12" 3-Way Speaker
- Easy to Assemble—Top Hi-Fi Quality
- Choice of Enclosure Finishes



Deluxe quality high fidelity speaker system at a money-saving low price. Easy to assemble—all you need is a screwdriver. System includes KNIGHT "Quik-Craft" corner-type folded-horn enclosure kit, and the famous-value KNIGHT 3-Way 12-inch speaker. Just assemble the enclosure—*no finishing required*—all surfaces are finished in hand-rubbed Korina blonde, mahogany or walnut. The speaker is the new 3-way type: 12" woofer cone for bass (full 1¾ pound woofer magnet), conical radiator for mid-frequencies, built-in compression-type tweeter (with wired level control and calibrated dial) for highest frequencies. Unexcelled enclosure efficiency and superb speaker performance combine to cover the whole spectrum of audible sound for true hi-fi response from 35 to 15,000 cps, ± 3 db. Kit includes 12" 3-Way speaker, prefinished enclosure panels, grille cloth, hardware and instructions. *Specify Korina blonde, mahogany or walnut when ordering.* Shpg. wt., 44 lbs.

Model Y-937. 3-Way Speaker System Kit. Net only..... **$89.50**



knight-kit 10-Watt Hi-Fi Amplifier Kit

Y-753

$23.50

$2.35 down

Low-cost, authentic hi-fi amplifier. Response, ± 1 db, 30-20,000 cps. Input for crystal phono or tuner; chrome-plated chassis is punched for preamp kit below, to permit use of magnetic phono. Only 0.5 volt drives amplifier to full output. Separate bass and treble controls. Only 1% harmonic distortion. Matches 8-ohm speaker. 7 x 13 x 6". With all parts, tubes and instructions. Shpg. wt., 13 lbs.

Model Y-753. Net only..**$23.50**
Y-235. Preamp Kit.....**$ 3.10**
Y-757. Metal Cover.....**$ 3.95**

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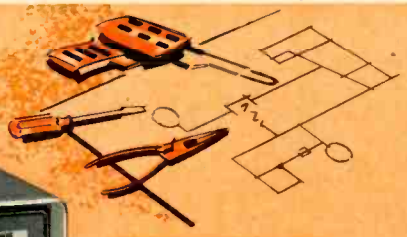


So Easy To Build
Anyone can build KNIGHT-KIT Hi-Fi. No experience required to get top results!

knight-kit High Fidelity Preamplifier Kit

Model Y-754
$39.95
Only $3.99 down

- Exclusive Printed Circuit Switches and Boards
- Equalization ±½ db of Recommended Accuracy
- 8 Inputs Including Tape Head
- Self-Powered
- DC on All Tube Filaments
- Custom-Styled

Sensational Hi-Fi design at amazing low cost. Provides precise record equalization guaranteed within ½ db of recommended accuracy!—more accurate than all but the most expensive factory-built preamps. Includes exclusive new KNIGHT-KIT printed circuit switches for easy, error-free assembly; 2 printed circuit boards eliminate all other wiring, except for power supply and control leads—so easy to build. Has built-in power supply; includes premium 12AY7 and ECC82 tubes. Frequency response, ± 0.5 db, 10-50,000 cps. Has 8 inputs: Tape Head; G.E. Phono; Pickering Phono; Ceramic; Microphone; Auxiliary; Tape Preamp; Tuner. Level adjustment for tuner input. Includes separate Bass and Treble controls; separate Level and Loudness controls; Rumble Filter switch; DC on all tube filaments; cathode follower output; 2 extra AC outlets. You get every advanced hi-fi feature in this easy-to-build preamplifier at the lowest possible cost. Includes beautiful custom-styled French-gray case, with tapered chrome-finished legs, 4 x 13 x 8″. With all parts, tubes, step-by-step instructions; ready for easy assembly. Shpg. wt., 12½ lbs.

Model Y-754. Hi-Fi Preamp Kit. Net only **$39.95**

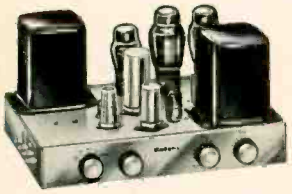
knight-kit 25-Watt Hi-Fi Basic Amplifier Kit

Model Y-755
$44.50
Only $4.45 down

- Hi-Fi Response, ± 0.5 db, 10 to 120,000 cps
- Only 0.15% Distortion at 30 Watts Output
- Printed Circuit Wiring Board
- Chrome-Plated Chassis
- Williamson-Type Circuit with Over 25 Watts Output

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

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



knight-kit 20-Watt Hi-Fi Amplifier Kit

Y-750
$35.75
$3.57 down

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

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

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

Model Y-789
$49.95
Only $4.99 down

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

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

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

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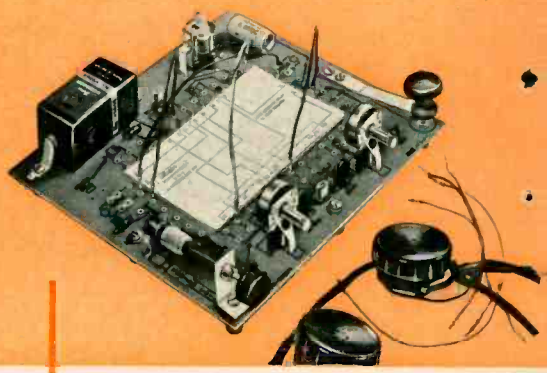
Fascinating ALLIED knight-kits FOR EXPERIMENTERS AND HOBBYISTS



knight-kit 2-Transistor Pocket Radio Receiver Kit

Model Y-262 $14.65

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

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

Model Y-262. Net only **$14.65**

knight-kit "Trans-Midge" Transistor Receiver Kit

Model Y-767 $2.45

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

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

knight-kit 10-Circuit Transistor Lab Kit

Model Y-299 $15.75

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

Model Y-299. Net only **$15.75**

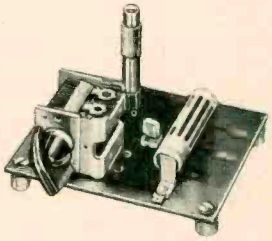
knight-kit 5-Transistor Superhet Personal Portable Radio Kit

Model Y-766 $29.95

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

Beautiful, easy-to-build transistorized personal portable with every ultra-modern design feature: 5 Texas Instrument Co. transistors; latest printed circuit chassis for easy, error-free assembly; bigger-than-average 3½" speaker; class B push-pull audio output; built-in high-gain ferrite loopstick antenna; plus phone jack output for private listening. Provides sensitive reception of the AM broadcast band with exceptional tone quality. Ultra-smart high-impact ivory plastic case has handsome gold trim with ebony accents; includes pull-out handle; only 7½x3¾x1¾". With all parts, transistors, 9 volt transistor radio battery, carrying case and instructions anyone can easily follow. Shpg. wt., 2 lbs.

Model Y-766. Net only **$29.95**



1-Transistor Radio Kit

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

Model Y-765. Net only **$3.95**

"10-In-One" Electronic Lab Kit

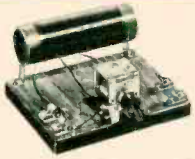
$12.65 Famous experimenters' kit. Builds any of 10 fascinating projects, including broadcast receiver, wireless phono oscillator, code practice oscillator, signal tracer, relays, etc. Shpg. wt., 5 lbs.

Model Y-265. Net only **$12.65**

"6-In-One" Electronic Lab Kit

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

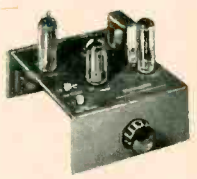
Model Y-770. Net only **$8.45**



Crystal Set Hobby Kit

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

Model Y-261. Net only **$2.15**



Wireless Broadcaster Kit

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

Model Y-705. Net only **$9.50**

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WIDEST CHOICE OF QUALITY HOBBYIST KITS

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

knight-kit Photoelectronic Relay Kit

Model Y-702 $13.50

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

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

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

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

Model Y-740 $11.95

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

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

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

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

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

Model Y-243 $15.95

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

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

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

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

"Ranger II" Superhet Receiver Kit

$17.25

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

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

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Model Y-295 $14.75

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

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

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

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Model Y-145. Net only **$19.75**

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Exceptional accuracy and versatility at amazing low cost. Ideal for service shop, lab or Amateur use. Large 4½", 400 microamp meter with separate scales for AC and DC voltage and current, decibels and resistance. *Uses 1% precision resistors;* has 3-position function switch and 12-position range switch. *38 ranges* include: AC, DC and output volts, 0-1-5-10-50-500-5000 (1000 ohms/volt sensitivity); Resistance, 0-1000-100,000 ohms and 0-1 meg (center scale readings of 60, 150 and 1500 ohms); Current, AC or DC, 0-1-10-100 ma and 0-1 amp; Decibels, −20 to +69 in 6 ranges. Precision resistors are used as shunts and multipliers to assure exceptional accuracy of measurements. With all parts, battery, test leads and black bakelite case with convenient carrying handle, 6¾ x 5¼ x 3¾". A great value in an easy-to-build quality instrument. Shpg. wt., 2½ lbs.

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- 200 μa Movement, 4½" Meter
- Includes AC, Peak-to-Peak
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- 1% Film-Type Resistors

Top buy in an extremely stable, highly accurate VTVM. Easy to assemble—entire chassis is printed circuit board. Perfect for radio-TV service work, lab and Amateur use. Features low-leakage type switches; 1% film-type precision resistors; balanced-bridge, push-pull circuit (switch to any range without readjusting zero set); zero center scale and direct-reading db scale; polarity reversing switch. Ranges: Input Resistance, 11 megs; DC and AC rms, 0-1.5-5-15-50-150-500-1500; AC Peak-to-Peak, 0-4-14-40-140-1400-4000; Response, 30 cycles to 3 mc; Ohms, 0-1000-10K-100K and 0-1-10-100-1000 megs; db, −10 to +5. Includes all parts, tubes, battery, test leads and portable case, 7¾ x 5¼ x 4-¼". Easy to assemble. Shpg. wt., 6 lbs.

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$43.75 Extreme linearity on a par with costly lab instruments; fundamentals to 250 mc; output flat within 1 db; electronic blanking. Easy, money-saving assembly. Shpg. wt., 16 lbs.

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Model Y-135 $26.50

A remarkable value in an easy-to-build instrument which permits visual and aural signal tracing of RF, IF, video and audio circuits. Has *highest gain in its price class.* Traces signal from antenna to speaker. Reproduces signal at plate or grid connection of any stage. Identifies and isolates "dead" stages. Features: usable gain of *91,000;* "magic eye" with calibrated attenuators for signal presence indication and stage-by-stage gain measurements; built-in 4" PM speaker; combination 2-position probe, one for RF (6 mmf. input), the other for audio. Provides noise test; built-in watt-meter calibrated from 25 to *1000 watts;* provision for external scope or VTVM. Binding posts provide output transformer and speaker substitution test, plus external 280 volts B+. With all parts, tubes and probe. 7x10x5". 12 lbs.

Model Y-135. Net only **$26.50**

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Model Y-144 $69.00

Only $6.90 down

- 5 mc Width for Color TV
- Horizontal Sweep to 600 kc
- 25 mv/inch Sensitivity
- Z-Axis Input
- Printed Circuit Construction

Equals or betters the performance of commercially wired scopes costing far more. Two printed circuit boards and laced wiring harness assure wiring accuracy and cut assembly time. Ideal for lab use, color TV servicing and high frequency applications. Wide sweep range—*15 to 600,000 cps.* Vertical response. ± 3 db, 5 cps to 5 mc; only 1 db down at 3.58 mc color burst. High vertical sensitivity of .025 rms v/inch. Input capacity, 20 mmf. Outstanding features: cathode follower inputs; 2nd anode provides 1400 volts high-intensity trace; push-pull amplifiers; positive and negative locking; frequency-compensated attenuator; Z-axis input; one volt P-P calibrating voltage; astigmatism control; retrace blanking circuit; DC positioning control. Includes CRT. 14½ x 9½ x 16". 40 lbs.

Model Y-144. Net only **$69.00**
Y-148. Demodulator Probe. Net ..... **$ 3.45**
Y-147. Low Capacity Probe. 12 mmf. Net ..... **$ 3.45**

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Permits use of any scope as precision peak-to-peak AC voltmeter. Puts a true square-wave voltage on scope screen. Selects any voltage between .01 and 100 volts; feeds external signal direct to scope for instant comparison. Shpg. wt., 5 lbs.

Model Y-136. Net only **$12.75**

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Model Y-146 $42.00

Only $4.20 down

- Phantastron Linear Sweep
- 25 mv/Inch Sensitivity
- Printed Circuit Board
- Retrace Blanking Circuit

Feature for feature the world's best oscilloscope kit value. A standout in its class with all these fine features: *Printed Circuit* wiring board and laced harness for quick, error-free assembly. *Phantastron Sweep Circuit* for high linearity of sweep from 15 to 150,000 cps. *25 Millivolts Per Inch Sensitivity*—3 times that of similarly priced scope kits. *Calibration Voltage*—1 volt peak-to-peak square wave, fully regulated. *Vertical Amplifier*—frequency response ± 3 db, 3 cps to 1.5 mc (± 6 db to 2.5 mc). Includes: Directly coupled positioning controls; retrace blanking circuit; frequency-compensated vertical input attenuator; positive and negative internal sync; high 2nd-anode voltage for high-intensity trace; input capacity, 45 mmf. Kit includes CRT. 9½ x 13¾ x 17¾". 26 lbs.

Model Y-146. Net only **$42.00**

Resistance Substitution Box

$5.95

Easily determines resistor values required in a circuit. Makes available 36 standard 1-watt resistance values in 2 ranges between 15 ohms and 10 megohms, with 10% accuracy. Slide switch selects range; 18-position switch for value selection. Shpg. wt., 2 lbs.

Model Y-139. Net only ..... **$ 5.95**

Capacitance Substitution Box

$5.95

Makes it easy to find capacitor values needed in a circuit. Provides 18 standard values from .0001 mfd to .22 mfd, ± 20%. All values are 600 volt, except .15 and .22, which are 400 volt. 18-position selector switch. Shpg. wt., 2 lbs.

Model Y-138. Net only ..... **$ 5.95**

Audio Generator Kit

$31.50

Excellent design; range, 20 cps to 1 mc; less than .25% distortion; 600 ohm output. Ideal for hi-fi testing; offers the flat response of a lab standard. Shpg. wt., 16 lbs.

Model Y-137. Net only **$31.50**

R/C Tester Kit

$19.50

Measures capacitance and resistance. Balanced-bridge circuit; indicates power factor; tests capacitors at rated voltage. Large, easy-to-read dial and "magic eye." Shpg. wt., 10 lbs.

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knight-kit All-Band Amateur Receiver Kit

Model Y-726

$104.50

Only $10.45 down

- Tunes 540 kc to 31 mc
- Built-In Q-Multiplier
- Constant Running HF Oscillator
- Worthy of the Advanced Ham Operator
- Printed Circuit Bandswitch
- Printed Circuit Board
- 1.5 μv Sensitivity

A sensational communications receiver value with all the selectivity, sensitivity and features of high-priced commercial units. Uses printed circuitry throughout, including the exclusive new KNIGHT-KIT printed circuit bandswitch, for remarkably easy assembly. Covers 540 kc to 31 mc in 4 ranges; calibrated, electrical bandspread on 80-10 meter Ham bands; slug-tuned Hi-Q coils; continuous, VR tube-regulated B+ applied to HF oscillator lets you switch from standby to receive with no drift; built-in Q-multiplier peaks desired signal or nulls interference; delayed AVC; provision for crystal calibrator (below). Sensitivity, 1.5 microvolts for 10 db signal-to-noise ratio. Selectivity: variable from 300 cps to 4.5 kc at 6 db down. Exalted BFO injection. Controls: Main tuning, bandspread, band selector, Q-multiplier selectivity, Q-multiplier tune, null-off-peak, BFO pitch, RF gain, AF gain, BFO-MVC-AVC-ANL, off-stby-rec-cal, antenna trimmer, and phone jack. Cold-rolled 1/16" steel chassis. Handsome metal cabinet, 10 x 10 x 16½". (Less phones, 8-ohm loudspeaker and S-meter.) 23 lbs.

Model Y-726. Amateur Receiver Kit. Net..... **$104.50**

Y-727. S-Meter Kit for above. 1 lb. Net..... **$9.50**

knight-kit 50-Watt CW Transmitter Kit

Model Y-255

$38.95

Only $3.89 down

- Ideal for the Novice
- Pi Antenna Coupler
- Bandswitching—80 to 10 Meters

There's exceptional value in this very popular bandswitching transmitter kit. Compact and versatile, it's the perfect low-power rig for the beginning novice as well as the seasoned veteran. Has bandswitching coverage of 80, 40, 20, 15 and 10 meters. Rated at 50 watts—actually operates at up to 60 watts on 80 and 40 meters. Oscillator is efficient 6AG7; final is reliable 807. Crisp, clean, cathode keying of oscillator and final. Built-in pi coupler permits use with random length antennas. Has highly effective TVI suppression. Other features not usually found in transmitter kits at this low price include: Ceramic-insulated final tank capacitor; pre-assembled switches; pre-wound parasitic chokes; ceramic coil forms; coax connector; crystal and VFO socket on front panel; power take-off jack for accessory equipment. Meter reads either plate or grid current of final. Takes crystal or VFO without circuit changes. Cabinet interior and chassis are copper-finished. Size, 8½ x 10½ x 8¼". With tubes and all parts for easy assembly. (Less crystal and key.) Shpg. wt., 19 lbs.

Model Y-255. 50-Watt Transmitter Kit. Net only..... **$38.95**

Model Y-725

$28.50

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knight-kit Self-Powered VFO Kit

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: 40v on 80, 20v on 40. With Spot-Off-Transmit switch for spot frequency tuning. Extra switch contacts for operating relays and other equipment. Attractive metal cabinet, 8¾ x 6 x 6". Ready for easy assembly. Shpg. wt., 8 lbs.

Model Y-725. VFO Kit. Net only..... **$28.50**

knight-kit 100 Kc Crystal Calibrator Kit

Model Y-256

$10.50

Crystal frequency standard at very low cost. Gives marker every 100 kc up to 32 mc. A "must" for marking band edges. Mounting flanges for installation in or back of receiver cabinet. Size only 1½x 1½x3". Requires 6.3 v. at 0.15 amp and 150-300 v. DC at 3-6 ma. Trimmer for zero-beating with WWV; On-Off switch. Complete with tube, crystal, all parts and easy-to-follow instructions. Shpg. wt., 1 lb.

Model Y-256. 100 Kc Crystal Calibrator Kit. Net only..... **$10.50**

Model Y-253

$5.85

knight-kit Amateur RF "Z" Bridge Kit

Measures standing wave ratio (SWR) and impedance of antenna systems; ideal for adjusting antenna systems for optimum results. Measures impedances from 20 to 400 ohms up to 100 mc; SWR to 150 mc. Any VOM may be used for null indicator. 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 (less meter). 2½ x 3 x 4½". Shpg. wt., 1½ lbs.

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

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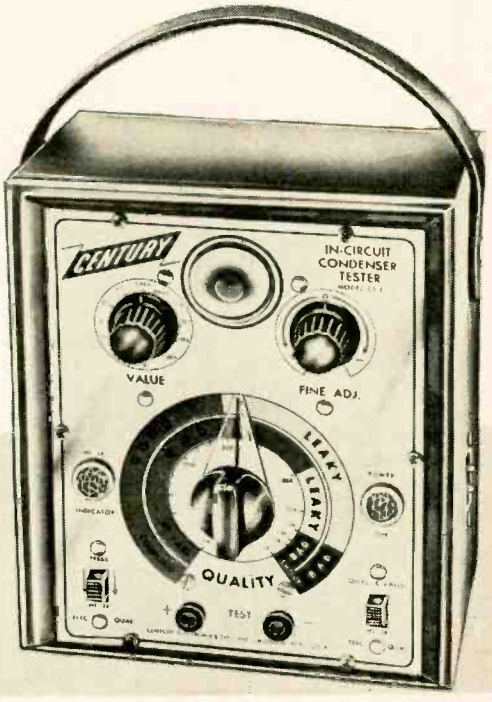
CT-1 checks capacitors for capacitance, leakage, opens and shorts; also checks electrolytics for quality—in a circuit or out

IN-CIRCUIT CAPACITOR TESTER



By WILLIAM KELVIN*

SERVICE technicians have always been attracted by the idea of checking capacitors without removing them from the circuit. Several instruments have been produced which try to do this job, but many have serious limitations.

To do a complete job, the checker should be able to test, in circuit, for capacitance value, leakage resistance, opens and shorts. It should also be reasonably priced.

Precision capacitor analyzers on the market today use a Wheatstone-bridge circuit. Fig. 1 is a simplified version of this circuit. The center arm of the potentiometer is the main dial shaft of the instrument. When you vary the resistance ratio of the two portions of the potentiometer, you reach a point where you balance against the ratio of your unknown unit and the precision standard capacitor in the bridge circuit. The scale of the instrument is calibrated in capacitance values, and you know that you have set the pointer to the value of the unknown capacitor when the electronic-ray indicator shows a null.

This type of instrument can be made extremely accurate by using 1% (or better) capacitors for the bridge standards and by adding a vernier to the dial shaft. *But it will not work in a circuit.*

It is the presence of shunt resistance across capacitors in a circuit which makes it difficult to do in-circuit testing with accurate results. Unless the shunt resistance is very high, you cannot balance the type of Wheatstone bridge shown in Fig. 1.

Century's CT-1 uses a variation of the Wheatstone bridge *which also balances the shunt resistance.* The result is an instrument with *two main dials.* One is calibrated in capacitance and the other in ohms—measuring the circuit's shunt resistance. Never before have these quantities been measured *simultaneously.* Since shunt resistance is a measure of circuit quality, this scale is called the QUALITY scale. The second scale (measuring capacitance) is the VALUE scale.

A simplified diagram of this bridge circuit is shown in Fig. 2. Notice that in this circuit, the precision standard capacitor has a precision standard resistance in shunt with it. This shunt resistance is the QUALITY adjustment. The original potentiometer is now used merely as a fine adjustment and is not variable over its full range.

For out-of-circuit measurements the QUALITY control is turned to the extreme left where a switch opens the resistance path, and the CT-1 circuit becomes the same as the one in Fig. 1. For an indicator, the CT-1 uses a 6AF6, with a separate dc amplifier.

The electrolytic test measures the ability of the capacitor to hold a charge and works both in and out of circuit. To add greater versatility to the instrument, a high-leakage check is included which can measure leakage resistances up to 300 megohms.

Calibration of the QUALITY scale is based on a statistical average of shunt-resistance values found in sets today.

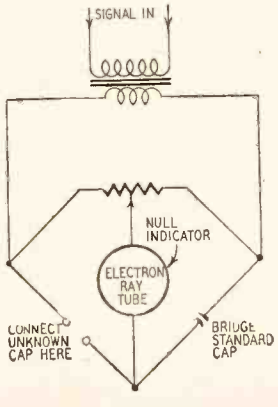


Fig. 1—Simplified capacitance bridge.

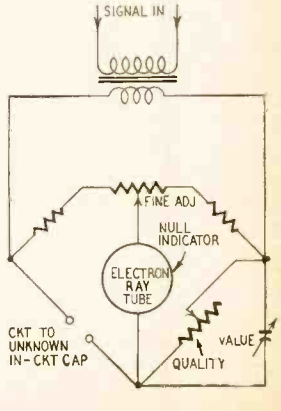


Fig. 2—Basic bridge circuit for in-circuit testing.

* Chief engineer, Century Electronics Co.

The most severe limitations are placed upon coupling capacitors, which have a separate scale. All other capacitors are included with bypass units, which can tolerate lower shunt resistances. It has been found that the CT-1 can be relied on for 80% accurate readings of circuit quality without the aid of a schematic diagram. With a circuit diagram, which shows where certain cases of low quality may be normal, accuracy of troubleshooting can be brought up to 100%.

Using the CT-1

The range of the CT-1 is very wide. It will measure in-circuit capacitors as small as 200 $\mu\mu$f, and values up to 0.5 μf, with shunt resistances as low as 500 ohms. It should take a technician very little time to become used to operating the instrument. Notice the photograph of the instrument panel. Operating the checker consists of getting a null on the indicator tube and reading the results from the scales. For example:

1. Set the VALUE pointer to the rating of the capacitor under test. If you can read the value printed on the capacitor, the task is easy. But a guess at its value is good enough for a first approximation.
2. Rotate the QUALITY control until the indicator is at its widest opening.
3. A slight adjustment of the FINE ADJUST control may be needed to open the eye fully.
4. Read the results:

a. The VALUE scale indicates the total circuit capacitance across the test clips. With coupling capacitors it is usually not much greater than the value of the capacitor being tested. For bypass capacitors, it can be as much as 10 times the value of the one you are testing, since it is normal to find several bypass capacitors in parallel circuits in a TV set.

b. The QUALITY scale measures the net shunt resistance across the capacitor. The ohmic value is printed on the inner ring, while the pointer lies in the GOOD, LEAKY or BAD zone. Though circuit designs change constantly, coupling and bypass capacitors will have fairly consistent limits to the range of their resistance. Thus, even the novice technician can accept the readings obtained on the CT-1 with fair assurance.

c. The FINE ADJUST setting indicates whether the capacitor under test is slightly larger or slightly smaller than the size indicated by the VALUE pointer.

The instruction manual includes procedures for testing in more difficult situations, such as when the ratio of resistance to reactance becomes too great. A complete set of procedures for out-of-circuit testing is included, along with a discussion of techniques to avoid the effects of stray hum.

The Century model CT-1 is designed to give the technician a fairly complete story about any capacitor in a circuit, by giving simultaneous readings of circuit resistance and reactance. Other features are: shielded circuit; isolated primary; four-color easy-to-read scales; low operating temperature (will not overheat); removable cheater cord for easy storage; light weight, easily portable; safety insulated clip leads; on–off pilot lamp. Its complete circuit is shown in Fig. 3.

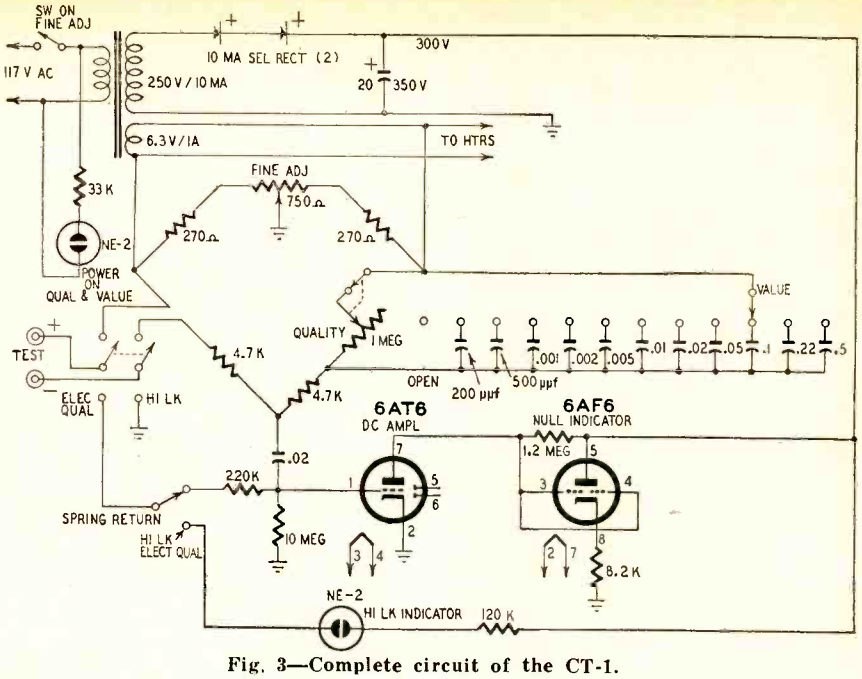


Fig. 3—Complete circuit of the CT-1.

The CT-1 in action

TV Chassis: Magnavox CT 259 (see Fig. 4)

Complaint: No horizontal sync

Procedure: Check capacitors in horizontal sync circuit (tubes checked OK)

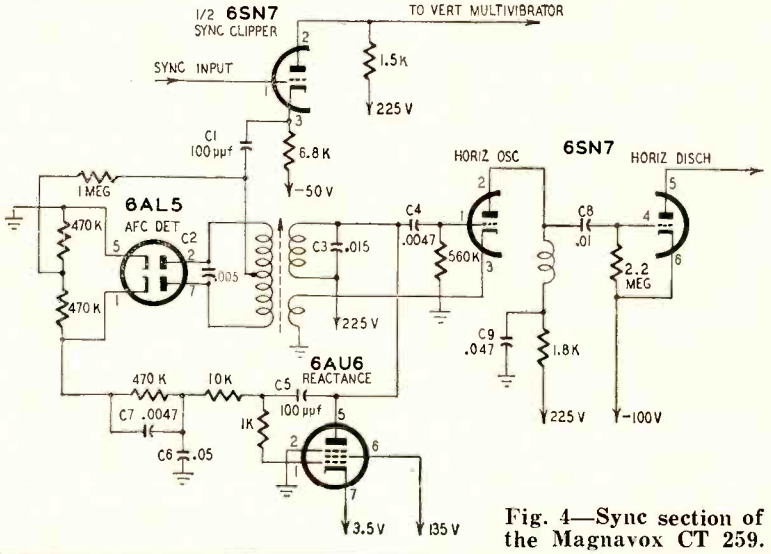


Fig. 4—Sync section of the Magnavox CT 259.

Capacitor	Readings on CT-1		Rated Value of Capacitor	Remarks
	Value (μf)	Quality (Ω)		
C4	.005	Good (500,000)	.0047 μf	OK
C8	.01	Good (800,000)	.01 μf	OK
C5	.05	Leaky (75,000)	100 μμf	Value reading OK because of effect of C6 in shunt with C5. Quality reading shows definite leakage condition. *Therefore, C5 is leaky.*

Thus, the third capacitor tested proved to be the culprit. The low quality reading might have been due to a low-resistance path back through the power supply, via the grid winding of the oscillator transformer—but even so, the circuit quality seemed too low. Once removed from the circuit, C5 showed 100,000-ohm leakage resistance. *Troubleshooting time: 6 minutes.*

TEST INSTRUMENTS

TV Chassis: RCA KCS-96B (see Fig. 5)

Complaint: Video smear and distorted sound

Procedure: Check capacitors in video circuit (tubes OK)

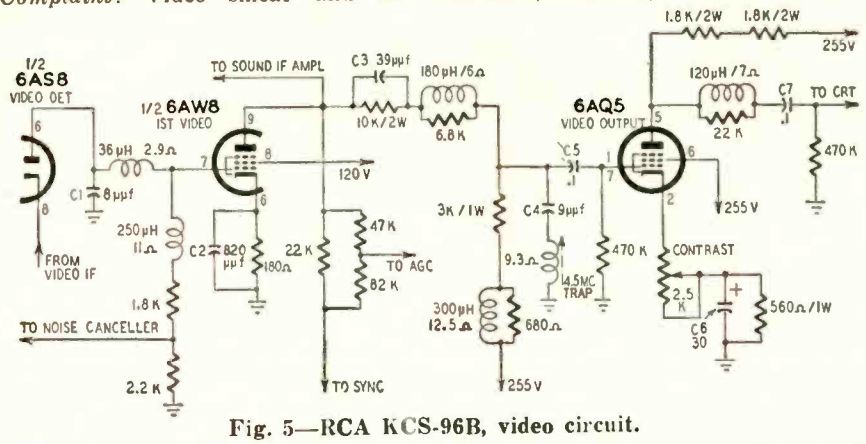


Fig. 5—RCA KCS-96B, video circuit.

Capacitor	Readings on CT-1 Value (μf)	Readings on CT-1 Quality (Ω)	Rated Value (μf) of Capacitor	Remarks
C5	0.1	Good (500,000)	0.1	OK
C7	0.1	Bad (5,000)	0.1	Must be leaky—there is no low-resistance shunt path. Out-of-circuit measurement showed 5,000 ohms leakage.

Replacement of C7 cleared up the video *but not the sound.* This set had two complaints which seemed common but which were really unrelated. A new troubleshooting job was begun on the sound if and audio circuits. (See Fig. 6.)

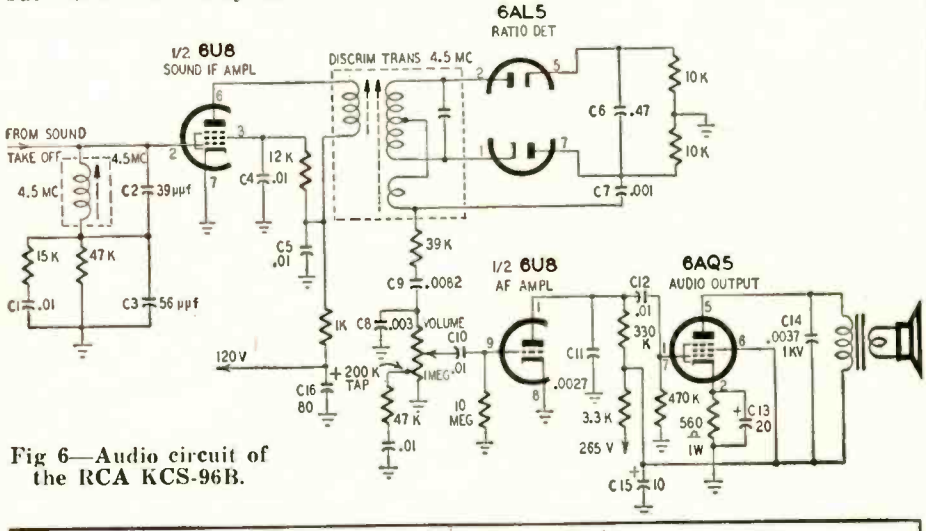


Fig 6—Audio circuit of the RCA KCS-96B.

Capacitor	CT-1 Readings Value (μf)	CT-1 Readings Quality (Ω)	Rated Value of Capacitor	Remarks
C3	.01	Leaky (50,000)	56 μμf	C1 dominates value reading. There should be 47,000 ohms in shunt, so this is OK. By same reading, C1 is OK too.
C8	.002+	Good (1 meg)	.003 μf	OK
C9	.01	Good (1 meg)	.0082 μf	C9 has a small amount of other capacitance in shunt. So this is OK.
C10	.01	Good (infinite)	.01 μf	Over 10 megs in shunt will give best quality reading at infinity.
C11	.002+	Good (300,000)	.0027 μf	OK
C12	.01	Good (500,000)	.01 μf	OK
C7	.002	Good (1 meg)	.001 μf	OK (has some shunt capacitance)
C6	.001	Leaky (20,000)	0.47 μf	Capacitor must be open. Value reading represents stray shunt capacitance. Leaky reading OK here, where 20,000 ohms is normal.

TEST INSTRUMENTS

Replacement of C6 restored audio volume and quality. For good measure, alignment of the ratio detector was included to get best audio bandwidth. *Troubleshooting time for both jobs in this chassis; 18 minutes.*

The usefulness of the CT-1's electrolytic action test is illustrated by the following history. Refer to Fig. 6 where a check of the 6U8 screen bypass (C5) yielded:

Capacitor	CT-1 Readings: Value	CT-1 Readings: Quality	Rated Value of Capacitor
C5	No result	Bad (short)	.01

Remarks

Shorted screen bypass should cause burning screen resistor. No evidence of burning, so without removing test clips, push function switch and test for electrolytic action.

Circuit	CT-1 Electrolytic-Action Reading
Across C5	This circuit contains a large electrolytic, with a shunt resistance of over 20,000 ohms.

Remarks

C16 electrolytic essentially in parallel with C5. *There is no short*, and therefore no further need to worry about C5.

END

Thirty-Five Years Ago

In Gernsback Publications

HUGO GERNSBACK, *Founder*

Modern Electrics	1908
Wireless Association of America	1908
Electrical Experimenter	1913
Radio News	1919
Science & Invention	1920
Television	1927
Radio-Craft	1929
Short-Wave Craft	1930
Television News	1931

Some larger libraries still have copies of ELECTRICAL EXPERIMENTER on file for interested readers.

In February, 1924, *Science and Invention (formerly Electrical Experimenter)*

Radio Town Crier, by H. Gernsback.
Broadcasting the President's Message, by A. P. Peck.
Radio for Hospital Patients.
Radio for the Beginner, No. 24—Single Tube Circuits, by Armstrong Perry.
Radio Trouble Shooting, by Jack Milligram.
Variometer and Variable Condenser Receiving Set.
Short Aerials Increase Selectivity.
"DX" Prize Winning Circuits.
Radio Oracle.

Here's why

THE WINEGARD COLOR-'CEPTOR IS OUTSELLING ANY OTHER ALL-CHANNEL YAGI TODAY!

TECHNICIANS LIKE
to sell the antenna that has set the ***standard of performance*** for the industry. ***No other*** all-channel antenna performs like the Color'ceptor. Color'ceptor pulls in the ***best possible picture*** . . . on any channel, anywhere, anytime!

TECHNICIANS LIKE
the Color'ceptor's ***sunfast gold anodized finish*** . . . one of several Winegard features that so many antenna manufacturers have imitated. The Color'ceptor ***looks better . . . lasts longer!***

TECHNICIANS LIKE
the Color'ceptor's ***extra sturdy construction*** . . . the reinforced reflectors; the heavy duty, hi-impact insulators; the precision drilled holes; the all-metal phasing lines and the rugged stainless steel hardware that locks every element firmly in place!

TECHNICIANS LIKE
to ***install*** the Color'ceptor. It goes up ***quickly, easily*** . . . perfectly balanced at the mast clamp . . . ***eliminating strain*** on rotor, guy wires, etc.!

TECHNICIANS LIKE
the way Winegard ***helps them sell!*** You get co-op advertising; national advertising; free truck and window decals, window banners, counter cards, check-up sheets.

Be sure you get ***your share*** of Color'ceptor sales and profits! Sell the antenna that is the ***number one*** choice of professional TV technicians from coast to coast . . . the ***Winegard Color'ceptor.***

For full information, see your distributor or write the Winegard Company, 3002 Scotten Blvd., Burlington, Iowa.

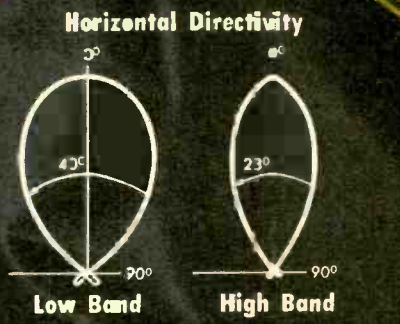
Gold Anodized

Winegard Color'ceptor TV Antenna

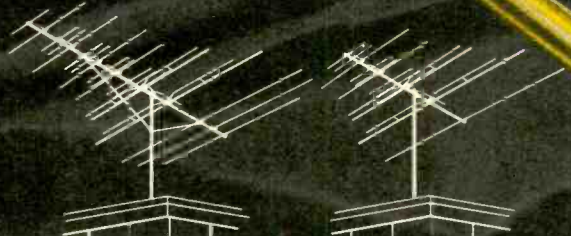
all 12 VHF Channel Reception For Both Black-and-White and Color

Color so bright they sell on sight!

Note:
Each gold Color 'Ceptor you install helps sell another. Once folks see these bright gold antennas sprouting up in their neighborhood, they won't be satisfied until they own the gold antenna, too!



Gain Chart
CL-4X with Power-Pack



Color'Ceptor Model CL-4X — $44.90

Color'Ceptor Model CL-3 — $29.95

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Exclusive Color'Ceptor features

- Completely non-corrosive gold-anodized finish.
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Winegard Color 'Ceptors are consistently advertised in leading national magazines your customers read!

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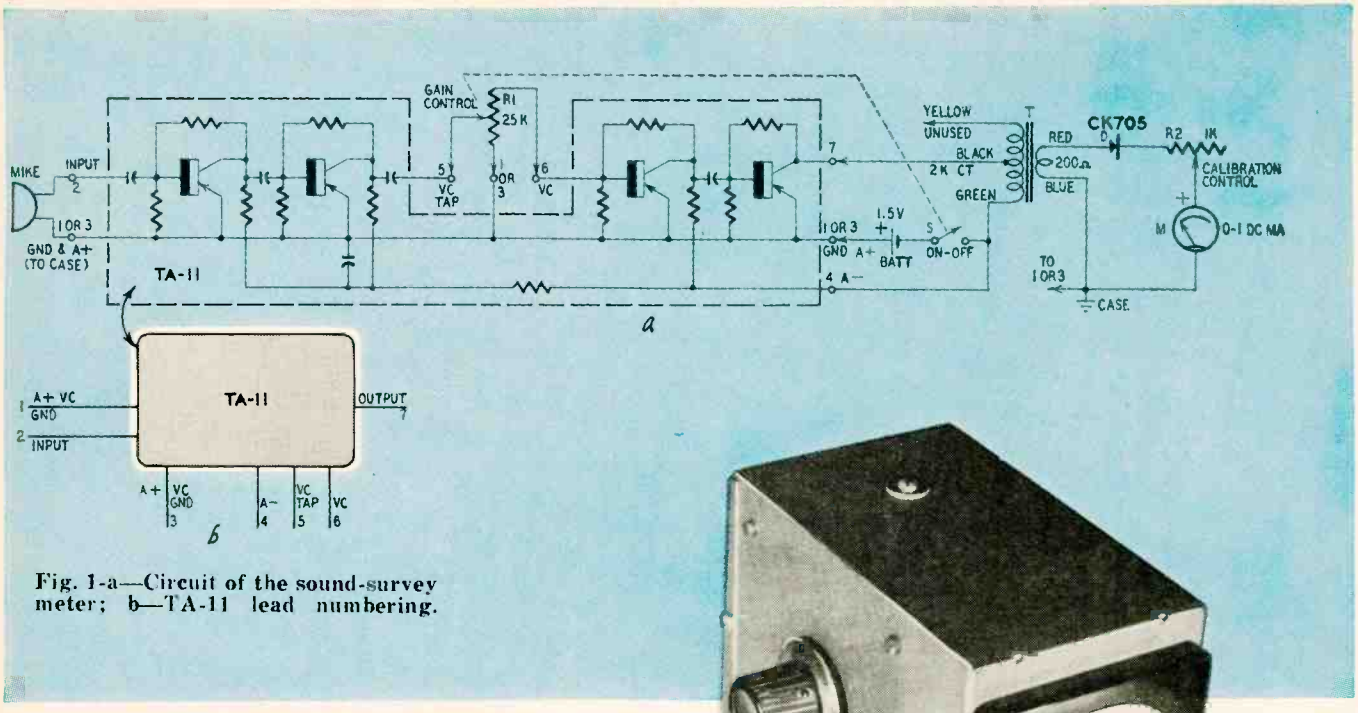


Fig. 1-a—Circuit of the sound-survey meter; b—TA-11 lead numbering.

SOUND-SURVEY METER

The completed unit. Gain control R1 is mounted on the instrument's side.

Handy unit for measuring and comparing sound levels is built around a 4-stage packaged transistor amplifier

By RUFUS P. TURNER

A *sound-survey meter* is composed of a microphone, high-gain audio amplifier and indicating meter. The meter's deflection is proportional to the volume of sounds picked up by the microphone. The sound-survey meter is invaluable for checking and comparing noise levels both in and out of doors, acoustic intensities and strength of echoes. It is also useful as an applause meter.

Some practical questions easily answered by a sound meter are: How noisy is a certain machine or how much quieter is a new one? How much noise does the kid's hot rod make? How quiet is the interior of my car? How much noise is made by typewriters in our office, all going at the same time? How loud is the hi fi two rooms away? How much good is the soundproofing of an apartment wall? Which is the noisiest intersection in town? How much oomph does a student orator need to fill the assembly hall without a PA system?

A battery-operated sound-survey meter is convenient since it is often used at locations remote from power lines. Even when ac power is available, it is sometimes not desired because of hum difficulties and the weight of transformer type power supplies. But when tubes are used, the high cost and short life of B-batteries is a problem. Furthermore, extraordinary precautions are necessary to prevent microphonics in a high-gain battery-operated tube amplifier. The use of transistors makes possible long-life operation from a small, easily obtained flashlight battery. The transistor instrument is free from microphonics, ready for operation the instant it is switched on, small in size and light in weight.

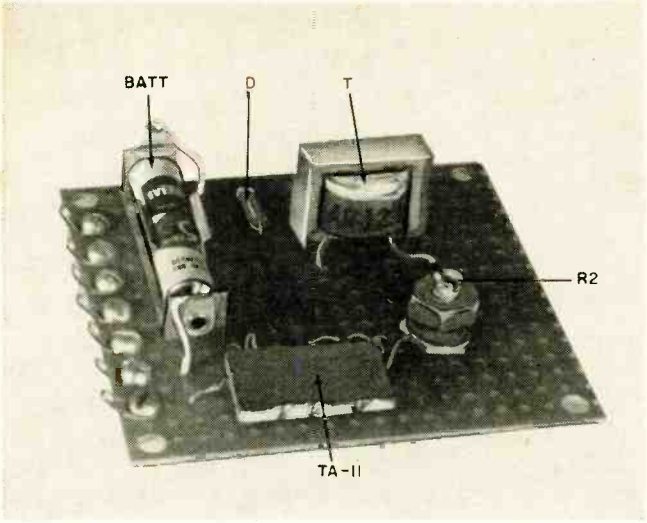
The sound-survey meter described in this article is powered by a single 1.5-volt penlight cell. Total current drain is 3.6 to 4.4 ma. The unit is 5 inches long, 3 inches wide and 4 inches high (a comfortable handful) but can be made much smaller. It weighs 1½ pounds. No costly meter is required; the indicator is a 0–1 dc milliammeter. At full gain a hoarse whisper 2 feet from the microphone pins the meter.

Circuit description

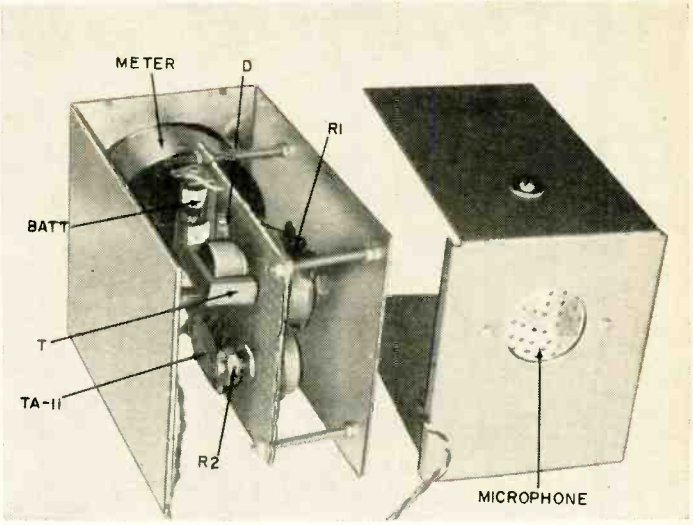
Fig. 1 shows the complete circuit of the instrument. The amplifier section is a subminiature four-stage R-C-coupled transistor amplifier (Centralab type TA-11). The advantages of using this ready-made amplifier package are: It is smaller (only 1.175 inches long, 0.665 inch wide and 0.250 inch thick) than an equivalent circuit built by the average technician. It is completely sealed, and the only connections necessary are to its input, output, a battery and a gain control. This ready-made package saves a lot of construction time too. (Ordinarily, 46 soldering operations

Parts List for Fig. 1

R1—pot, 25,000 ohms, audio taper, with spst switch
R2—pot, 1,000 ohms, wirewound
BATT—1.5 volts, penlight cell
D—CK705, germanium diode
M—0–1 dc milliammeter
S—spst on R1
T—miniature input transformer: primary, 200 ohms; secondary 2,000 ohms, ct (Argonne AR-123 or equivalent)
TA-11, miniature 4-stage transistor amplifier
Crystal microphone, miniature (Lafayette MS-108 or equivalent)
Battery holder for penlight cell
Case 5 x 3 x 4 inches (LMB No. 140 or equivalent)
Chassis, perforated phenolic board (cut to 3¼ x 3½ inches)
Knob
Solder lugs (7)
Miscellaneous hardware



Parts layout on subpanel. The transformer is glued down.



Inside the case. Note subpanel mounting.

would be required in the amplifier circuit alone. They are reduced to 7 by using the TA-11.)

It is surprising that this little amplifier, smaller than a special-delivery stamp, contains 4 high-gain low-noise transistors, 12 resistors and 5 capacitors. There are no bulges, and the 7 pigtails coming out of the package are numbered as shown in Fig. 1-b. The amplifier is designed to be powered by a 1.3-volt mercury cell but may be used with a conventional 1.5-volt cell. Negative feedback and stabilization of the dc bias are supplied. Overall gain is 73 db at 1,000 cycles, and frequency response is ±5 db from 250 to 20,000 cycles. Input and output impedances are both 1,000 ohms. The signal-to-noise ratio is such that with a 30-μv input signal, noise is at least 20 db below signal level.

In the instrument circuit, the amplifier's output is matched to the meter circuit with a small input transformer, connected backward to obtain a step-down ratio. The meter circuit is composed of diode D, CALIBRATION CONTROL R2 and the 0–1 dc milliammeter M. With R1 set for maximum gain and R2 set to zero (or lowest obtainable resistance), an input signal of only 200-μv rms at input terminals 1 and 2 deflects milliammeter M to full scale. This sensitivity permits using a crystal microphone without a matching transformer. (Even with the obvious mismatch between microphone and amplifier, there is ample signal transfer even at low sound levels. However, a proportionate increase in overall sensitivity is obtained with miniature low-impedance microphones.) Meter response is very nearly linear with respect to input signal voltage.

R1 allows the gain to be set at various levels corresponding to sound ranges. R2 is for initial standardization of the instrument and recalibration. It is mounted inside the case, protected from accidental adjustment and has a slotted shaft for occasional screwdriver adjustment. A clearance hole cut in the side of the case allows insertion of the screwdriver.

Construction kinks

The photos show construction details of the sound-survey meter.

My instrument is built into an aluminum chassis box 5 x 3 x 4 inches. The 3-inch meter determined the dimensions. The instrument may be made much smaller by using smaller components. For example, it can be made small enough to fit into a pocket by using a 1-inch microphone (Shure MC-11 round or MC-20 rectangular), a 1-inch milliammeter (International Instruments model 100), a dime-size potentiometer and switch (Centralab B16-217) for R1, S, and a miniature slotted-shaft potentiometer (Centralab JL-102) for R2. I wanted the increased ease of reading provided by the larger meter and built the instrument around this component.

The meter is mounted in one end and the microphone in the other end of the case. This arrangement permits the instrument to be pointed, probelike, at the sound source while being held in the palm of the hand, and the meter is easily read from the rear. GAIN CONTROL R1 is mounted on the left side of the case.

The microphone is a small wafer type unit, 1½ inches in diameter. It is mounted behind a 1¼-inch hole in one end of the case. A small ring of sponge rubber, to which the microphone is cemented, provides a shock-absorbing cushion. This ring is held to the case with screws or glue. The microphone may be attached directly to the case without the cushion, but it then becomes subject to vibrations picked up from any object on which the instrument rests or from the operator's hands. This will cause erratic wiggling and sometimes even slamming of the meter's pointer.

All components except the microphone, milliammeter and GAIN CONTROL are mounted on a 3¼ x 3½-inch subpanel of perforated phenolic. The pigtails and leads pass through the tiny holes and are connected underneath to complete the wiring. In this way, construction as compact as a printed circuit is secured. Seven solder lugs mounted along the left edge of the subpanel provide connections for the meter, GAIN CONTROL and microphone. The battery (a 1.5-volt penlight cell) is held in a bracket type battery holder mounted along the left side of the subpanel. CALIBRATION CONTROL R2 is seen near the lower right corner. The subpanel is held to one wall of the case by four 1½-inch 6-32 screws. These screws keep the board well away from the case's inner wall and provide clearance for R1 which is mounted on the same wall and under the board. The on–off switch is attached to the GAIN CONTROL.

The metal case provides good shielding for the high-gain circuit. However, to prevent current loops which might cause feedback and body-capacitance effects, connect the ground side of the circuit to the case at only one point. A good spot is at *one* of the subpanel mounting screws.

Wiring must be done with the shortest practicable leads. This is not difficult with the point-to-point wiring used. Take particular care when soldering to the pigtails of the TA-11 and the germanium diode. To prevent heat damage to these components, the soldering operation should be as rapid as possible and each pigtail must be held with long-nose pliers while being soldered *and until the joint is completely cool.* To prevent breakage, do not place any strain upon the TA-11's leads and do not flex them any more than absolutely necessary.

Be careful to observe battery, meter and diode polarities, and the amplifier and transformer coding shown. The cathode of the diode goes to the meter (thru R2) so the meter reads forward. The number coding on the TA-11 amplifier and the color coding on transformer

TEST INSTRUMENTS

T correspond to the manufacturer's coding of these components.

Initial testing

Carefully check the instrument's wiring before turning on the power. *This is a must* since the components are easily damaged by incorrect connections.

After wiring has been checked, to test the instrument:

1. Set R2 to its zero-resistance position.

2. Set R1 for maximum gain. This also switches on the instrument, since S is attached to R1.

3. Whistle sharply, noting that meter M deflects. With the instrument set as it is for maximum sensitivity, the meter can be pinned easily, even with the microphone pointed away from the whistling as it is when reading the meter.

4. While whistling a sustained note at uniform volume, reduce the setting of R1, noting that the meter reads progressively lower values. Instead of whistling, which is unsteady at best, you can use a loudspeaker (operated at 1,000 cycles from an amplifier and audio oscillator) as the sound source.

After this rough check, the instrument will be satisfactory for comparative measurements. For example, to use as an applause meter point the microphone toward the audience and have everybody applaud as loudly and evenly as possible. During the noise, adjust R1 for exact full-scale deflection of the meter. This corresponds to 100% audience response (1 on the meter scale). Subsequent applause will deflect the pointer either to 100% or to some lower value. Thus, 0.4 corresponds roughly to 40% response. Similarly, in checking the interior noise in an automobile take a noise reading outside the car, adjusting R1 to bring the pointer to an easily read upscale point (preferably full scale, 1) and record this reading as E1. Then, without disturbing the setting of the gain control, take the meter inside the car, close all windows and record the meter reading as E2. The percentage of noise reaching the interior then is equal to $(E2/E1) \times 100$.

An actual noise or sound calibration in decibels may be made only by checking against another, previously calibrated sound-survey or sound-level meter (such as General Radio type 1551-A sound-level meter or type 1555-A sound-survey meter). The two instruments must be placed as close together as possible, side by side, both with microphones pointed toward an adjustable sound source. Set the standard meter to its most sensitive (lowest sound-level) range. Set R1 in the experimental meter to its maximum-gain position. Adjust the sound source for full-scale deflection of the standard meter. Note the reading of the latter in db. Adjust R2 to bring the meter exactly to full scale. Record this point as the number of db indicated by the stand-

ard meter. Reduce the amplitude of the sound source in steps, noting the reading of the standard meter and recording the deflection of the milliammeter, against the number of decibels indicated by the standard meter. Repeat the procedure with the standard meter switched progressively to its other ranges, and adjusting R1 in the experimental meter as before. Note each setting of R1 since this will set the ranges of the instrument. For best accuracy, a step type attenuator should be substituted for R1 to allow close setting when changing ranges. After a calibration of this sort, R1 may be provided with a decibel-range scale, and a db scale can be drawn for the meter.

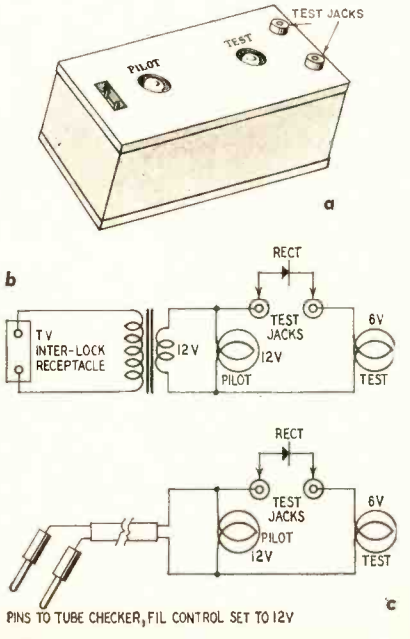
A quiet location is needed for any sort of sound-meter calibration. When the instrument is set for maximum gain, the noise of a passing car or airplane or children at play can cause a sizable meter deflection. END

RECTIFIER CHECKER

This selenium-rectifier checker is utterly simple. Two versions are shown . . . a self-contained unit *(a, b,)* and one to be used with a tube tester *(c)*. The tube tester is set for 12 volts and the checker is plugged into any socket's heater pins.

In operation, the pilot lamp (12 volts) lights to normal brilliance. A good rectifier will light the 6-volt test lamp as bright or a bit brighter than pilot. Weak rectifiers will cause the test bulb to light to lesser degrees of brightness. A shorted rectifier may burn out the test bulb. Therefore, the test bulb should be easily replaceable. New silicon rectifiers will light the test bulb noticeably brighter than seleniums, due to their lower voltage-drops.

The checker is shockless and polarity need not be observed. It will not test for high-voltage breakdown.—*Fritz C. Hoffman*



GIRLS' DRILL TEAM at St. Joseph's Parish is supported by Remo De Nicola, Quincy, Mass., as one of his many community services. He also gives free television service to a school for retarded children and is always ready to lend sound equipment for charitable affairs.

CIVIL DEFENSE LEADER Richard G. Wells, Jr., Pikeville, Ky., installed television cables from a community antenna to Pikeville College, high school, fire department, Scout building and Methodist Hospital. He is working to give the high school a closed-circuit TV system.

FIVE PUBLIC SERVICE CITATIONS plus a civilian Navy award were given Frank J. Hatler, Roselle, N. J., for his communications work in community emergencies. As local civil defense head, Frank organized communications networks, helped many to get radio licenses.

BLIND CAN SKATE because Philip G. Rehkopf, Jr., Louisville, Kentucky, installed a record player and placed loud speakers around the walls of the gymnasium at the Kentucky Home for the Blind. He developed an electronic device to give scores to blind basketball fans, and tape records text books for blind students.

WHEEL CHAIR is no handicap for Mortimer Libowitz of Brooklyn, New York. Though disabled all of his life, Morty has devoted his time to helping others in his community. With a crew of student volunteers, he maintains the radio station at Thomas Jefferson High School, Brooklyn. He also services a Red Cross radio station and is active in civil defense communications. Morty has trained many youths in radio, developing some into amateur operators and skilled television technicians.

ELECTRONICS LABORATORY at Long Beach City College, California, was established with help from Harry E. Ward. Harry serves as chairman of the Business and Technology Advisory Committee and for fifteen years has devoted his time to finding work for students, graduates and others.

STUDENT BENEFACTOR Philip T. Di Pace, of Albany, N. Y., contributes used radio and television chassis and parts to Siena College students who are interested in electronics. Phil now heads a project to finance an athletic field and playground for 75 neighborhood children.

BASIC ELECTRONICS is taught to neighborhood boys by John H. Stefanski, Pontiac, Michigan. He has organized a scientific library for the boys and is now planning a new Pontiac Boy's Club. John has served as chairman of the Business Ethics Board of the Pontiac area Chamber of Commerce. Television sets in the Oakland County Sanatorium are serviced without charge through his efforts.

GOOD SPORTSMANSHIP is developed by Marcus E. Denham at Whitaker State Orphans' Home, Pryor, Oklahoma, where he assists in recreational activities. He is also prominent in many local community service groups. His work is typical of the many public service contributions of TV technicians everywhere.

BOY SCOUT WORK and assistance to Charlotte, Michigan, youth groups make Bart Rypstra, Jr., another "All-American". He is a member of the Charlotte city council, active in civil defense communications, and belongs to many community service clubs. When time permits, Bart devotes his technical talents to servicing sound equipment, movie projectors and record players at city schools.

JUDGES SELECTED 13 WINNERS to receive this trophy, $500 for use in community improvement, and luncheon with Under Secretary of Commerce Walter Williams at Washington, D.C.

"ALL-AMERICAN" TV TECHNICIANS WIN GENERAL ELECTRIC AWARDS FOR PUBLIC SERVICE

AMERICANS everywhere responded to General Electric's invitation to nominate candidates for "All-American" Awards, honoring television technicians who have distinguished themselves in public service.

The winners, whose pictures appear on these pages, were selected by a panel of judges composed of *Wendell Barnes,* Administrator, Small Business Administration; *Wendell Ford,* 1956-57 President, United States Junior Chamber of Commerce; *Herman Hickman,* Sports Authority; and *Ed Sullivan,* Columnist and TV Personality.

General Electric has established these awards as another step in its program to recognize the public service contributions made by independent businessmen everywhere.

The accomplishments of these television technicians should serve as an inspiration to all Americans. *General Electric Company, Receiving Tube Department, Owensboro, Kentucky.*

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VOLUNTEER FIREMAN and Instructor John R. O'Brien, Evanston, Wyoming, teaches first aid at neighboring fire companies and schools. He is active in communications during civic emergencies, and lends and installs sound equipment for town functions. Many community service groups benefit from his time and skills.

MANY WERE SAVED by Scott Witcher, Jr., during Lampasas, Texas, disaster. Here he shows height of water in raging flood which swept his area. Scott saved lives and helped restore communications to the community. He is active in the National Guard, in civic and youth organizations.

TV FOR THE SICK is provided by Billy Joe Jenkins of Paducah, Texas. By installing antenna cable and servicing sets without charge, Billy Joe has made it possible for patients in Richards Memorial Hospital to enjoy TV. He helps community improvement drives, teaches electronics to Boy Scouts.

Technicians' News

PHILCO CLOSES SERVICE SHOPS

The last eight Philco Manufacturer's service branches have been closed as the firm starts its centralized-service policy with independent dealers appointed to service in-warranty appliances, including TV receivers, radios and hi-fi sets.

Philco now has appointed about 6,000 auto-radio service firms to make in-warranty repairs and has about 30,000 Philco factory-supervised service technicians throughout the country. It was emphasized that the new program is not mandatory on the dealer. This is important to firms operating their own service department.

Under the new system, each Philco distributor will have service managers with the primary purpose of conducting training meetings for the in-warranty repair stations to keep them up to date on new developments in Philco products.

COLOR TV CLOSE UP

At a recent technical meeting of the Radio Television Guild of Long Island (RTGLI) the techniques used in convergence of an RCA color TV set were demonstrated by Ed Klingerman of the RCA Service Co. After convergence was completed, Mr. Klingerman answered questions for the guild's members, going back to the set to make some answers clearer.

PRICES TOO LOW

Service prices set by television repair firms are too low, according to Russell Hansen, coordinator for RCA Service Inc. Addressing a meeting of the St. Louis, Mo. zone of the West Central division of the National Alliance of Television and Electronic Service Associations (NATESA), he declared that gross income for a repair shop should total 2½ times payroll expenses. Mr. Hansen further suggested that shop owners survey their costs and make the necessary adjustments to get a satisfactory service margin. As Mr. Hansen says, "service can and should pay."

LICENSING HITS SNAG

Hearings in San Francisco, Calif., on a proposed city ordinance that would license television technicians, have run into a string of delays. It started in March, 1957, when the law was first proposed. The initial hearing was postponed when it was disclosed that the city attorney had not approved the form of the desired ordinance.

The second hearing was also postponed as only one copy of the 19-page act was available. It was felt that a discussion using only one copy would have taken weeks.

Now, while mimeographed copies are being run off, both sides are preparing for a fight. The co-sponsors of the new legislation are the San Francisco TV Service Guild and Local 202 of the International Brotherhood of Electrical Workers. The opposition, represented by attorney Theodore Ambrose, who would not reveal his clients' names, said he represents some independent TV service dealers. Their view is that no city ordinance should be passed until the state has made a final ruling on a licensing bill now being studied by a State Senate committee.

Proponents of the bill said that, since a state licensing bill had not gotten through the last assembly, the way was clear for city ordinances.

ELECTRONIC TECHS HONORED

Thirteen electronics technicians who have distinguished themselves in community activities have received General Electric's first annual All-American Award for public service.

Among them are a Texan who saved many lives in a flood, a Kentuckian noted for aiding blind children, and a New Jersey resident with a long record of civil-emergency service. A Brooklyn, N.Y., service technician was cited for educational work as were technicians in California and Wyoming. Supplying free radio and television repair service to hospitals, churches and indigent persons brought recognition to technicians in Michigan, Oklahoma and Massachusetts.

As a reward for their outstanding public service, each of the thirteen received a trophy and a $500 check for use in a community activity or charity of their choice.

The thirteen are: *Harry E. Ward*, (shown in photo), 55, partner, Ward

Brothers Radio & TV, Long Beach, Calif. *Philip G. Rehkopf, Jr.*, manager, radio-electronics division, Bonnycastle Appliance Stores, Louisville, Ky. *Richard G. Wells, Jr.*, Valley Television Service, Pikeville, Ky. *Remo De Nicola*, 40, partner, South Shore TV Co., Quincy, Mass. *Bart Rypstra, Jr.*, 47, proprietor, Rypstra Radio & TV Serv-

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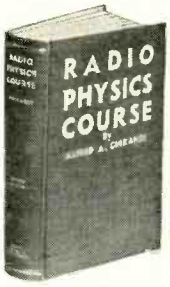

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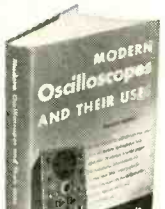

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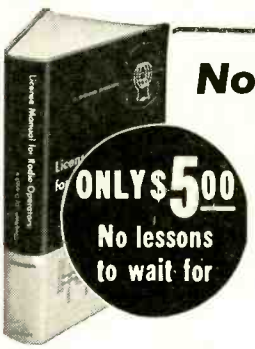

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REBUILT PICTURE TUBES

Philadelphia servicing firms report that rebuilt TV picture tubes now make up 25–30% of dealer and distributor picture-tube sales. One dealer bases the increasing sales on the combination of lower cost and a belief held by many technicians that rebuilt tubes made from used glass stay brighter and last longer than those made from new glass.

ESDA JOINS NATESA

The Electronic Service Dealers Association (ESDA) of Pittsburgh, Pa., has voted to affiliate with the National Alliance of Television & Electronics Service Associations (NATESA). Joseph Doyle, president of the Pittsburgh group, made the announcement.

SERVICE LITERATURE

A subscription plan offering an aid to radio service technicians has been announced by W. T. Curtis, product service manager of General Electric's radio receiver department at Utica, N. Y.

Subscribers will receive a service manual on each new G-E radio at the time the set reaches the market. Bonus publications will include a complete replacement parts list plus up-to-date revisions for all available components of postwar G-E sets, and technical bulletins on subjects like transistor circuitry and printed-circuit developments.

The initial subscription began Jan. 1, and ends Dec. 31. Cost of subscriptions is $2 each. END

CORRECTIONS

There are errors in the values of C1 and C3, series grid and plate capacitors, respectively, in the mid-range circuit of Fig. 4 of "Multi-Channel Electronic Crossovers" on page 54 of the December, 1957, issue. C1 should be 170 $\mu\mu$f and C3 260 $\mu\mu$f.

We thank reader J. Ray Jesse, of Owensboro, Ky., for calling this to our attention.

Mr. Crowhurst has pointed out an error in the photo caption in his article "Single-Groove Stereo Discs" on page 54 of the January, 1957, issue. The Westrex head in the photo is a recording type.

Patents

AUTOMATIC BRAKE CONTROL

Patent No. 2,804,160

George Rashid, Detroit, Mich.

Many automobile mishaps result from the slow reactions of a driver. This patent discloses an automatic brake that is applied when a car is being driven in an unsafe manner. Control is by shortwave radio. This device considers the following factors: (a) distance between cars; (b) the rate at which the distance is varying; (c) velocity of the controlled car.

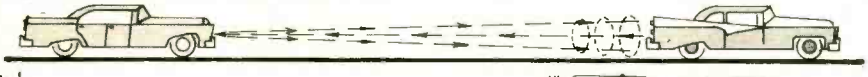


Fig. 1

Fig. 1 shows how the controlled car emits a radio beam which is reflected from the car in front of it. If their distance is safe, the echo is too weak. Automatic braking occurs only when the cars are close enough to present potential danger.

The second factor gives rise to Doppler effect: the echo frequency differs from that of the original signal. If the cars are approaching (relatively), the echo frequency is higher. This beats with the original signal and the audio beat is amplified, then fed to a thyratron. When this tube fires, it energizes a solenoid and applies the brake. The higher the beat (the faster the cars approach each other), the greater the signal passing through capacitor C (Fig. 2) to fire the thyratron (V2).

Car velocity is taken into account by the arm of potentiometer R, which turns with the speedometer. If the car is moving slowly, the moving contact is near ground so there is a large bias on V2. At high speeds the bias is near minimum so V2 is more easily fired by the audio signal at the grid.

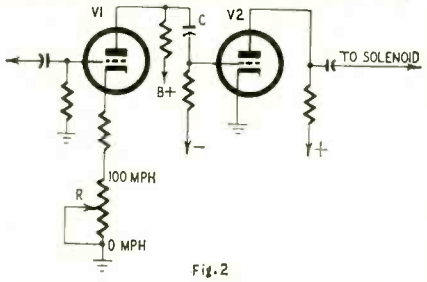


Fig. 2

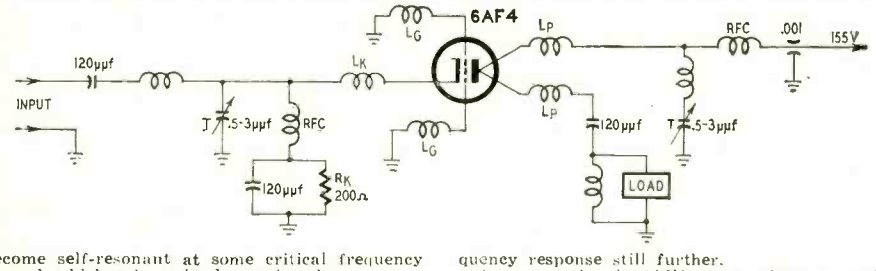
When the combination of speed, distance and acceleration exceeds a safe value, V2 fires and applies the brake. Otherwise the mechanism does not interfere with normal operation of the car.

UHF AMPLIFIER

Patent No. 2,799,736

Robert J. Hannon, Huntington Station, N.Y. (Assigned to Standard Coil Products Co. Inc., Los Angeles, Calif.)

Even a uhf tube has its upper frequency limit. It is largely determined by the inductance of internal leads to grid, plate, cathode. These become self-resonant at some critical frequency beyond which tube gain drops sharply.



This diagram shows a circuit based on the new invention. The cathode leads (LK) form part of a T network (which is equivalent to a transformer). Since an ideal transformer has no loss, LK does not attenuate the signal. In addition, the plate leads (LP) are used as part of the output tank, which improves the frequency response still further.

A conventional 6AF4 may show a noise factor of 18 db or more at 885 mc. By comparison, the circuit shown in the diagram has a noise factor of only 10.5 db at this 885-mc frequency.

PUSH-PULL SAWTOOTH GENERATOR

Patent No. 2,797,327

Marshall C. Kidd, Haddon Heights, N. J. (Assigned to RCA)

This is an application of *delayed collector conductivity*, an effect that occurs when a junction transistor is reverse-biased between emitter and base, and collector voltage is high. One result of this operation is that the transistor shows negative resistance (Fig. 1). A simple sawtooth generator using this principle is shown in Fig. 2.

The n-p-n collector is biased as usual (positive) but the voltage is about 86. Note, also, that the emitter bias is positive. When the batteries are switched on, C begins to charge. Current through V is small because of the large circuit resistance. At this time the transistor resistance is positive (see Fig. 1). When C has accumulated a considerable charge, a heavier current begins to flow from it through V. Now negative resistance exists and considerable flow passes through V, discharging the capacitor very quickly.

As the current drops off, V returns to its positive resistance region. C begins to charge again. The output waveform is a sawtooth as shown.

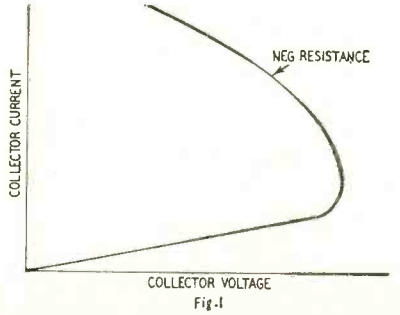


Fig. 1

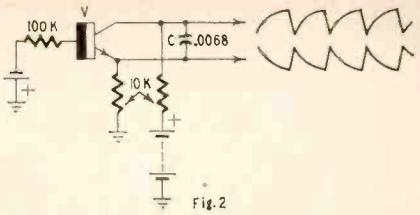


Fig. 2

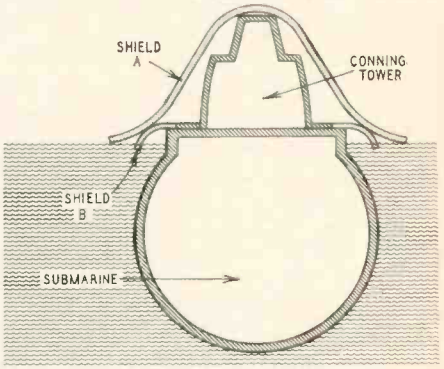
When collector and emitter resistors are equal, the output voltage from each terminal is equal but opposite and can be applied to push-pull circuits; for example, ungrounded cathode-ray deflecting plates.

RADAR SHIELD

Patent No. 2,801,411

Robert Weinstock, Palo Alto, Calif. (Assigned to USA as represented by Secretary of Navy)

Radar echoes, like those of sound and light, reflect best from flat surfaces of large area. These echoes can be reduced by conductive screens that deflect them away from the radar



receiver. The diagram shows how shields, properly placed, can help to hide a submarine from the radar of enemy vessels. Shield A, around the conning tower, disperses the radar wavefront and sends much of the energy upward instead of back to the radar receiver. Shield B, a curved apron, protects hull and deck.

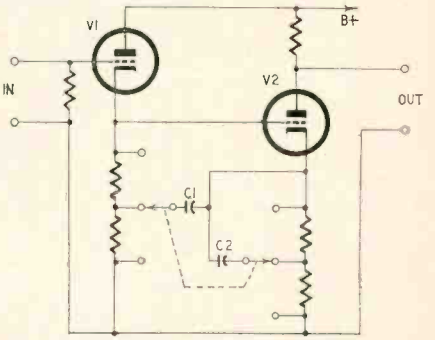
While such shields cannot eliminate all radar echo, they can reduce the reflected energy. This weakens the observed radar pips and renders them less distinct on the scope.

DOUBLE-ACTION GAIN CONTROL

Patent No. 2,801,302

Truman H. Quinn, Richland, Wash. (Assigned to USA as represented by the US Atomic Energy Commission)

This gain control does not affect input or output impedances nor does it upset tube biases as other controls often do. It is connected between V1, a cathode follower, and V2, a direct-coupled amplifier stage. In this particular circuit there are three steps, but any number could be included for finer control.



In the upper position of the ganged switch, no signal is impressed upon V2. Actually its grid–cathode circuit is shortened under this condition. In the middle position (shown in the diagram) V2 does receive voltage through coupling capacitor C1. Also, C2 bypasses only a portion of the cathode resistor of V2 so there is considerable degeneration. Gain is less than maximum.

In its lowest position, the switch feeds maximum signal from the cathode of V1 to the grid-cathode of V2. Also, C2 bypasses the *entire* cathode resistor of V2 and there is maximum gain. END

new Records

MONITOR

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

Vox L-3 (16⅔ rpm)

TSCHAIKOVSKY: *Piano Concerto No. 1*
Symphony No. 6
Romeo & Juliet Overture

Vox L-1 (16⅔ rpm)

BEETHOVEN: *Piano Concerto No. 5*
Violin Concerto
Leonore Overture No. 3
Cariolan Overture

Vox L-2 (16⅔ rpm)

RIMSKY-KORSAKOV: *Scheherezade*
TSCHAIKOVSKY: *Nutcracker Suite*
BIZET: *L'Arlèsienne Suites 1 and 2*
BORODIN: *Polovetsian Dances*
Round the World, Round the Clock

Vox L-4 (16⅔ rpm)

BEETHOVEN: *Symphony No. 5*
DVORAK: *Symphony No. 5*
SCHUBERT: *Unfinished Symphony*
PROKOFIEFF: *Classical Symphony*

Vox L-5 (16⅔ rpm)

The 16⅔ speed has been available on most changers and turntables for the past two years, but hitherto has been used principally for the "talking-book" type of voice recordings. Vox is the first major record company to issue musical recordings in this speed, and the above comprises the first lot—mostly dubbed off tapes from which previously issued 33 rpm's had been mastered. Vox has succeeded surprisingly well in overcoming the difficulties of the slow speed. And while the quality is by no means in the class of the best available 33-rpm LP's, it is considerably better than I anticipated, and will prove acceptable for many purposes—particularly for background music.

The first releases are well chosen to demonstrate the virtues of the slow speed. The records average nearly an hour of music per side. One record can present a thorough sampling of one composer's work or present a long program of the works of several composers. L-3 is the most suitable for demonstration of classical and L-4 of popular capabilities. Now that Vox has broken the ice, we can expect issues in this speed from other labels, and I suspect they will find a good market, provided the price is comparable to that of 33-rpm recordings. The 16⅔-rpm speed presents a severe challenge to the low-end stability of amplifiers, subsonic pickup resonances and wow characteristics of turntables.

ROSSINI: *Overtures*
Dorati conducting Minneapolis Symphony

Mercury MG-50139

This has a half dozen of Rossini's early overtures, including *La Gazza Ladra, La Scale di Sets, La Cenerentola, The Barber of Seville. L'Italiana in Algeri* and *Il Signor Buschino.* It offers some very spectacular sound with terrific peaks, especially in *La Gazza Ladra.* Some of these overtures are better than others, but none are dull and between them they give the orchestra a thorough workout and a thorough sampling of Rossini's characteristic idiom. Easy to listen to and, on a fine system, most impressive in sound.

BRITTEN: *Young Person's Guide to the Orchestra*
Sea Interludes and Passacaglia from Peter Grimes
Matinées Musicales
Soirées Musicales
Boult conducting Philharmonic Promenade Orchestra

Westminster XWN-18601

Not only a very admirable sampling of the works of this contemporary British composer, but a fine demonstration test and showoff recording. The *Young Person's Guide* offers as good a demonstration of the capabilities of the orchestra and its several choirs as well as individual instruments as any single piece of music provides. It is given here without any distracting narration. The two *Musicales*, based on Rossini themes, are delightful individually and also offer some excellent sound and test material. The excerpts from *Peter Grimes*, not as spectacular sonically though more important musically, are useful for their orchestral and instrumental nuances. The recording is one of the finest, very well balanced, extremely well defined and clean, with very fine high highs and very low-down drums, the full effect of which will be notable only on the finest speaker systems fed by amplifiers with very stable low ends. A recording which needs the best hi-fi system and makes the most of one.

Readers of this column will be pleased to know that, beginning next month, discs and tapes will be reviewed by **Chester Santon.** Mr. Santon is well known in the high-fidelity world, having been on the staff of WQXR, the good-music AM and FM station of *The New York Times*, for the past 16 years. He has conducted the Sunday evening record program "Adventures in Sound" during the last three years and also conducts the newer all-tape program "Frontiers of Sound." The first reviews received from Mr. Santon indicate a slant that we believe will add new interest to the column without detracting from its established features.

BEETHOVEN: *Symphony No. 5*
SCHUBERT: *Unfinished Symphony*
Prohaska conducting Vienna State Opera Orchestra

Vanguard SRV-106

Another bargain demonstration recording by Vanguard, this one couples the two symphonies which are probably the most popular currently. Few recordings combine so authoritative an in-

terpretation of the music with such magnificent sound. Hence, though not as spectacular as some, this would be extremely useful to demonstrate the worth of hi fi to those more interested in music than sonic tricks.

GLIÈRE: *Ilya Mourometz*
Stokowski conducting Houston Symphony Orchestra
Capitol P-8402

One of the most colossal symphonies which relates musically the tales of the Russian equivalent of our Paul Bunyan. It gives each section of the orchestra the opportunity to show its possibilities, and has some very spectacular moments. This is a very fine recording and should be an authoritative one, for Stokowski was associated with Glière in reducing the score to a length suitable for concert performance. The recording is brilliant, clean, well balanced, and, on a fine system, will present this spectacular music with tremendous effect. There is a little of everything here from very fine tympani to delicate spiccato strings and quiet diminuendoes to terrific crescendoes.

GLIERE: *Excerpts from the Red Poppy Ballet*
IPPOLITOV-IVANOW: *Caucasian Sketches*
Fistoulari conducting London Philharmonic Orchestra
RCA-Victor LM-2133

One of the most appealing of recent records for show-off and demonstration. *The Red Poppy* is bright and full of sonic effects, and *The Caucasian Sketches* are concert favorites. The recording is on the spectacular side with very fine and big low-down drums and string basses, a very fine and clean high end with lots of tinkling percussives and a liveness which yields a high illusion of presence. The subtle and compound bass in *The Caucasian Sketches* requires fine definition to resolve and presents an exceptional test of low-end system response. Could be a hi-fi hit.

BACH: *Three Sonatas for Cello and Harpsichord*
Antoni Janigro, Cello; Robert Veyron-Lacroix, Harpsichord
Westminster XWN-18627

A most unusual combination of instruments receives a very faithful recording. The contrast between the legato cello and the percussive harpsichord produces an interesting effect. For Bach buffs and those who like the unusual in sound.

Pour la Harpe
Marcel Grandjany, Harpist
Capitol P-8401

One of the great masters of the harp plays a dozen short French classics written or transcribed for harp and extremely well recorded with all the natural transients.

***German University Songs*, Vol. 2**
Male Chorus and Orchestra of Vienna State Opera
Vanguard VRS-1010

This formal version of 21 examples of the German "fraternity" songs with professional chorus and full orchestra is a little too slick to communicate the authentic student flavor, but few people will mind that. The recording is as real as life.

Fighting Songs of Algerian Rebels
Westminster WF-12006

Recorded in caves, ruined farmhouses and the forests of the Atlas Mountains by two NBC correspondents, these are thoroughly authentic and unprofessional. The musical background is from improvised instruments and such improvisations as clicking bayonets, beating rifle stocks with spoons, etc. Recorded with a portable recorder, the quality is not up to Westminster's usual high, but good enough to give an authentic on the spot impression. END

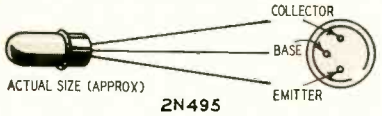
Name and address of any manufacturer of records mentioned in this column may be obtained by writing Records, RADIO-ELECTRONICS, *154 West 14th St., New York 11, N.Y.*

New Tubes & Semiconductors

Only semiconductor devices appear this month. Three types are built for use in portable radios in converter, if amplifier and audio output stages. An unusual four-layer switching diode and a line of 20-amp stud-mounted silicon rectifiers round out the group.

2N495

A hermetically sealed, p-n-p silicon surface alloy transistor designed for amplifier and oscillator applications at



2N495

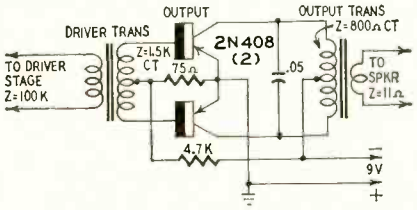
frequencies through 15 mc. The use of silicon permits transistor operation at temperatures as high as 140° C. The unit is made by Philco.

Tentative maximum ratings are:

V_{CB} or V_{CE}	− 25
I_C (ma)	− 50
P_{total} (mw) (at 25° C)	150
h_{fe} (current ampl factor) (min)	18
Storage temperature	−65 to 140° C

2N407, 2N408

Alloy-junction transistors of the germanium p-n-p type designed especially for use in class-A and class-B push-pull power output stages. The two



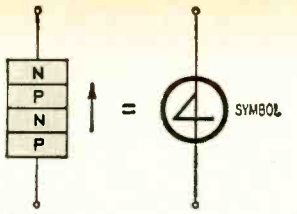
units have identical characteristics and ratings. The only difference is the basing. The 2N407 has in-line pins for socket plug-in use while the 2N408 has flexible leads arranged in a semi-circle.

The circuit shows typical use of these RCA units in a class-B output stage. Maximum ratings in class-B amplifier service are:

V_{CB}		− 20
V_{CE}		− 18
V_{EB}		− 2.5
I_C (ma)		− 70
I_B (ma)		70
P_C (mw)	(at 25° C)	150
	(at 55° C)	50
	(at 71° C)	20

4N20D, 4N30D, 4N40D, 4N50D

Silicon four-layer switching diodes they operate in either of two states: open or high-impedance where they have a resistance of 1–100 megohms, and a closed or low-impedance state where it is less than 20 ohms.

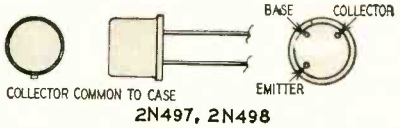


4N20D, 4N30D, 4N40D, 4N50D

The diodes are switched from one state to the other by voltage and current applied to them. As voltage is raised, the Shockley diodes, available from Beckman Helipot Corp., reach a breakdown voltage and switch to the low-impedance high-conduction condition, closing the circuit. It remains closed as long as the required holding current is maintained. If current falls below this value the diode resumes its open (high-impedance) condition. The symbol used for the switching diode is the number 4, indicating the number of layers in the unit. The slanting line shows the diode's forward direction when in the on condition. Breakdown voltages are: 20 volts for the 4N20D, 30 for the 4N30D, 40 for the 4N40D and 50 for the 4N50D (± 5 volts for each). Breakdown current 500 μa. A 2-volt holding voltage, 50-ma minimum holding current and on resistance of 20 ohms apply to all four diodes.

2N497, 2N498

These diffused-junction n-p-n silicon transistors deliver up to 4 watts at 25° C and operate at 60 and 100 volts.



2N497, 2N498

Tentative maximum rating of the Texas Instruments units at 25° C are:

	2N497	*2N498*
V_{CB} (I_C 100 μa)	60	100
V_{CE} (I_C 250 μa)	60	100
V_{EB} (I_E 250 μa)	8	8
P_{total} (watts)	4	4
(at 150° C)	1	1

2N409, 2N410

Germanium-alloy junction p-n-p transistors made especially for 455-kc if amplifier applications in transistor portable radios. The 2N410 has a hermetically sealed metal case and flexible leads. The 2N409 has in-line pins for socket plug-in use, otherise it is identical to the 2N410 made by RCA.

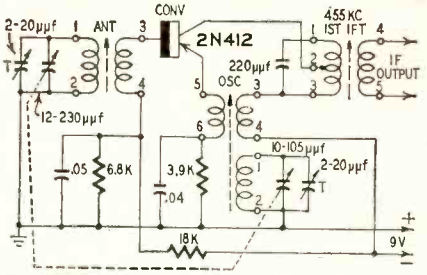
The diagram shows a typical two-stage if amplifier using the 2N410.

Maximum ratings for the 2N410 in this circuit are:

V_{CB}		− 13
V_{EB}		− 0.5
I_C (ma)		− 15
I_E (ma)		15
P_O (mw)	(at 25° C)	80
	(at 55° C)	35
	(at 71° C)	10

2N411, 2N412

Germanium-alloy junction p-n-p transistors designed for converter and mixer oscillator applications in standard, AM-broadcast, transistor portable radios. Both are identical except for basing.



The 2N411 is intended for socket plug-in applications and the 2N412 has long flexible leads.

The diagram shows a typical converter circuit using the RCA 2N412. Other circuits are feasible, provided operation is within the transistors' maximum ratings. Maximum for converter service:

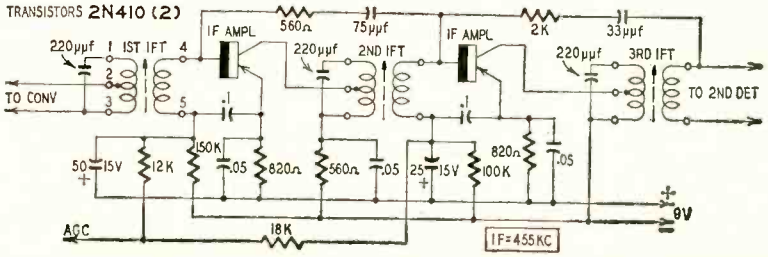
V_{CB}		− 13
V_{EB}		− 0.5
I_C (ma)		− 15
I_E (ma)		15
P_O (mw)	(at 25° C)	80
	(at 55° C)	35
	(at 71° C)	10

IN1301, IN1302, IN1304, IN1306

These 20-amp stud-mounted 200° C silicon rectifiers are designed for operation in computers, airborne electronic equipment and two-way radio power supplies. Developed by G-E they have a ¼-inch No. 28 stud for mounting directly to a power-supply chassis.

The units have a peak 1-cycle current surge rating of 300 ma. The 1N1301 has a 50-volt piv rating (peak inverse voltage); 1N1302, 100 volts; 1N1304, 200 volts; and 1N1306, 300 volts.

END

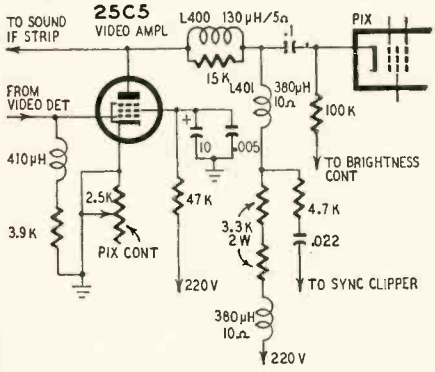


Technotes

RAYTHEON UM 2133

The customer complained of a loud buzz. The usual quick remedies were tried in the home—tubes and trap adjustment plus sound-detector secondary balancing. When this didn't help, the chassis was pulled to the shop.

All voltages and resistances were checked with no radical departure from tolerance. The sound seemed normal with a weak—poor-contrast—picture. Whenever the contrast was raised to yield a good picture, the buzz came in—unmistakably sync-pulse buzz overriding the sound detector. The picture appeared to be slightly out of focus. Several days and two good benchmen later brought no better results than at the home.



I found, by manipulating the fine tuning and contrast controls, that the contrast had to be advanced excessively to get a reasonably good picture. The picture retained the fuzzy appearance. Close inspection showed that the fuzziness was not a focus defect, but a loss of detail. Reasoning that the contrast was advanced to give greater high-frequency response, it followed that the low frequency was similarly increased if this assumption was true. A scope check was made for normal or abnormal low-frequency amplitude of the video signal—the peak-to-peak video including sync.

Result was a normal sync to white (video) voltage with a normal contrast setting. Contrast setting to produce a good picture resulted in some overloading from too much low frequency. Evidently, the hunch was correct—the set was losing high frequencies.

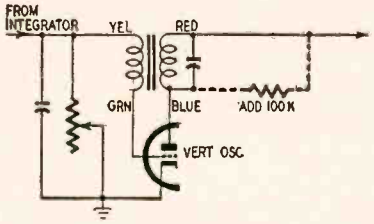
Each peaking coil was removed and substituted. Changing L401 made a substantial improvement. Its resistance was within tolerance (about 9.25 ohms contrasted to 10 on the schematic) but it apparently had some shorted turns. The set was restored to normal operation by replacing this coil and a tube.

Cause: the video amplifier had to be overdriven to produce detail in the picture with consequent second audio-if carrier increase. The excessive modulation could not be removed by the sound detector, hence the buzz.—*James A. McRoberts*

VERTICAL RINGING

Complaint of moving crosshatched and diagonal lines in the pix on one low-frequency channel was the reason for pulling a Sylvania Model 614. The rf interference on this channel was generated within the set since it behaved the same in the shop and in the customer's home.

Another set was tuned to the same channel and the offending chassis ex-



plored with a pickup probe hooked to the good set's aerial. Trouble was localized to the red and blue leads of the vertical oscillator transformer.

Resistors were shunted across both primary and secondary experimentally. A 220,000-ohm resistor across the red and blue leads stopped the oscillation and interference. This was replaced with a 100,000-ohm unit as a safety measure to reduce the Q so the secondary would not ring.

Similar trouble on other receivers indicates either the primary or the secondary may be responsible—always try both!—*A. Phillip Monroe*

JITTER AND RINGING

Careless lead dress involving the lead carrying information to the picture-tube socket (cathode in Bendix sets) can cause more confusion and lost troubleshooting time (which is $$$ to you) than almost any other item. If the lead rides over the horizontal oscillator, a slight horizontal jitter takes place. Resting close to the yoke or yoke plug causes ringing—very pronounced depending on the proximity of the lead to the deflection yoke. Everything points to trouble in the sync circuits, but every tube, component and voltage measurement says no!

To correct—simply dress the lead away from the yoke and horizontal oscillator tube. It may be helpful to tie the lead permanently in an out-of-the-way position. — *Bendix, Service Newsletter*

DEAD MIXER

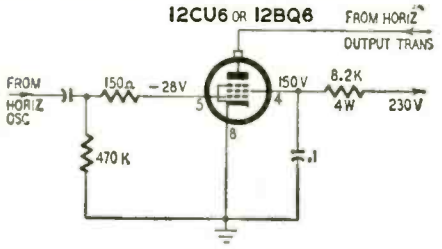
Mixers of the 6SA7 type using a screen dropping resistor may fail to operate for a very elusive reason. Ordinary voltage checks and circuit analysis usually will not reveal the

trouble. This is the absurd type of thing that can keep you guessing for a week.

If the screen bypass capacitor is open, the oscillator section will not oscillate, resulting in a completely dead stage. Shunting a good capacitor across the open one immediately reveals the trouble by restoring operation.—*Edwin Bohr.*

WESTINGHOUSE V-2352

The complaint was an intermittent and shrinking raster. A check showed that high voltage was lost and bias was high on the grid of the 12CU6 horizontal output tube. Placing a hot soldering gun near the 470,000-ohm grid-leak re-

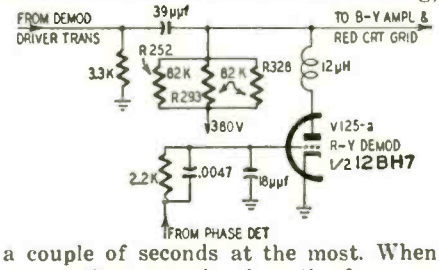


sistor caused a jumpy reading increasing in value to a final open.

Evidently the intermittent resistor had a poor deposit of carbon inside since the usual shaking and putting stress on it wouldn't affect this condition in any way. The narrow raster was caused by an increase in the value of the 470,000-ohm resistor.—*G. P. Oberto*

FLASH OF RED

This RCA 21-CT-660U looked like trouble. There was a flash of red on the screen which was soon followed by a blown fuse. A new fuse didn't last long,



a couple of seconds at the most. When we got the set to the shop, the fuse was jumped and the power turned on. Smoke soon started curling up from below the chassis. R252, R293, R328, 82,000-ohm plate resistors, were burning. A careful check showed that V125-a had developed a grid-to-cathode short. As the cathode is connected directly to ground the tube acted just like a rectifier, drawing a large amount of current from the 380-volt supply. This blew the fuse. The heavy current load caused the resistors to smoke. I've run into this a couple of times and each time the blowing of the fuse was preceded by a flash of red on the screen. Probably when V125-a, the R — Y demodulator, goes, it causes a short burst of red. Of course, after changing the tube, check the resistors. They may have been damaged and may require replacement.—*Jim White*

END

new Devices

REPLACEMENT COMPONENTS. Flybacks: *HO-279* replaces Magnavox 360632-1; *HO-276*, Philco 32-8624/1 and 32-8465-2; *HO-277*, Philco 32-8509-

/-2; *HO-278*, Philco 32-8484-2 and 32-8695/-1. Deflection yokes: *DY-24A* replaces RCA 103114; *DY-25A*, RCA 972913 and Emerson 708288.—**Stancor, Chicago Standard Transformer Co.**, 3501 W. Addison St., Chicago 18, Ill.

FLATTED PRECISION RESISTOR, *CMF*. Deposited-carbon type encapsulated with one

flatted side. Flat side serves as index surface for automation processes. ½-watt units, resistance range of 10 ohms to 2.5 meg, 1% tolerance—**Clarostat Manufacturing Co.**, Dover, N. H.

TRANSISTOR TRANSFORMERS, 6 units. *A-2701:* output, primary 725 ohms ct, secondary 3.2 ohms, 175 mw; *A-2702:* output, primary 450 ohms ct, secondary 3.2 ohms, 100 mw. *A-2703:* driver, primary 10,000 ohms, secondary 2,000 ohms ct, 100 mw. *A-2704:* interstage, primary 5,000 ohms, secondary 2,500 ohms ct, 350 ma. *A-2705:* output, primary 250 ohms ct, secondary 11 ohms, 175 mw. *A-2706:* output, primary 500 ohms, secondary 12 ohms, 175 mw.—**Merit Coil & Transformer Corp.**, 4427 N. Clark St., Chicago 40, Ill.

TV BOOSTER, *model B-23*. All-channel (vhf) broadband amplifier designed to improve TV reception. Also permits operation of 2 or 3 TV receivers from 1 antenna without interaction. 300-ohm input and output. With 2 sets, provides 6-db gain for

channels 2–6, 2-db gain channels 7–13. With 3 sets, delivers unity gain. — **Blonder-Tongue Laboratories Inc.**, 9–25 Alling St., Newark, N. J.

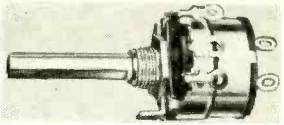
TWO-SET COUPLER, *model TL-2*. For TV or FM receivers. 300-ohm input and output. High-

impact case. Screw terminals. —**DeRo Electronics**, 134 Nassau Rd., Roosevelt, N. Y

SURGISTOR, *series 4000*. Limits inrush current until tube heaters are fully warmed, in all electronic devices including TV, radio and hi-fi sets. Easily con-

nected in power-line circuits. Also, temporarily holds down B-voltages to prevent cathode stripping.—**Wuerth Tube-Saver Corp.**, 9125 Liverinois Ave., Detroit, Mich.

PUSH-PULL SWITCH is now available on replacement volume controls. Used in many new TV sets, it gives extra convenience and added control life. Single and dual controls to match original components in radio and

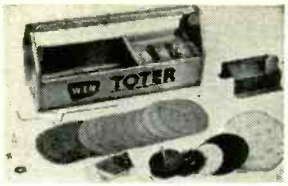


TV sets.—**P. R. Mallory & Co.**, Distributor Div., 3029 E. Washington St., Indianapolis 6, Ind.

BATTERY ELIMINATOR KIT, *model B-10*. 6- and 12-volt outputs, automatic overload protection and continuously variable voltage output. Doubles as battery charger. Self-contained low-ripple L-C filter output (0.3% maximum ripple) de-

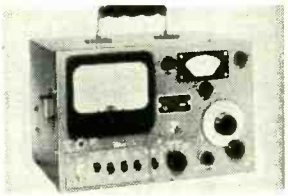
signed to power transistor circuits. — **Paco Electronics Co., Inc.**, Div. of Precision Apparatus Co., Inc., 70-31 84th St., Glendale 27, N. Y.

DRILL ACCESSORIES KIT, *Toter model 80K35*. Tote box with tray measures 18 x 6 x 8 inches, contains an assortment of accessories: paint mixer, 3-inch wire brush, 3 x 3¼-inch grinding wheel, 3-inch buffing



wheel, assorted twist drills, 15 sandpaper discs and 5-inch rubber pad.—**Wen Products Inc.**, 5808 Northwest Highway, Chicago 31, Ill.

FIELD-STRENGTH METER, *model FSM-1.* Battery-operated; tunes through 54–216 mc. Covers vhf TV, FM, aircraft, mobile, amateur and other special-service bands. Includes phone jack,

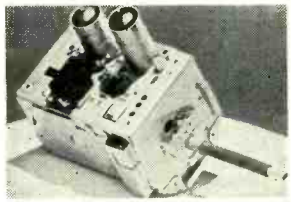


front-panel attenuator switches, pilot lamp, db and percentage AM modulation scales and model MB balun for 300-ohm inputs.—**Blonder - Tongue Laboratories Inc.**, 9-25 Alling St., Newark 2, N. J.

FUSE-CIRCUIT TESTER, *model FS3.* Checks ac, dc or combination of both. Unit connects in place of fuse, fuse resistor or circuit breaker and indicates whether it is safe to make a replacement. Separate scale for each value fuse resistor. Green up to maximum current used by TV manufacturers; red beyond that point. Also reads line-current and power ratings up to 1,100 watts

at 115 volts.—**Service Instruments Corp (Sencore)**, 171 Official Rd., Addison, Ill.

AUTOMATIC FINE TUNER. *Neutrode* turret tuner when linked to special TV set circuitry automatically adjusts fine

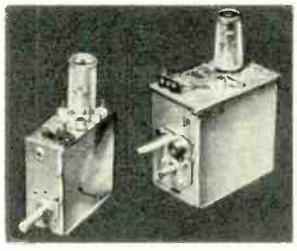


tuning. Oscillator stabilizing circuits end if drift. *Neutrode* feeds drift-correcting signal into oscillator to provide continuously perfect, automatically fine-tuned picture. — **Standard Coil Products Co., Inc.**, 2085 N. Hawthorne, Melrose Park, Ill.

FM TUNER, *LT-60.* 9 tubes plus rectifier. Tuned rf stage, 4 if stages (including dual limiters)

and Foster-Seeley discriminator. Afc insures drift-free operation. Less than 1% harmonic distortion and 3–5-μv sensitivity for 20–30 db of quieting.—**Lafayette Radio,** 165-08 Liberty Ave., Jamaica 33, N. Y.

MINIATURE UHF TUNER (left), almost half the size of previous model (right). For monochrome or color receivers.



Compensates for temperature rise and reduces interference-causing radiation.—**General Instrument Corp.**, 65 Gouverneur St., Newark 4, N. J.

COAXIAL SPEAKER, *model DU-120.* Nominal response: 30–

15,000 cycles. Power rating: 15 watts (British), 30 watts (US). Impedance: 15 ohms. Bass resonance: 40–45 cycles. Crossover frequency: 2,000 cycles. Manufactured by *Vitavox Ltd.* of London, England.—**Ercona Corp.**, Electronic Div., 551 Fifth Ave., New York 17, N. Y.

SPEAKER SYSTEM, *model SY-9.* 3 speakers in a 2-way system

with 2,000-cycle L-C crossover network. Uses Jensen 15-inch woofer and two 5-inch tweeters. Frequency response: 35–15,000 cycles; impedance: 8 ohms. Handles 20 watts. Comes with ¾-inch plywood precut baffle board, 19 x 24 inches, and necessary mounting hardware.—**Lafayette Radio,** 165-08 Liberty Ave., Jamaica 33, N. Y.

SPEAKER SYSTEM, *model HFS-2.* Slot-loaded horn covers 30–200 cycles. Frontal radiation from horn's 8½-inch driver covers 200–6,000 cycles. Separate coaxial-mounted cone tweeter for 6,000–20,000 cycles. Acoustical crossover at 200 cycles; electrical crossover at 6,000 cycles. Handles 30 watts

continuous program material. 36 x 15¾ x 11½ inches. — **Electronic Instrument Co. (EICO),** 33-00 Northern Blvd., Long Island City 1, N. Y.

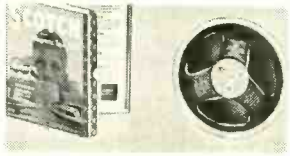
SUPER-TWEETER HORN, *model HR-3.* Frequency response, 2,000–17,500 cycles; impedance, 12–16 ohms; power

(program capacity) 35 watts; weight, 3 pounds. Die-cast acoustic-path parts. — **Atlas Sound Corp.,** 1451 39th St., Brooklyn 18, N. Y.

SPEAKER ENCLOSURES, *Bass-Plane.* For manufacturer's Free-Cone Suspension speakers. Combination of high reactive duct venting and high-resistance diffraction plates discharges the

back wave along a flat wall or in a corner. Wall acts as support plane for propagation of bass wave. — **Stephens Tru-Sonic Inc.,** 8538 Warner Drive, Culver City, Calif.

MAGNETIC TAPE, *Scotch brand No. 200.* Double-play type with ½-mil backing of polyester film treated to double its

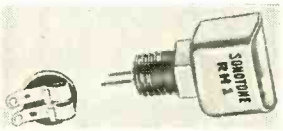


strength. 7- and 10½-inch reels, 2,400 and 4,800 feet, respectively. — **Minnesota Mining & Manufacturing Co.,** 900 Bush Ave., St. Paul 6, Minn.

TAPE RECORDER, *Knight KN-4010.* Push-button controls, 8-watt push-pull amplifier and

transistor preamp. Digital index counter, high-frequency erase and safety interlock to prevent accidental erasure. Loudness compensation. Dual neon indicators show recording level. 3¾- and 7½-inch-per-second speeds. Input for recording from mike, radio or TV. — **Allied Radio Corp.,** 100 N. Western Ave., Chicago 80, Ill.

TAPE-RECORDER HEADS. High-fidelity low-price units.

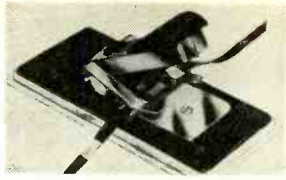


Calibrated to within 3-millionths of inch. Frequency response: 20–15,000 cycles. Smooth, unbroken face adds to tape life. Three types: record-playback, erase dual playback and erase. —**Sonotone Corp.,** Elmsford, N. Y.

TAPE-INDX, a plastic tag with a pressure-sensitive adhesive

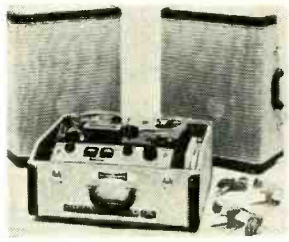
on one side to attach to tape recordings. Identifies start of recording. Accurately spots selection in middle of reel.— **Datrel Co.,** 520 5th Ave., New York 36, N. Y.

TAPE SPLICER, *Irish brand.* For fast, precise tape editing and repair. Makes neat, professional splice. As little as ¼ inch of tape need be removed to make the splice. — **ORRadio Indus-**



tries, Inc., Shamrock Circle, Opelika, Ala.

STEREOPHONIC RECORDING and playback system. *Stereorecorder* tape machine provides both facilities. Response 50–12,000 cycles. Complete editing



and cueing facilities. Comes with 2 matched high-impedance dynamic microphones. Independent channels for preamplification and power amplification. Each channel has separate volume and tone controls. 2 VU meters indicate recording level. Can also be used for monaural, half-track or full-track recording and playback.—**Superscope Inc.,** Audio Electronics Div., 780 Gower St., Hollywood 38, Calif.

TRANSCRIPTION TURNTABLE, *model PK-180.* 4 speeds: 16, 33, 45 and 78 rpm. 10-inch

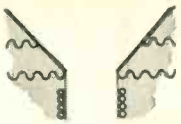
Indisputably the Finest!

UNIVERSITY'S NEW 315-C 3-WAY 15" DIFFAXIAL

This speaker protected by U. S. Patent nos. 2,641,320; 2,690,231; 2,751,996 and other patents pending.

THESE ARE THE REASONS WHY

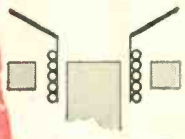
Exclusive self-stabilized woofer cone structure and dual spider construction ensure lifetime centering of moving system, for all extreme excursions.



University-controlled processing of imported cone pulps results in consistently uniform, distortion-free response.

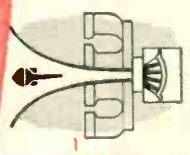
Exclusive, massive flux-contoured 6 pound Gold Dot Alnico 5 magnet provides efficient power drive for deepest low frequencies, free of transient distortion.

Extra-long voice coil ensures purity of maximum low frequency energy conversion during periods of extreme cone excursion.



Exclusive University-formulated long polymer lattice permeates rim suspension for effective acousto-mechanical rim damping.

True through-axial construction permits balanced tweeter, mid-range and woofer acoustic integration without design compromise.

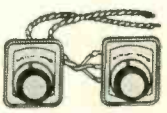


Exclusive hypersonic tweeter incorporating radial phasing equalizer automatically balances all high frequencies for smooth, realistic reproduction.

Exclusive "reciprocating-flare" horn now has wave front equalizer for more uniform wide-angle treble coverage.

Exclusive multi-sectional Diffusicone provides controlled diffraction for linear mid-range response and dispersion.

Continuously variable dual control network integrates and blends mid-range and tweeter for concert realism regardless of room acoustics.



Response: 25 cps to inaudibility; **Power capacity:** 50 watts, integrated program; **Total magnet wt.:** 6½ lbs. Alnico 5; **Impedance:** 8-16 ohms; **Depth:** 12"; **User net:** $156.00.

UNIVERSITY LOUDSPEAKERS, INC., 80 SO. KENSICO AVENUE, WHITE PLAINS, N. Y.

LISTEN *University sounds better*

Duraluminum turntable with extra-heavy rim for flywheel action. Magnetic eddy-current brake permits ±7% variation of each speed, exact speed adjustment. Rim drive, 4-pole induction motor. — **Lafayette Radio,** 165-08 Liberty Ave., Jamaica 33, N. Y.

PICKUP ARM, *model M12 Studio Dynetic.* Handles up to 12-inch records, 1-gram stylus pressure. 0.7-mil diamond stylus for better tracking. Moving-

magnet cartridge, jewel bearings. Frequency response 20–20,000 cycles, ±2 db. 14-mv output.—**Shure Brothers Inc.,** 222 Hartrey Ave., Evanston, Ill.

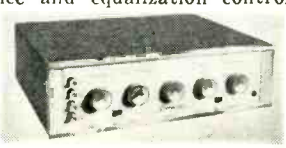
20-WATT AMPLIFIER, *model PA-20.* Frequency response: 20–20,000 cycles. Phono hum level below −60 db at full output. Phono input sensitivity 5–7 mv,

accurate phono equalization. 5 inputs and 3 outputs. Bass, treble, level and loudness controls, and rumble filter.—**General Electric Co.,** Specialty Electronic Components Dept., Auburn, N. Y.

HI-FI AMPLIFIER, *Bantam, Knight KN-515.* Frequency response 20–20,000 cycles within 0.5 db at rated 15-watt output. Harmonic distortion 0.8% at mid-range frequencies. 7 inputs: low- or high-level magnetic

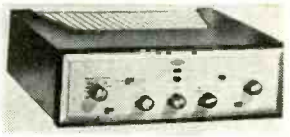
cartridges, ceramic cartridge, TV, tuner or crystal phono, tape head, tape recorder and microphone. 3 compensation positions: Eur, FFRR and RIAA. 4-, 8- or 16-ohm output. —**Allied Radio Corp.,** 100 N. Western Ave., Chicago 80, Ill.

36-WATT HI-FI AMPLIFIER with built-in preamp, *model S-1000 II.* Frequency response at full output: 20–20,000 cycles within 0.5 db. 6 inputs: 2 high gain, 3 high level and tape monitor. Bass, treble, loudness, presence and equalization controls.



Scratch and rumble filters.—**Sherwood Electronic Laboratories Inc.,** 2802 W. Cullom Ave., Chicago 18, Ill.

HI-FI AMPLIFIER–PREAMP, *model 99-D.* 22-watt amplifier, speaker selector switch, tape-recording input and output.

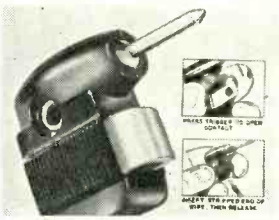


Tape-playback channel. Scratch and rumble filters. Dc on preamp heaters. Bass, treble and loudness controls.—**H. H. Scott Inc.,** 111 Powdermill Rd., Maynard, Mass.

PREAMPLIFIER, *model PA-110.* Converts present amplifier or radio phonograph to operate with variable-reluctance pickup or tape recorder. Frequency response 11–25,000 cycles within 1.5 db. Overall gain 34 db. Noise and hum level −60 db below

10 μv. — **Dynamic Electronics Inc.,** 73-39 Woodhaven Blvd., Forest Hills, N. Y.

SOLDERLESS TEST PROD. To connect to test lead, pull trigger on prod body, insert stripped wire and release trigger. Sold separately or in kits of two (red and black).—**General Cement**



Manufacturing Co., Div. of Textron Inc., 400 S. Wyman St., Rockford, Ill.

TEMPERATURE CONTROL, *No. 40* (for 40-watt soldering irons), *No. 60* (for 60-watt irons). Regulates soldering-iron temperature. Variable from 300–600°. — **Drake Electric Works Inc.,** 3654-56 Lincoln Ave., Chicago 13, Ill.

SAVBIT SOLDER contains small percentage of copper along

with normal tin–lead alloy. Copper soldering-iron tips last longer with its use. 1-pound cartons or 7-pound production reels. — **Multicore Sales Corp.,** 80 Shore Rd., Port Washington, N. Y.

SCREW-HOLDING SCREWDRIVER, *model M5.* Has 3/16-inch blade and holds small screw sizes Nos. 3 through 6. 5¼-inch overall length with insulated handle.—**Hunter Tool Co.,** Box 564, Whittier, Calif. END

BUILD 16 RADIO CIRCUITS AT HOME

with the New Deluxe 1958
PROGRESSIVE RADIO "EDU-KIT"

A COMPLETE RADIO COURSE

only **$22.95**

Reg. U.S. Pat. Off.

Now Also Includes

- ★ TRANSMITTER
- ★ SIGNAL TRACER
- ★ SIGNAL INJECTOR
- ★ CODE OSCILLATOR

- ★ No Knowledge of Radio Necessary
- ★ No Additional Parts or Tools Needed
- ★ EXCELLENT BACKGROUND FOR TV
- ★ School Inquiries Invited
- ★ Attractively Gift Packed

NO NEED TO SPEND HUNDREDS OF DOLLARS FOR A RADIO COURSE

The "Edu-Kit" offers you an outstanding PRACTICAL HOME RADIO COURSE at a rock-bottom price. Our Kit is designed to train Radio & Electronics Technicians, making use of the most modern methods of home training. You will learn radio theory, construction practice and servicing.

You will learn how to build radios, using regular schematics; how to wire and solder in a professional manner; how to service radios. You will work with the standard type of punched metal chassis as well as the latest development of Printed Circuit chassis.

You will learn the basic principles of radio. You will construct, study and work with RF and AF amplifiers and oscillators, detectors, rectifiers, test equipment. You will learn and practice code, using the Progressive Code Oscillator. You will learn and practice trouble-shooting, using the Progressive Signal Tracer, Progressive Signal Injector, Progressive Dynamic Radio & Electronics Tester & the accompanying instructional material.

You will receive training for the Novice, Technician and General Classes of F.C.C. Radio Amateur Licenses. You will build 16 Receiver, Transmitter, Code Oscillator, Signal Tracer and Signal Injector circuits, and learn how to operate them. You will receive an excellent background for Television.

Absolutely no previous knowledge of radio or science is required. The "Edu-Kit" is the product of many years of teaching and engineering experience. The "Edu-Kit" will provide you with a basic education in Electronics and Radio, worth many times the complete price of $22.95. The Signal Tracer alone is worth more than the price of the entire Kit.

THE KIT FOR EVERYONE

You do not need the slightest background in radio or science. Whether you are interested in Radio & Electronics because you want an interesting hobby, a well paying business or a job with a future, you will find the "Edu-Kit" a worth-while investment.

Many thousands of individuals of all ages and backgrounds have successfully used the "Edu-Kit" in more than 79 countries of the world. The "Edu-Kit" has been carefully designed, step by step, so that you cannot make a mistake. The "Edu-Kit" allows you to teach yourself at your own rate. No instructor is necessary.

PROGRESSIVE TEACHING METHOD

The Progressive Radio "Edu-Kit" is the foremost educational radio kit in the world, and is universally accepted as the standard in the field of electronics training. The "Edu-Kit" uses the modern educational principle of "Learn by Doing." Therefore you construct, learn schematics, study theory, practice trouble-shooting—all in a closely integrated program designed to provide an easily-learned, thorough and interesting background in radio.

You begin by examining the various radio parts of the "Edu-Kit." You then learn the function, theory and wiring of these parts. Then you build a simple radio. With this first set you will enjoy listening to regular broadcast stations, learn theory, practice testing and trouble-shooting. Then you build a more advanced radio, learn more advanced theory and techniques. Gradually, in a progressive manner, and at your own rate, you will find yourself constructing more advanced multi-tube radio circuits, and doing work like a professional Radio Technician.

Included in the "Edu-Kit" course are sixteen Receiver, Transmitter, Code Oscillator, Signal Tracer, and Signal Injector circuits. These are not unprofessional "breadboard" experiments, but genuine radio circuits, constructed by means of professional wiring and soldering on metal chassis, plus the new method of radio construction known as "Printed Circuitry." These circuits operate on your regular AC or DC house current.

A COMPLETE RADIO COURSE—NOTHING ELSE TO BUY

You will receive all parts and instructions necessary to build 16 different radio and electronics circuits, each guaranteed to operate. Our Kits contain tubes, tube sockets, variable, electrolytic, mica, ceramic and paper dielectric condensers, resistors, tie strips, coils, hardware, tubing, punched metal chassis, Instruction Manuals, wire, solder, etc.

In addition, you receive Printed Circuit materials, including Printed Circuit chassis, special tube sockets, hardware and instructions. You also receive a useful set of tools, a professional electric soldering iron, and a self-powered Dynamic Radio & Electronics Tester. The "Edu-Kit" also includes Code Instructions and the Progressive Code Oscillator, in addition to F.C.C.-type Questions and Answers for Radio Amateur License training. You will also receive lessons for servicing with the Progressive Signal Tracer and the Progressive Signal Injector, a High Fidelity Guide and a Quiz Book. You receive all parts, tools, instructions, etc. There is nothing else to buy. Everything is yours to keep.

FREE EXTRAS

- **SET OF TOOLS**
- SOLDERING IRON
- ELECTRONICS TESTER
- TESTER INSTRUCTION MANUAL • HIGH FIDELITY GUIDE • QUIZZES • TELEVISION BOOK • RADIO TROUBLE-SHOOTING BOOK • MEMBERSHIP IN RADIO-TV CLUB: CONSULTATION SERVICE • FCC AMATEUR LICENSE TRAINING • PRINTED CIRCUITRY • PLIERS-CUTTERS • ALIGNMENT TOOL • CERTIFICATE OF MERIT • VALUABLE DISCOUNT CARD • WRENCH SET

SERVICING LESSONS

You will learn trouble-shooting and servicing in a progressive manner. You will practice repairs on the sets that you construct. You will learn symptoms and causes of troubles in home, portable and car radios. You will learn how to use the professional Signal Tracer, the unique Signal Injector and the dynamic Radio & Electronics Tester. While you are learning in this practical way, you will be able to do many a repair job for your friends and neighbors, and charge fees which will far exceed the price of the "Edu-Kit." Our Consultation Service will help you with any technical problems you may have.

J. Stataitis, of 25 Poplar Pl., Waterbury, Conn., writes: "I have repaired several sets for my friends, and made money. The "Edu-Kit" paid for itself. I was ready to spend $240 for a Course, but I found your ad and sent for your Kit."

FROM OUR MAIL BAG

Ben Valerio, P .O. Box 21, Magna, Utah: "The Edu-Kits are wonderful. Here I am sending you the questions and also the answers for them. I have been in Radio for the last seven years, but like to work with Radio Kits, and like to build Radio Testing Equipment. I enjoyed every minute I worked with the different kits; the Signal Tracer works fine. Also like to let you know that I feel proud of becoming a member of your Radio-TV Club."

Robert L. Shuff, 1534 Monroe Ave., Huntington, W. Va.: "Thought I would drop you a few lines to say that I received my Edu-Kit, and was really amazed that such a bargain can be had at such a low price. I have already started repairing radios and phonographs. My friends were really surprised to see me get into the swing of it so quickly. The Trouble-shooting Tester that comes with the Kit is really swell, and finds the trouble, if there is any to be found."

PRINTED CIRCUITRY

At no increase in price, the "Edu-Kit" now includes Printed Circuitry. You build a Printed Circuit Signal Injector, a unique servicing instrument that can detect many Radio and TV troubles. This revolutionary new technique of radio construction is now becoming popular in commercial radio and TV sets.

A Printed Circuit is a special insulated chassis on which has been deposited a conducting material which takes the place of wiring. The various parts are merely plugged in and soldered to terminals.

Printed Circuitry forms the very basis of Automation Electronics.

UNCONDITIONAL MONEY-BACK GUARANTEE

ORDER DIRECT FROM AD
RECEIVE FREE BONUS RESISTOR AND CONDENSER KITS WORTH $7.00

☐ Send "Edu-Kit" Postpaid. I enclose full payment of $22.95.
☐ Send "Edu-Kit" C.O.D. I will pay $22.95 plus postage.
☐ Send me FREE additional information describing "Edu-Kit."

Name .....

Address .....

.....

PROGRESSIVE "EDU-KITS" INC.
497 Union Ave., Dept. 137G, Brooklyn 11, N.Y.

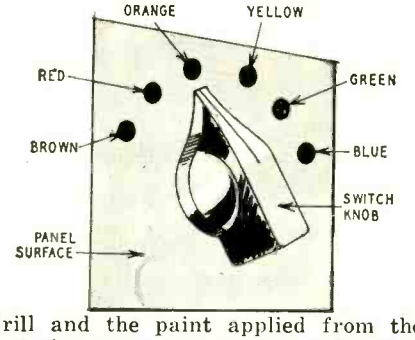
try This one

ROTARY-SWITCH INDEX

An easy way to index a rotary switch so that each position may be readily identified is to use a variety of colors in drilled pits on a panel (see diagram).

Paint in a pit remains longer than on a flat surface and cannot be removed as easily by friction or abrasion.

The pits can be made with a hand



drill and the paint applied from the end of a match. The paint may be made more durable by adding varnish and may be used in a code. For example: position 1, brown; position 2, red, and so on, the same as first figures in a resistor color code.—*Howard Chandler*

BAD TUBES ARE USEFUL

Don't throw all those useless tubes away! A 6SN7-GTB with all but the heater pins removed makes an excellent substitute for the picture-tube heater when firing up a chassis with 600-ma series-string heaters. Just plug the modified 6SN7-GTB into holes 1 and 12 of the picture-tube socket.

As long as the mixer section is good, old converter tubes, with the oscillator's grid pin removed, make a handy substitute for the mixer–oscillator tube in the tuner of a set being aligned. With the oscillator out of action, there is no danger of spurious markers on the if trace.

A set of tubes with just heater pins left intact (kept in tube cartons for easy identification) make it easy to put any stage temporarily out of action in a series set on the bench (for example, replace, the horizontal output tube while hunting for trouble in the oscillator).

Tubes which are already more or less shot because of low emission can be plugged into a stage which is being checked for excessive current drain—better to ruin an old tube than a new one.—*Bob Eldridge*

ANTENNA INTERCOM

Unless you have iron lungs or are capable of mental telepathy, you have

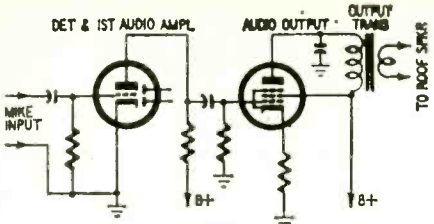


Fig. 1

probably spent considerable time and patience aligning TV antennas. Of course, two-way phones can be used, but they mean an additional expense.

Here's a simple gismo which you can build using parts usually found around the shop. A small ac–dc radio, a microphone, PM speaker and some lead-in wire puts you in business.

The mike is connected to the input grid of the radio's first audio amplifier (Fig. 1). And a hunk of lead-in carries the signal to the speaker on the roof. Disconnect the set's speaker when the mike is used or you'll have a feedback problem. Now, directions can be relayed to the man positioning the antenna.

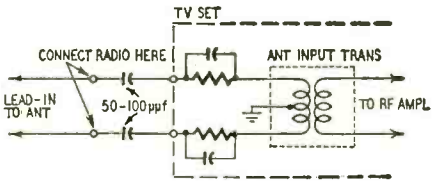


Fig. 2

This system expedites the installation and shows that you are making a definite effort to get a good installation.

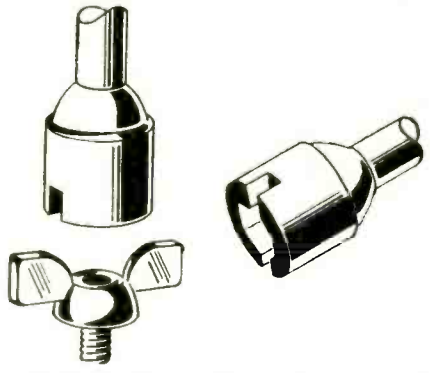
The antenna lead-in can be used to carry the signal to the rooftop speaker as long as the antenna does not have a driven element with continuity. Antenna continuity shorts out the signal.

Then, too, the radio's output must be isolated from the primary of the antenna input transformer in the TV set. To do this, simply insert two capacitors between the lead-in and the TV set (Fig. 2).

Audio quality is not quite hi fi, but "Whoa there, back up some, we're picking up a little snow" or "Right there, hold it, lock it in, that's it" can be easily understood.—*Harold Jones*

WING-NUT DRIVER

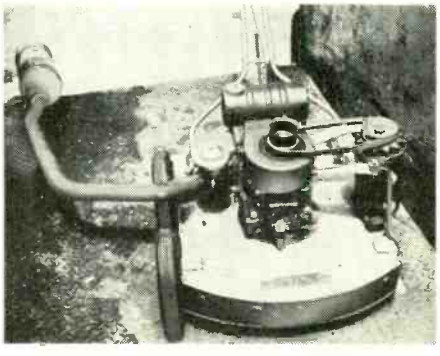
I have found that a slot cut in the end of a ½-inch nut driver is just the thing to speed up work on electronic



equipment where wing nuts are used. This is a lot faster and easier on tempers than trying to use a pair of pliers.—*Robert E. Riddle*

PORTABLE POWER FOR HAMS

When our local radio hams turn out for the conclaves and simulated emergency situations, they rent a trailer and



load aboard a power mower. The motor is belted to a generator to keep battery voltages up. A discarded auto muffler insures quiet operation of the power unit.—*Harry J. Miller* END

"Yes, it looks as if he's getting somewhere with his 3-D TV."

Suggested by Lester Terry, Birmingham, Ala.

Business and People

John Bentia (left), president of Alliance Manufacturing Co., Alliance, Ohio, is shown outlining sales promotion plans for Sessions clocks at a recent meeting in New York. Alliance recently assumed merchandising of the line under an arrangement with Sessions Clock Co., Forestville, Conn.

Arthur L. Chapman, president of CBS-Hytron, Danvers, Mass., announced a separation of the company's activities into two operations. **Robert G. Marchisio** is now vice president and general manager of semiconductor operations, and **Michael Callahan**, vice president and general manager of receiving tube operations.

Joseph F. Degen was appointed to the executive group of Weston Electrical Instrument Co., Newark, N. J., as vice president in charge of manufacturing. He comes to the company from IBM, where he was manufacturing superintendent of the company's Poughkeepsie, N. Y., plant.

William J. Nagy, advertising and sales promotion manager of the Accessory Div. of Philco Corp., Philadelphia, Pa., was promoted to general sales manager of the division.

John M. Malone, electronic equipment sales manager of Tung-Sol Electric Co., Newark, N. J., has been named assistant general sales manager.

Daniel Von Recklinghausen, H. H. Scott, Inc., was named chairman of the Institute of High Fidelity Manufacturers' Subcommittee on Tuners in connection with its standards of Measurement for High-Fidelity Equipment program. Other subcommittee chairmen include: **Dick Shottenfeld**, Pilot Radio Corp., amplifiers; **Abe Cohen**, University Loudspeakers, speakers; **George Silber**, Rek-O-Kut Co., turntables, and **Milton Thalberg**, Audiogersh Corp., record changers.

Crump Smith has been appointed manager of institutional and export advertising for International Telephone

& Telegraph Corp., New York. Since 1943, he has been manager of advertising and sales promotion for the IT&T manufacturing unit, Federal Telephone & Radio Co.

William (Bill) Wennerberg joined Electro-Voice Inc., Buchanan, Mich., as director of the newly formed Marketing Research Div. He comes to the company from Armour & Co.

Joseph S. Ramer joined Heath Co., Benton Harbor, Mich., as engineering advisor. Prior to joining Heath, he was head of the Fuse Dept. of the US Naval Ordnance Laboratory, Corona, Calif.

Donald G. Fink, director of research of the Philco Corp., was elected president of the Institute of Radio Engineers for 1958.

Robert D. Browning joined the research and engineering staff of ORRadio Industries, Opelika, Ala. He was formerly a recording engineer for RCA Victor.

Frank Randall, vice president and general sales manager of Amperex Electronic Corp., Hicksville, N. Y., was elected president of the company.

W. R. Entrikin joined the Electronics Div. of Elgin National Watch Co., Elgin, Ill., as sales manager. He comes to Elgin from Martin Co. where he was a field-service representative. For five years prior, he was general manager in charge of battery development at American Machine & Foundry Co.

James Hervey, director of audio-visual products for American Electronics, Los Angeles, Calif., was promoted to marketing manager in charge of consumer products.

Obituary

Harry F. Randolph, manager of receiving tube operations, for RCA Electron Tube Div., Harrison, N. J., suddenly of a heart attack at the age of 57.

Business

Transistor sales by manufacturers for the first 10 months of 1957 reached 22,386,300 units for a total dollar volume of $56,131,000. This compares with the unit sale of 9,403,000 valued at $27,102,000 for the like period in 1956, according to a report by the EIA (formerly RETMA). Manufacturers' picture-tube sales for January–October, 1957, totaled 8,304,181, and receiving tube sales, 388,738,000. This compares with 9,233,780 and 390,357,000 in the 1956 period.

EIA reports TV production of 5,251,158 for the first 10 months of 1957. Last year TV production for the same period was 6,080,052. Radio production for the 1957 period was 11,945,534, and in 1956, 10,884,760.

Technical Appliance Corp., Sherburne, N. Y., is under way in an all-out promotion on its Taco Golden Topliner TV antenna. The program includes promotion at distributor, service technician and consumer levels. One of the point-of-sale banners is shown here.

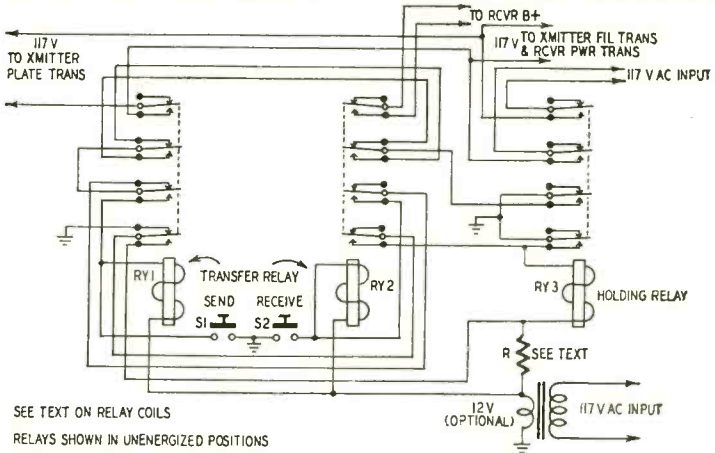
EICO celebrated its 12th anniversary recently with a weekend at the Concord Hotel, Lake Kiamesha, N. Y., for company executives and their wives.

Merit Coil and Transformer Corp., Chicago, recently held cornerstone-laying ceremonies for its new plant being built in Hollywood, Fla. END

radio-electronic Circuits

PUSHBUTTON CONTROLS FOR YOUR HAM STATION

This circuit was designed for complete control of a transmitter and receiver with two pushbutton switches. It requires running only a single three-wire low-voltage cable to the operating position. The switches can be mounted in the mike stand for phone operation.



Assume that the transmitter and receiver are turned off. Pressing S2 energizes transfer relay RY2 and holding relay RY3 so they lock in through their interconnected contacts. RY3 applies line voltage to the primary of the transmitter's filament transformer and to the primary of the receiver's power transformer. RY2 closes the B-plus (standby) circuit in the receiver.

When S1 is pressed in turn, it energizes RY1 and releases RY2. This applies plate voltage to the transmitter and removes B plus from the receiver. Pressing S2 again energizes RY2 and releases RY1, thus throwing the transmitter to standby and the receiver to listen.

The coils of RY1 and RY2 have equal resistances. Resistor R and RY3's coil are each half the resistance of RY1's coil. RY1 and RY2 may be identical 12-volt relays and RY3 may be a 6-volt type. R then equals RY3's resistance. A 12-volt battery may be used in place of the transformer.

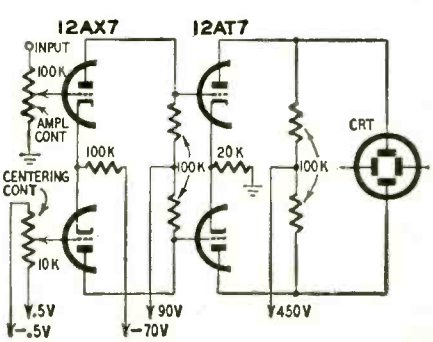
To close down the station, depress both switches simultaneously and then release S2 and S1 in that order. This releases holding relay RY3 and removes primary power from all circuits.—*L. M. Dilley*

DIRECT-COUPLED AMPLIFIER

The difficulty with direct-coupled amplifiers is that any unwanted variation of voltage, due to drift in the supply voltages to the input stage, for example, appears amplified at the output and can be very troublesome.

When it is necessary to amplify all frequencies down to and including zero and when direct-coupled circuits are a must, a neat solution to the problem is to use a symmetrical amplifier. All accidental variations are then simultaneously applied to both symmetrical halves of the amplifier and cancel at the output. The signal, however, is applied to one input grid only and appears normally amplified at the output.

A practical circuit, using two double-triodes, is shown in the diagram. It appeared in *Elektronik*. The amplifier's stability increases with the value of the cathode resistor. The input stage then uses a 100,000-ohm cathode resistor and, to obtain correct bias with the input grounded on one side, it is connected to a −70-volt supply. The input signal applied between one grid and ground through a 100,000-ohm amplitude-control potentiometer. The other input grid is connected to a variable dc voltage of 0.5 to −0.5. This provides a centering control when the amplifier is used in an



oscilloscope. The circuit can be suppressed if necessary, the grid being then simply tied to the ground. The plate loads for the input stage are 100,000-ohm resistors. The anodes are then at approximately 50 volts, and are connected directly to the grids of the output stage.

For this stage, correct bias is obtained with a 20,000-ohm resistor returning to ground. The plates are connected to 450 volts, through 100,000-ohm load resistors. The output is taken from plate to plate. For an oscilloscope, the deflection plates are tied to the output stage anodes, which are at approximately 270 volts.

All supply voltages can be obtained from a single 525-volt source. They can be stabilized advantageously, specially for the input stage.

This amplifier has a bandwidth of 0–10,000 cycles and a gain of about 1,000. Peak-to-peak undistorted output voltage is 200.—*A. V. J. Martin.*

WINDOW ALARM

This alarm protects windows that must be left open. Its operation is simple. When the alarm wire is broken, the transistor draws more current, the relay closes and the alarm (I used a doorbell) goes off. A CK722 is used in a grounded-emitter circuit, with its base shorted to the emitter by the alarm wire. With 6 volts applied to the circuit (see Fig. 1) the transistor

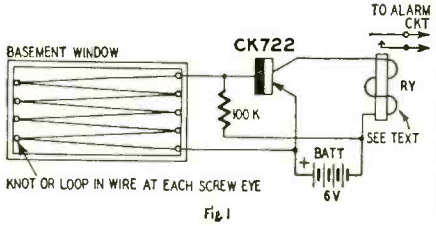


Fig. 1

draws about 55 μa. When the alarm wire is broken, it draws a little more than 2 ma. The base is biased by the 100,000-ohm resistor connected to the negative side of the battery. This bias is applied when the alarm wire is broken.

A 6-volt battery or a power supply (see Fig. 2) powers the circuit. If you decide to use batteries, remember there is a constant 55-μa drain and do not use flashlight type cells.

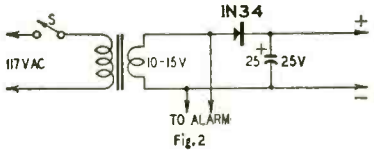


Fig. 2

The relay is small meter relay that operates on 0.5 ma at 3 volts. Any relay with a pull-in at 1 ma or less can be used. The alarm wire is fine enough to be easily broken, yet strong enough to stay up. (No. 30 is about right.) Where it goes through the screweyes, either a knot is tied or another loop is made so the screw cannot be removed without breaking the wire.—*W. G. Eslick* END

technical Literature

Any or all of these catalogs, bulletins, or periodicals are available to you on request direct to the manufacturers, whose addresses are listed at the end of each item. Use your letterhead—do not use postcards. To facilitate identification, mention the issue and page of RADIO-ELECTRONICS on which the item appears. UNLESS OTHERWISE STATED, ALL ITEMS ARE GRATIS. ALL LITERATURE OFFERS ARE VOID AFTER SIX MONTHS.

MASTER INDEX lists all television and radio material covered in this firm's service manuals, pinpointing volume and page containing the desired information. —**Supreme Publications**, 1760 Balsam Rd., Highland Park, Ill. 5c for RADIO-ELECTRONICS readers.

LAMP CHART compiled by United Catalog Publishers is a complete listing, numerically arranged, of panel and flashlight lamps manufactured by 7 firms. By checking lamp numbers, the user can determine the manufacturer's bulb type, base, voltage, amps and bead color. — **Radio-Electronic Master**, 60 Madison Ave., Hempstead, N. Y.

PRINTED-CIRCUIT RESIST, a coating which facilitates production of printed-circuit boards, is detailed in a 3-page leaflet. How to use the product and theory behind the way it works are indicated. — **LePage's Inc.**, Gloucester, Mass.

ELECTRON TUBES, test equipment, batteries, transistors and semiconductor diodes are listed among the 216 pages of the 1958 edition of RCA Pocket Reference Book. Important data for each are included. The book has, also, interchangeability directories for tubes, transistors and batteries. — **Available through RCA distributors.**

OSCILLOSCOPE RECORDING UNITS are offered in a 16-page illustrated catalog. Items described include 1-, 2-, 4-, 6- and 8-channel systems; plug-in preamplifiers; systems for analog computer readout, and a group of accessory units. —**Sanborn Co.**, Industrial Div., 175 Wyman St., Waltham 54, Mass.

ACOUSTIC SUSPENSION design is briefly explained in a 4-page booklet on the AR-2 speaker system which also offers harmonic distortion and frequency response curves for the AR-2.— **Acoustic Research Inc.**, 24 Thorndike St., Cambridge 41, Mass.

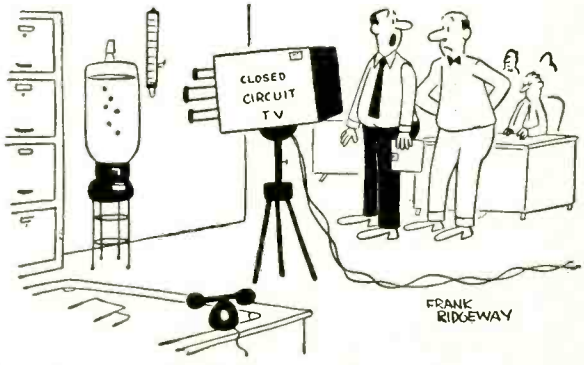
SPEAKER-ENCLOSURE KITS. *Kwikits* for 12- and 15-inch speakers and multi-speaker systems are detailed in a pocket-sized folder. Specifications and prices, along with a display of speakers that can be used with the enclosures, are included. — **University Loudspeakers Inc.**, 80 S. Kensico Ave., White Plains, N. Y.

INDOOR ANTENNAS and TV accessories are presented in two brochures. A 6-page 4-color pamphlet describes and illustrates this manufacturer's complete line of indoor antennas. A second folder covers the firms expanded line of TV accessories such as set couplers, wavetraps, antenna isolators, etc.—**JFD Manufacturing Co. Inc.**, 6101 16th Ave., Brooklyn 4, N. Y.

TEST INSTRUMENTS for radio–TV servicing, such as tube checkers, scanners and other specialized equipment, are displayed in *Bulletin No. AP10.*—**B & K Manufacturing Co.**, 3726 N. Southport Ave., Chicago 13, Ill.

HIGH-FIDELITY COMPONENTS are offered in a two-color folder which illustrates the units and contains appropriate technical information. Three amplifiers, 5 tuners, a turntable and 2 power amplifiers are included.—**H. H. Scott**, 111 Powdermill Rd., Maynard, Mass.

PACKAGED ELECTRONIC CIRCUIT *Guide No. 4* contains schematics and specifications on all 96 types of printed-electronic circuits (PEC's) made by this manufacturer. A complete cross-reference section which lists the manufacturer's part number of all packaged circuits used by 130 radio and TV manu-



"All I know is that the wires lead into the boss' office!"

facturers since 1949 and the corresponding replacement is included. Another subdivision shows the proper test procedure for checking all listed packaged circuits. — **Centralab**, Div. of Globe-Union Inc., 900 Keefe Ave., Milwaukee 1, Wis.

COIL REPLACEMENT GUIDE *No. 158* lists more than 2,000 TV chassis and 11,000 TV model numbers and cross-references the set manufacturer's coil number with the replacement number in its 72-pages. —**J. W. Miller Co.**, 5917 S. Main St., Los Angeles 3, Calif.

GENERAL CATALOG *ARC-7* lists complete line of electronic components imported or manufactured by this company. Miniature transistor components, phonograph pickup arms, microphones and multitesters, accompanied by illustrations and brief descriptions, are covered in its 12 pages.—**Argonne Electronics Manufacturing Corp.**, 165-11 South Road, Jamaica 33, N. Y.

ELECTRONIC EQUIPMENT for industrial and research uses is detailed in a 2-color 8-page brochure which presents dc power supplies, ac line-voltage regulators, digital readout voltmeters and meter calibrators in its coverage.—**Davenport Manufacturing Co.**, 1713 N. Ashland Ave., Chicago 22, Ill.

TRANSISTOR NEWS is presented in *Philco Small Signals*, a bimonthly publication. *Vol. 1, No. 2* contains details of the MADT, a transistor capable of 10-db gain at 200 mc, as well as many other interesting items.—**Philco Corp.**, Lansdale Tube Co. Div., Lansdale, Pa.

SELENIUM RECTIFIERS, industrial type *Petti-Sel*, ratings and dimensions are listed in *Bulletin No. 248A*. Data on uprating the rectifiers when forced-air-cooled is also presented.—**Radio Receptor Co., Inc.**, 240 Wythe Ave., Brooklyn 11, N. Y.

PANORAMIC ANALYZER, published occasionally, contains interesting information on the use of many laboratory instruments. Also available is this manufacturer's *Catalog Digest*, which contains detailed specifications of many types of waveform and spectrum analyzers, telemetering test instruments and special accessories. — **Panoramic Radio Products Inc.**, 520 S. Fulton Ave., Mt. Vernon, N. Y.

TELEVISION FUSE CHART presents a listing arranged by TV set model or chassis, showing the fuses used and how they are mounted. Answers the which-fuse question.—**Bussman Manufacturing Co.**, McGraw-Edison Co., University at Jefferson, St. Louis 7, Mo.

METERS AND METER COMPONENTS are described and illustrated in a 4-page brochure. *Catalog 22* lists dimensions, ranges and internal resistances.—**Ideal Precision Meter Co., Inc.**, 126 Greenpoint Ave., Brooklyn 22, N.Y. END

Books

HIGH FIDELITY SIMPLIFIED, 3rd Edition, by Harold D. Weiler. John F. Rider Publisher Inc., 116 W. 14th St., New York 11, N. Y. 5½ x 8½ inches, 216 pages. $2.50.

For the beginning hi-fi fan who wants to know the how and why of his equipment. Explains what hi fi is and how your system reproduces it. Shows how to use your components to get the utmost performance.

Substantial revisions have been made in this edition. Many older models of hi-fi equipment have been removed and new ones added. Separate chapters cover speakers, speaker enclosures, the amplifier, the record player, tuners and tape recorders. Written for the non-technical reader.—*LS*

AN INTRODUCTION TO JUNCTION TRANSISTOR THEORY, by R. D. Middlebrook. John Wiley & Sons, Inc., 440 Fourth Ave., New York, N. Y. 6 x 9 inches, 296 pages. $8.50.

To understand a transistor, one must learn the complicated behavior of charges inside a crystal. It is not an easy subject. This book attempts to clarify it for the electronic engineer. It provides clear physical descriptions as well as mathematical analysis.

A good knowledge of mathematics is needed to appreciate the book fully, although much can be learned without it.

ELECTRICITY and ELECTRONICS—Basic, by William B. Steinberg and Walter B. Ford. American Technical Society, 848 E. 58 St., Chicago 37, Ill. 245 pages, 6 x 9 inches. $4.50.

Any junior ham operator, young student or nontechnical (but curious) friend will probably thank you for calling his attention to this book. It is an interesting presentation of the highlights of radio and electrical circuits. It explains fuses, buzzers, magnetism, radio, and tells how to solder. Among how-to-build projects are: tin-can motor, simple radios, toy telephone and light meter.—*IQ*

ESSENTIALS OF TELEVISION by Morris Slurzberg, William Osterheld and Elmo N. Voegtlin. McGraw-Hill Book Co., Inc., 330 W. 42 St., New York 36, N. Y. 9 x 6 inches, 687 pages. $8.50.

A comprehensive guide to the theory and operation of electronic circuits and their application in television receivers. Written in a clear, easy-to-understand manner, only high-school level math and a knowledge of basic circuit elements and circuit applications is needed to make full use of the text.

The first chapters cover the basic principles of television. Later chapters present detailed descriptions of all circuits found in the TV receiver. Color TV, uhf circuits and antennas are also discussed. The appendix contains listings of TV channel frequencies, picture-tube characteristics, sine and cosine tables and an abbreviated logarithm table.—*LS*

THE CATHODE-RAY OSCILLOSCOPE, by J. Czech. Philips Technical Library; distributed by Interscience Publishers, Inc., 250 Fifth Ave., New York 1, N. Y. 6 x 9 inches, 340 pages, $8.50.

Contains a clear explanation of the oscilloscope's workings and applications. One part is devoted to instructions for design and construction and a time-base expansion unit. What makes this book remarkable, however, is inclusion of data not ordinarily found in such books. It shows how to measure impedance, capacitance, shutter action and timing with a scope. There are also circuits for generating circular, spiral, dot and cycloid patterns for measuring very large frequency ratios.

TRANSISTOR AF AMPLIFIERS, by D. D. Jones and R. A. Hilbourne. Philosophical Library, Inc., 15 E. 40th St., New York 16, N. Y. 5½ x 8½ inches, 152 pages. $6.

By limiting their transistor book to *only* audio amplifiers, these authors are able to cover their ground thoroughly. The book begins with fundamental theory: bias and thermal stabilization, gain and impedance formulas, equivalent networks. Thereafter, it confines itself to the practical design of amplifier circuits. The busy designer will find the equation he needs, presented without derivation or proof. —*IQ*

ATOMIC RADIATION. Prepared by RCA Service Co., Inc., (Reprinted by permission of Wright Air Development Center, USAF). Camden 8, N.J. 8½ x 11 inches, 120 pages. $1.60.

The release of atomic energy represents a major breakthrough in man's effort to master the universe. Like fire and electricity, however, radiation must be properly controlled or it may become a dangerous enemy. It is invisible and painless, yet may inflict long-range injury or death. This booklet is the result of research for the Air Force. It is written to safeguard the growing army of nuclear scientists and technicians.

The book is complete and understand-

able for all levels of radiation workers. The initial chapter tells of particles, fission, fusion, istotopes, cosmic rays, etc. Under "biological effects" it explains normal and abnormal cell division and describes the effects of injury to the skin, blood or organs. Correct shielding, protective devices and permissible dosage are covered. An important chapter details the latest medical treatment for radiation sickness, burns, wounds and infections.—*IQ*

ADDITIONAL 1957 TELEVISION SERVICING INFORMATION (Vol. TV-13), compiled by M. N. Beitman. Supreme Publications, 1760 Balsam Road, Highland Park, Ill. 8½ x 11 inches, 292 pages. $3.

The second volume of original manufacturers' circuit diagrams and service information for 1957 TV sets covers over 500 models and chassis of 15 brands.

STEREOPHONIC SOUND, by Norman Crowhurst. John F. Rider Publisher, Inc. 116 W. 14 St., New York, N.Y. 5½ x 8½ inches. 118 pages. $2.25.

In an interesting easy-to-read style, the author takes the reader through the theory of stereophonic sound and describes the various systems developed for disc, tape, radio and movies. He also covers the selection and placement of speakers for stereophonic reproduction.—*RFS*

RADIO VALVE DATA, compiled by staff of Wireless World. Iliffe & Sons Ltd., London, England. (Available in U.S. from British Radio Electronics Ltd., 1833 Jefferson Place, N.W., Washington 6, D.C.) 8½ x 11 inches, 126 pages. $1.50.

A manual giving the characteristics and base connections for approximately 2,500 British and American receiving tubes, 300 C-R tubes and 37 transistors. The book is divided into sections for voltage regulators, tuning indicators, damper tubes, rectifiers and similar tube classifications to simplify its use. A complete index and table of British-American equivalents are included.

TV ANTENNAS, by Martin Schwartz. American Electronics Co., 1203-05 Bryant Ave., New York 59, N.Y. 6 x 9 inches, 28 pages. 50c.

A nontechnical manual designed to guide the layman in the selection, installation and repair of TV receiving antennas.

FREQUENCY-MODULATED RADIO, by K. R. Spurley, Macmillian Co., 60 5th Ave., New York, N.Y. 5 x 7½ inches, 120 pages. $3.

Despite its comparatively small size, this book does a good job of covering the general principles and theory of FM and the design, construction and servicing of FM broadcast receivers. Each stage of the receiver is discussed in detail and the most common circuit variations are illustrated. Values are

not given on the diagrams but the text often lists the acceptable limits of critical components and describes the symptoms that develop when components are outside the listed tolerances. Instructions are given for aligning and troubleshooting FM receiver circuits with a minimum of test equipment.

RCA VICTOR 1957–58 TELEVISION SERVICING INFORMATION. Supreme Publications, 1760 Balsam Road, Highland Park, Ill. 8½ x 11 inches, 95 pages. $1.50.

A compilation of original RCA service data on 68 1957–58 TV receiver models using 26 different chassis.

AUDIO AMPLIFIERS AND ASSOCIATED EQUIPMENT (Vol. 9). Compiled and published by Howard W. Sams & Co., Indianapolis 5, Ind. 8½ x 11 inches. 226 pages. $3.95.

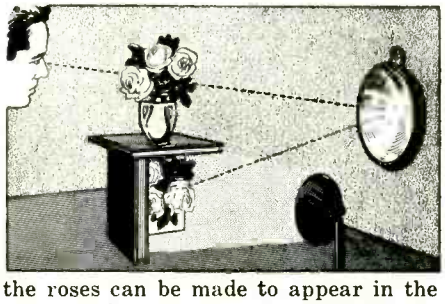
The ninth volume in a series of service manuals consisting of compilations of Photofact folders covering audio amplifiers and tuners. This volume has diagrams, photographs, parts lists and other service data on 18 amplifiers of different brands and 17 tuners by 10 manufacturers.—*RFS*

ELECTRONIC COMPONENTS HANDBOOK, edited by Keith Henney and Craig Walsh. McGraw-Hill Book Co., 330 W. 42 St., New York, N.Y. 8½ x 11 inches, 244 pages. $9.

A guide book to assist designers in selecting the best-suited resistors, capacitors, relays and switches for maximum reliability in military and commercial electronic equipment. It describes in detail the various types of components and lists the effects that heat, humidity, high altitude, shock, vibration and other unfavorable conditions have on each. END

HOW PHANTOMS ARE MADE

The drawing shows how such a "phantom image" as mentioned in Mr. Gernsback's editorial can be projected. In this well known magicians' illusion,



the roses can be made to appear in the vase, or disappear, as the light illuminating them is switched on or off. In another illusion, less easy to illustrate here, the head and bust of a young lady assistant are projected in such a manner that they appear on the top of a thin-legged table, as if sheared off from the body. Possibly our future *phantomcasting* will use similar economy, projecting only the head of a news commentator or the legs of a dancer.

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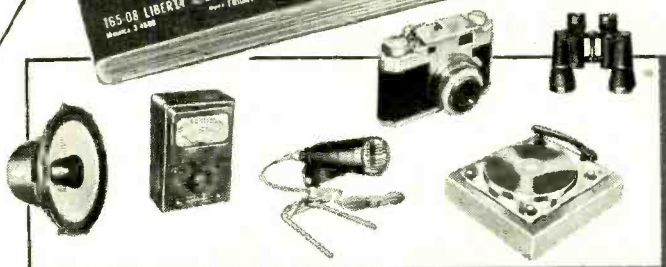

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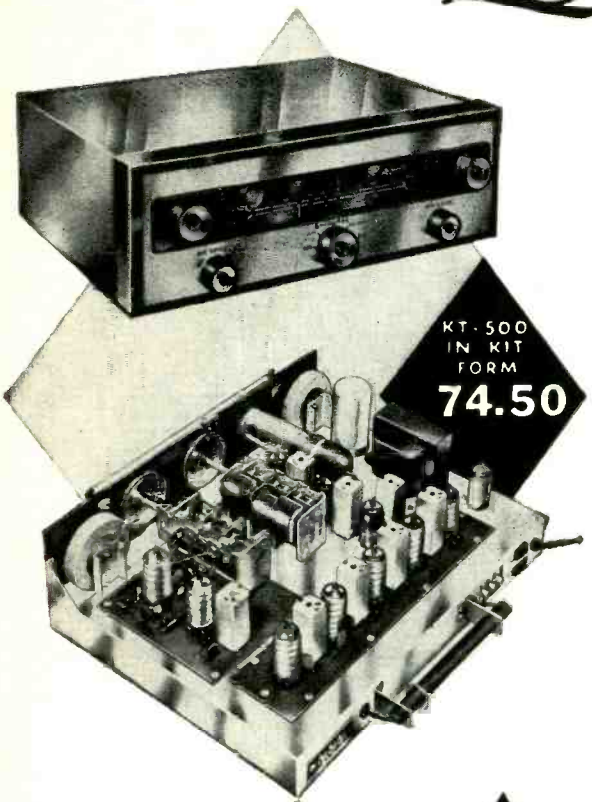

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More than a year of research, planning and engineering went into the making of the Lafayette Stereo Tuner. Its unique flexibility permits the reception of binaural broadcasting (simultaneous transmission on both FM and AM), the independent operation of both the FM and AM sections at the same time, and the ordinary reception of either FM or AM. The AM and FM sections are separately tuned, each with a separate 3-gang tuning condenser, separate flywheel tuning and separate volume control for proper balancing when used for binaural programs. Simplified accurate knife-edge tuning is provided by magic eye which operates independently on FM and AM. Automatic frequency control "locks in" FM signal permanently. Aside from its unique flexibility, this is, above all else, a quality high-fidelity tuner incorporating features found exclusively in the highest priced tuners.

FM specifications include grounded-grid triode low noise front end with triode mixer, double-tuned dual limiters with Foster-Seeley discriminator, less than 1% harmonic distortion, frequency response 20-20,000 cps ± ½ db, full 200 kc bandwidth and sensitivity of 2 microvolts for 30 db quieting with full limiting at one microvolt. AM specifications include 3 stages of AVC, 10 kc whistle filter, built-in ferrite loop antenna, less than 1% harmonic distortion, sensitivity of 5 microvolts, 8 kc bandwidth and frequency response 20-5000 cps ± 3 db.

The 5 controls of the KT-500 are FM Volume, AM Volume, FM Tuning, AM Tuning and 5-position Function Selector Switch. Tastefully styled with gold-brass escutcheon having dark maroon background plus matching maroon knobs with gold inserts. The Lafayette Stereo Tuner was designed with the builder in mind. Two separate printed circuit boards make construction and wiring simple, even for such a complex unit. Complete kit includes all parts and metal cover, a step-by-step instruction manual, schematic and pictorial diagrams. Size is 13¾" W x 10⅜" D x 4½" H. Shpg. wt., 18 lbs.

The new Lafayette Model KT-500 Stereo FM-AM Tuner is a companion piece to the Models KT-300 Audio Control Center Kit and KT-400 70-watt Basic Amplifier Kit and the "Triumvirate" of these 3 units form the heart of a top quality stereo hi-fi system.

KT-500.....Net **74.50**

LAFAYETTE MASTER AUDIO CONTROL CENTER with BINAURAL CHANNEL AND DUAL VOLUME CONTROLS

- **Self-Powered**
- **DC On All Filaments**
- **24 Positions of Equalization**
- **Tape Head Input, High Impedance**
- **Dual Cathode Follower Output Stages**

This is not only the finest hi-fi preamp characterized by unmatched features, but it has been functionally designed to keep pace with the conversion of your present hi-fi system to binaural (Stereophonic) sound. Incorporates an extra channel and dual volume control for binaural reproduction. Features include DC on all tube filaments, negative feedback in every stage, dual cathode follower output stages and latest printed circuit construction. Less than 0.09% IM distortion and less than 0.07 harmonic distortion at 1V. Hum and noise level better than 80 db below 3V. Uniformly flat frequency response over entire audible spectrum. 7 inputs for every type of phono, tuner or tape. Tasteful styling, brilliantly executed. Size 12¾ x 9⅛ x 3¾". Shpg. wt., 10½ lbs.

KT-300—Lafayette Master Audio Control Kit Complete with cage and detailed assembly instructions. ..... Net **39.50**

LT-30—Same as above completely wired and tested with cage and instruction manual.
Net **59.50**

DELUXE 70 WATT BASIC AMPLIFIER

- **Conservatively Rated At 70 Watts**
- **Inverse Feedback**
- **Variable Damping**
- **Metered Balance And Bias Adjust Controls**
- **Available In Kit and Wired Form**

Here's ultra-stability in a 70 watt basic power amplifier employing highest quality components conservatively rated to insure performance and long life. Features matched pair KT 88's and wire range linear Chicago output transformer, variable damping control, meter for bias and balance and gold finish chassis. Frequency response 10-100,000 cps ± 1db. Hum and noise 90 db below full output. IM distortion less than 1½% at 70 watts, less than 0.3% below 30 watts. Harmonic distortion less than 2% at 70 watts from 20 to 20,000 cps ± 1 db. Output impedance 4, 8 and 16 ohms. Handsome decorative cage perforated for proper ventilation. Size 14½ x 10 x 7⅜" including cage and knobs. Shpg. wt., 40 lbs.

KT-400—Lafayette 70 watt Deluxe Basic Amplifier Kit complete with cage and detailed assembly instructions. .....Net **69.50**

LA-70—Same as above completely wired and tested with cage and instruction manual.
Net **94.50**

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100 SIXTH AVE., NEW YORK, N. Y.
NEWARK, N. J., 24 Central Ave. BOSTON, MASS., 110 Federal St.
BRONX, N. Y., 542 E. Fordham Rd. PLAINFIELD, N. J., 139 West 2nd St.

Exclusive Lafayette Money-Saving Values

PROFESSIONAL TRANSCRIPTION TURNTABLE AND VISCOUS-DAMPED TONE ARM

THE FINEST TRANSCRIPTION TURNTABLE AND TONE ARM FOR THE PROFESSIONAL USER AND THE AUDIOPHILE

PK-300 TURNTABLE, PK-90 TONE ARM AND G.E. CARTRIDGE WITH GENUINE DIAMOND AND SAPPHIRE STYLI.

72.50

PK-300

ILLUMINATED BUILT-IN STROBOSCOPE & VIEWER

COMBINATION DEAL

PK-90

PK-300 TRANSCRIPTION TURNTABLE

New 4-speed instrument with built-in stroboscope and viewer for exact speed determination, and magnetic brake for instantaneous speed variation. Precision engineered to meet professional standards for wow, rumble and flutter content. Heavy 12" cast aluminum rim-driven turntable. Variable speed control permits adjustment of each speed within ± 7% using efficient frictionless magnetic brake. Heavy-duty constant speed 4-pole induction motor freely suspended and isolated by shock-mountings to eliminate vibration transferral. R-C filter network suppresses "pop" in speaker. Truly a delight for the connoisseur. Size: 13½" x 14" and requires 2¾" clearance above and 3¾" below motorboard. For 110-130V and 60/50 cycle AC. Power consumption 12 watts. Handsome hammertone gray finish. Shpg. wt., 20 lbs.

PK-300 ..... Net **49.50**

PK-90 VISCOUS-DAMPED TONE ARM

This transcription arm assures dependable and stable operation, utilizing the "floating action" principle of "viscous-damping." The arm is supported at a single point by a pivot and jewel bearing having negligible friction. Damping is accomplished by a silicone fluid occupying the gap between a ball and socket. This damping control permits high compliance and negligible tracking error, and prevents damage to either record or stylus should the tone arm be accidentally dropped. Low frequency resonance, skidding and groove-jumping are likewise minimized. The tone arm accepts all records up to 16" and accommodates virtually all hi-fi cartridges by means of precisely engineered adapters which simplify installation and provide proper stylus pressure.
This tone arm is a quality companion to the PK-300 with matching finish. Shpg. wt. 2½ lbs.

PK-90 ..... Net **11.95**

TRANSCRIPTION MANUAL PLAYER

with TONE ARM and TWO PLUG-IN HEADS

PK-160

- MAGNETIC BRAKE FOR FINE ADJUSTMENT OF EACH SPEED
- 4-POLE, HEAVY DUTY TRANSCRIPTION-TYPE MOTOR
- ACCOMMODATES ALL POPULAR CARTRIDGES
- STYLUS WEIGHT ADJUSTMENT SCREW ON TONE ARM

All the important features of professional transcription players have been incorporated in this precision turntable. Extremely smooth and quiet heavy duty 4-pole motor plays 78, 45 and 33⅓ RPM records. Exclusive magnetic brake, controlled by knob on base plate, permits instantaneous fine adjustment of each speed. Stroboscope disc included checks speeds. Speed selector safety switch protects mechanism by making it necessary to pass through OFF position when switching from one speed to another. 10" weighted turntable has rubber traction mat.

Mounting plate has pickup rest and ON-OFF switch. Size 12-15/16" left to right. 10⅞" front to rear. Requires 2¾" clearance below motor board and 3" above. With AC line cord, 2 plug-in heads, output cable, 45 RPM adapter. For 105-120V., 60 cycles AC. Shpg. wt., 12 lbs. *(NOTE: For protection in shipping, tone arm is separate. Just fasten to mounting plate.)*

PK-160— Less cartridge and base ..... Net **25.95**

PK-164—Same as above except equipped with new genuine GE VRII Triple Play Magnetic Cartridge with diamond-sapphire cartridge ..... Net **37.50**

PK-162—Wood base for PK-160. Shpg. wt., 5 lbs. ..... Net **3.95**

PK-163—Unfinished mounting board only. Shpg. wt., 1 lb. ..... Net **.95**

TV-FM SWEEP & MARKER ALIGNMENT GENERATOR

Compare it with instruments at twice the price!

- SWEEP RANGE 3MC-260MC
- MARKER RANGE 3MC-225MC
- COMBINATION CRYSTAL AND VARIABLE MARKER—1% ACCURATE
- SUPPLIED WITH 4.5MC CRYSTAL 0.002% ACCURATE
- SWEEP WIDTH 0-12MC CONTINUOUSLY VARIABLE
- 2-5" DIALS

LSG-50 79.50
FACTORY WIRED AND TESTED

The Lafayette LSG-50 is a factory-wired and calibrated precision instrument for fast alignment of IF and RF stages of TV and FM receivers. Accurate, linear electromagnetic sweep system covers 3MC-120MC and 140MC-260MC. Sweep width continuously variable 0-12MC. 3 volts RMS, 60 cps sine wave (for oscilloscope) available from front panel. Marker covers 3MC-225MC in 4 ranges. Combination of crystal and variable marking. Marker calibration accuracy better than 1%. 4.5MC crystal mounts on front panel and accurate to 0.002%. Extra input for external marker. The built-in marker may be used independently of the sweep. RF output 100,000 microvolts, controlled by 3-step (X1, X10, X100) and continuously-variable fine adjustment attenuators. Output impedance 75 ohms, unbalanced. CONTROLS: Sweep Width, Horizontal Phase, Retrace Blanking with Off position, Marker Amplifier, RF Attenuators, Sweep Range Selector, Marker Range Selector. Crystal socket, pilot light, external marker input also on front panel. 2-5" easy-to-read dials with vernier-driven dial pointers. Sturdy gray wrinkle metal cabinet with handle. Complete with tubes, 75 ohm output and external marker input cables, 4.5MC crystal. Size 9" x 13½" x 6". Shpg. wt., 20 lbs.

MODEL LSG-50 ..... Net **79.50**

6 TRANSISTOR SUPERHET RECEIVER KIT

- 100% SUBMINIATURIZED
- SENSITIVE, SELECTIVE, STABLE
- PUSH-PULL OUTPUT — PLENTY OF POWER
- AN INCOMPARABLE VALUE

The Lafayette KT-119 6 Transistor Superhet Transistor Kit provides superior commercial quality with maximum sensitivity, selectivity and stability. The circuit features 6 selected transistors and crystal diode, a specially matched set of 3 IF's, Oscillator coil, high Q loop, and audio transformer coupling. Has efficient 2¾" speaker and earphone jack for private listening. Complete with all parts, transistors, pre-punched chassis and easy to follow step-by-step instructions. 6½" x 3½" x 1½". Shpg. wt., 3 lbs.

KT-119—Complete Kit—Less Case & Battery ..... Net **29.95**

BATTERY RCA VS300 ..... Net **1.23** BURGESS P6 ..... Net **.77**

MS-339—Sturdy, attractive brown leather case with carrying strap for KT-119. Shpg. wt., 1 lb. ..... Net **2.95**

MS-366—Sensitive matching earphone Net **1.29**

NEW POCKET AC-DC VOM MULTITESTER

2,000 ohm per volt sensitivity on both DC and AC
160 ua 3" METER 1% PRECISION RESISTORS
SILVER CONTACT SELECTOR SWITCH
FULL SCALE RANGES

D.C. Volts: 0-10; 0-50; 0-500; 0-1000 Volts—A.C. Volts: 0-10; 0-50; 0-500; 0-1000 volts—D.C. Current: 500 ua and 500 ma—Resistance: 0-10K; 0-1 Meg—Decibels: —20 to +22; +20 to 36 db (0 db—0.775 V)—Capacity: 250 mmfd. to .2 mfd—.005 mfd to 1 mfd—Output Ranges: 0-10; 0-50; 0-500; 0-1000 volts.

Best Buy in America! A very accurate and sensitive VOM. This Multitester is a complete instrument (not a kit) with high quality and sensitive 160 microamp meter; 2000 ohm per volt on both AC and DC. Single selector switch, 1% precision resistors, 3" meter. Features extreme versatility, accuracy and ruggedness. In attractive plastic front panel, with metal bottom for ruggedness and shielding. First capacity range requires 50 volt AC source. Second capacity range requires 10 volt AC source. Size 4¼" x 3½" x 1⅝". Complete with test leads and batteries. Shipping weight 4 lbs.

RW-27A ..... Complete **8.95**

Nationally Advertised

4-SPEED AUTOMATIC RECORD CHANGER

39.50 ~~Reg. 50.50~~

with NEW G.E. TURNOVER CARTRIDGE VRII and GENUINE G.E. DIAMOND SAPPHIRE SYTLI

GE VRII DIAMOND and SAPPHIRE STYLI

NOT A CLOSEOUT—NOT A DISCONTINUED Model, this is a nationally advertised, latest model record changer, with new GE VRII Series Triple Play Cartridge with G. E. Genuine diamond and sapphire styli and is priced so low that we DARE NOT mention the manufacturer's name. This fully automatic record changer has exclusive and deluxe features for the finest hi-fi systems, such as automatic intermix, muting switch, click filter and automatic shut-off after last record. Heavy duty 4-pole shaded pole motor with heavy rim-weighted turntable. 4 speeds, 78, 45, 33⅓, 16-2/3 RPM. Negligible wow and flutter. We are so confident that you will be happy with this purchase, that if for any reason you do not feel you have received an exceptional value, we shall cheerfully refund your purchase price. Size 12¼" x 13¾", requiring 11/16" clearance above and 2-11/16" below motorboard. Shpg wt., 21 lbs.

PK-250 RECORD CHANGER (less woodbase) with NEW GE 4G-052 Diamond Sapphire Cartridge ..... Net **39.50**

MAHOGANY OR BLONDE WOODBASE CUT TO FIT ABOVE

PK-111—Specify Finish, Shpg. wt., 5 lbs. ..... Net **3.95**

For Problem-Solving . . . Experimentation . . . Teaching . . . or Just Fun

BUILD YOUR OWN ELECTRIC BRAIN MACHINE *IN JUST A FEW HOURS!*

Remarkable 400-Component Construction Kit Enables You to Create Any of 50 Brain Machines! Build LOGIC MACHINES That Compare, Reason, Test Intelligence; ARITHMETICAL MACHINES (Binary & Decimal); GAME-PLAYING MACHINES (Tic-Tac-Toe, Nim, etc.)

Teachers and Scientists: *Design Your Own Machines!*

GENIAC® is the only kit and text combination that presents the basic ideas of cybernetics, boolean algebra, symbolic logic and computer circuitry for all levels of knowledge and intelligence. Sold to all customers on a one-week return guarantee; actually use it during that time, return it if you decide not to keep it.

WITH GENIAC® you build any of 50 electric brain machines in a few hours by following the clear-cut, step-by-step directions in the basic text provided. Advanced students and scientists can design machines for special problems. No soldering required, and little wireing. Change design of your machines in minutes! Build Binary Adding Machine • Secret Coder & Decoder • Machine for Arithmetical Carrying • Comparing Machine • Reasoning Machine • General Combination Locks • Games Requiring Logic • Machine for a Space Ship's Airlock • Intelligence Tester • Burglar Alarm • Puzzle Solvers and many others.

OVER 400 COMPONENTS AND PARTS

Circuits operate on one flashlight battery, and use ingeniously designed parts. 1958 GENIAC® Kit has been constructed by the original inventor to provide all the advantages of previous electrical brain construction kits plus what we have learned in answering the questions and examining the new designs created by hundreds of users.

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Each GENIAC® comes as a self-contained course in computer design. All instructions are so simple that we have records of intelligent twelve-year-olds designing factoring machines and puzzle-solving circuits—while hundreds of schools and industrial training programs have incorporated our kits in their curricula.

YOUR COURSE FOR GENIAC® KIT: ONLY $19.95 POSTPAID

The coupon will bring your GENIAC® Electric Brain Construction Kit and Manuals for only $19.95 postpaid. You may return the Kit within 7 days if you are not completely satisfied. For schools we offer bulk rates on extra texts and parts; for teachers, we offer 10% deduction on GENIAC® if ordered for use in institutions. Send for your Kit today!

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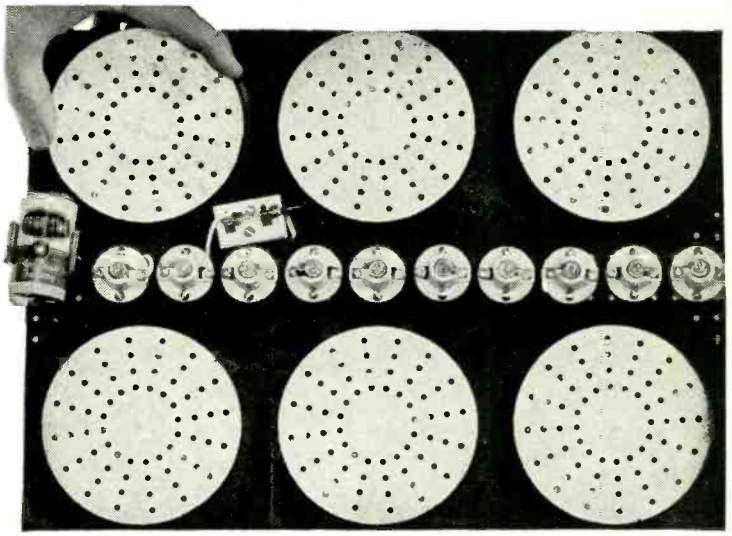

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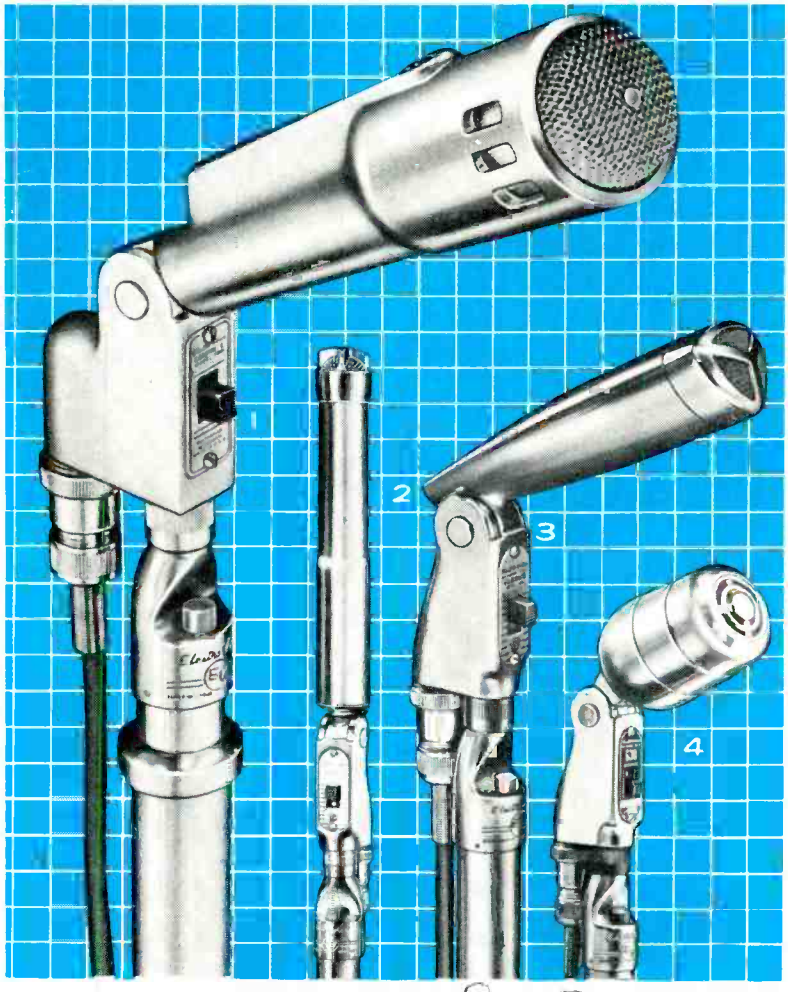
Electro-Voice®

DYNAMIC MICROPHONES

OUT-PERFORM ALL OTHERS for P.A. and RECORDING!

new acoustic principle — VARIABLE D acclaimed the most significant microphone development in 20 years!

Because of their durability and uniformity of response, dynamic microphones are almost universally used by recording studios. Electro-Voice dynamic microphones are a triumph of electro-acoustics in the recording, P.A. and general purpose fields. One of the many reasons for this is the Variable D principle which employs three distinct sound entrances, with acoustical filters; achieves flat response and excellent back cancellation while eliminating boominess caused by close talking—and susceptibility to shock. That's why those who want true fidelity, life-like recorded tape choose Electro-Voice dynamic microphones.



❶ E-V MODEL 664

Utilizing the revolutionary Variable D, this high-fidelity cardioid dynamic brings broadcast quality to tape recording and the P.A. and general purpose field. Proper placement of microphone stops unwanted sounds, gives accurate, natural pick-up of voice and music. Unprecedented ruggedness largely eliminates possibility of accidental damage.

Indestructible Acoustalloy diaphragm and precision manufacture assure long-life and dependable performance. Frequency response: 40 to 15,000 cps. Pressure cast case. Chrome finish. 18′ cable. Size: 7-3/16″ long, 1⅞″ diameter. Net weight: 1 lb. 10 oz. List price: $85.00 (less stand).

❷ E-V MODEL 636

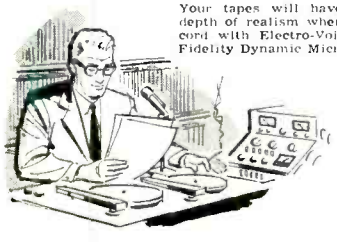
This model brings style and quality to the recording and public address fields. Slim and trim—only 1⅛″ in diameter x 10¼″ long – it greatly reduces recording staging problems. Frequency response: 60 to 15,000 cps, essentially flat. Adjustable impedance. Gold or satin chrome finish. On-off switch standard equipment. Net weight: 15 oz. List price Chrome Finish: $72.50 (less stand).

❸ E-V MODEL 623

Excellent for both speech and music, its small, slim size makes it inconspicuous and easy to handle. Swivel mounting permits tilting microphone through a 57° arc toward the sound source. Acoustalloy diaphragm. Frequency response: 60 to 12,000 cps. Satin chrome finish. Net weight: 1 lb. List price: $57.00 (less stand).

❹ E-V MODEL 630

This is similar to Model 623 in performance characteristics but is traditionally styled. Frequency response: 60 to 11,000 cps. Satin chrome finish. Net weight: 1 lb. List price: $52.50.



Your tapes will have a new depth of realism when you record with Electro-Voice High-Fidelity Dynamic Microphones!

See your E-V hi-fi dealer **today**. Write for "The ABC's of Microphones," Booklet W.82

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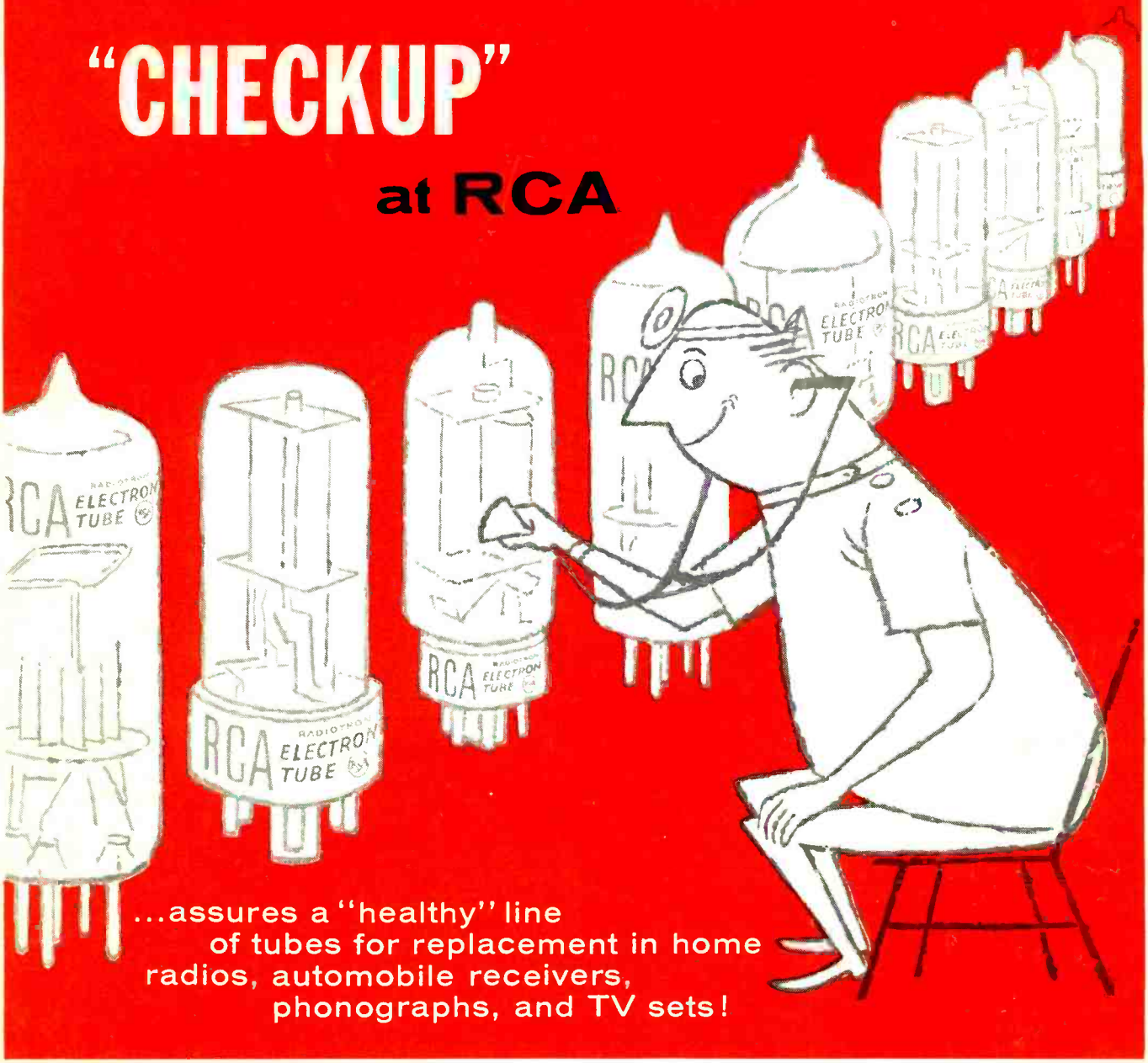
"CHECKUP"

at RCA



...assures a "healthy" line of tubes for replacement in home radios, automobile receivers, phonographs, and TV sets!

Fast service, efficient service—*without time-taking callbacks due to early hour tube failures*—are the vitamins, minerals, proteins and plasma of the healthy service business. "Out-of-the-carton" and "right-into-the-set" is the service dealer's dream. And RCA's rigid program of production-line testing and warehouse sampling converts it to reality.

Tests for shorts, heater-cathode leakage, and transconductance help weed-out the weaklings—assure superior-quality tubes. And where low noise and low microphonics are essential to top performance, certain tubes undergo visual and acoustic tests. Before RCA tubes are put into the famous red-and-black RCA carton they are tested all over again at the warehouse for "solid" shorts, "flicker" shorts, and continuity. Add to this RCA's quality monitor: *microscopic inspection* of welds, seals, stems, and electrodes of all popular-types and new-type receiving tubes used in black-and-white and color-TV sets, and automobile receivers...and you have powerful reasons why RCA tubes are preferred by manufacturers of electronic equipment and by you who service it. So, never ask your distributor for "tubes" alone. Always specify: RCA TUBES!

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