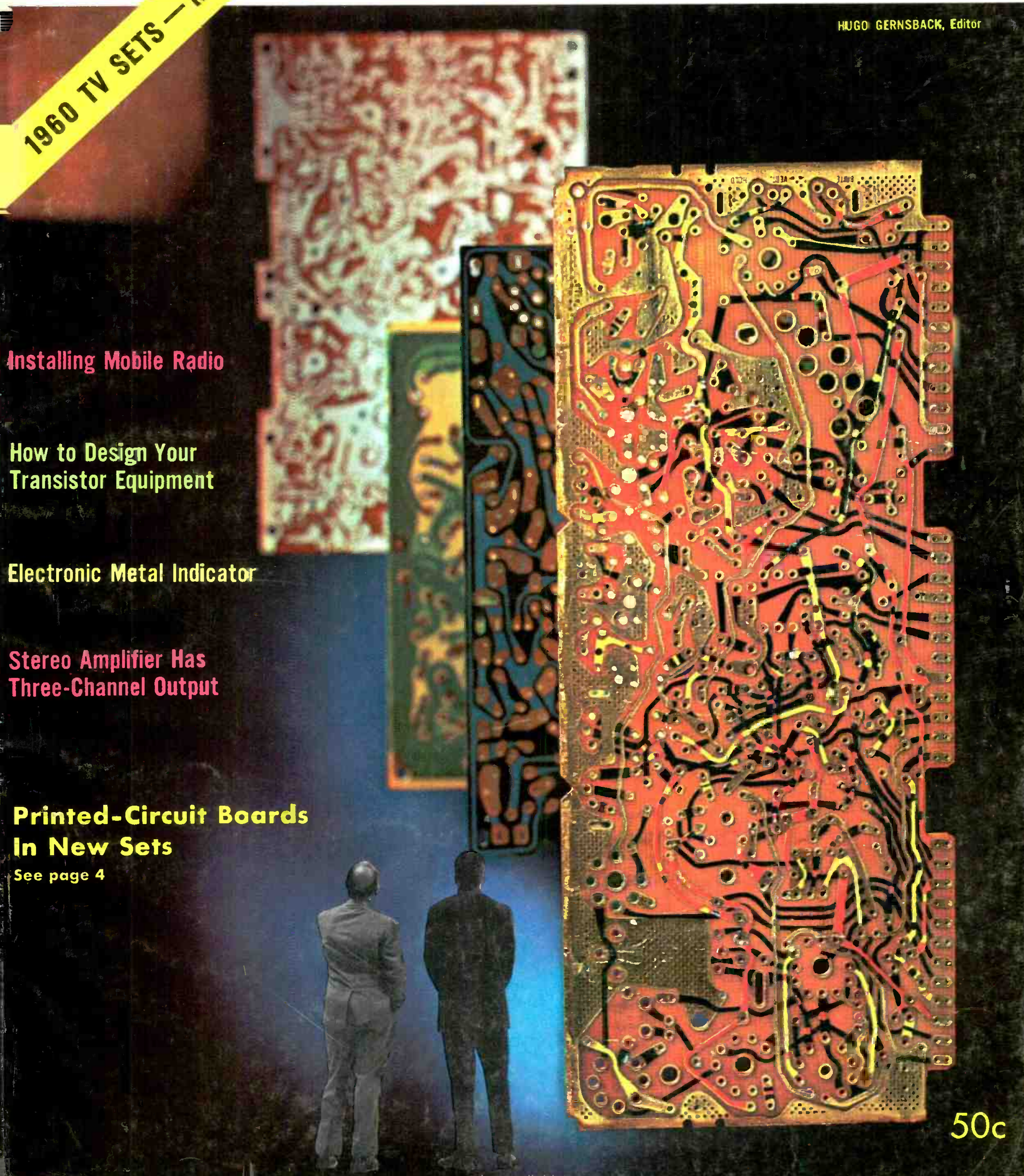
DECEMBER 1959

IND

Radio-Electronics

1960 TV SETS — New Design Trends

HUGO GERNSBACK, Editor



Installing Mobile Radio

How to Design Your Transistor Equipment

Electronic Metal Indicator

Stereo Amplifier Has Three-Channel Output

Printed-Circuit Boards In New Sets

See page 4

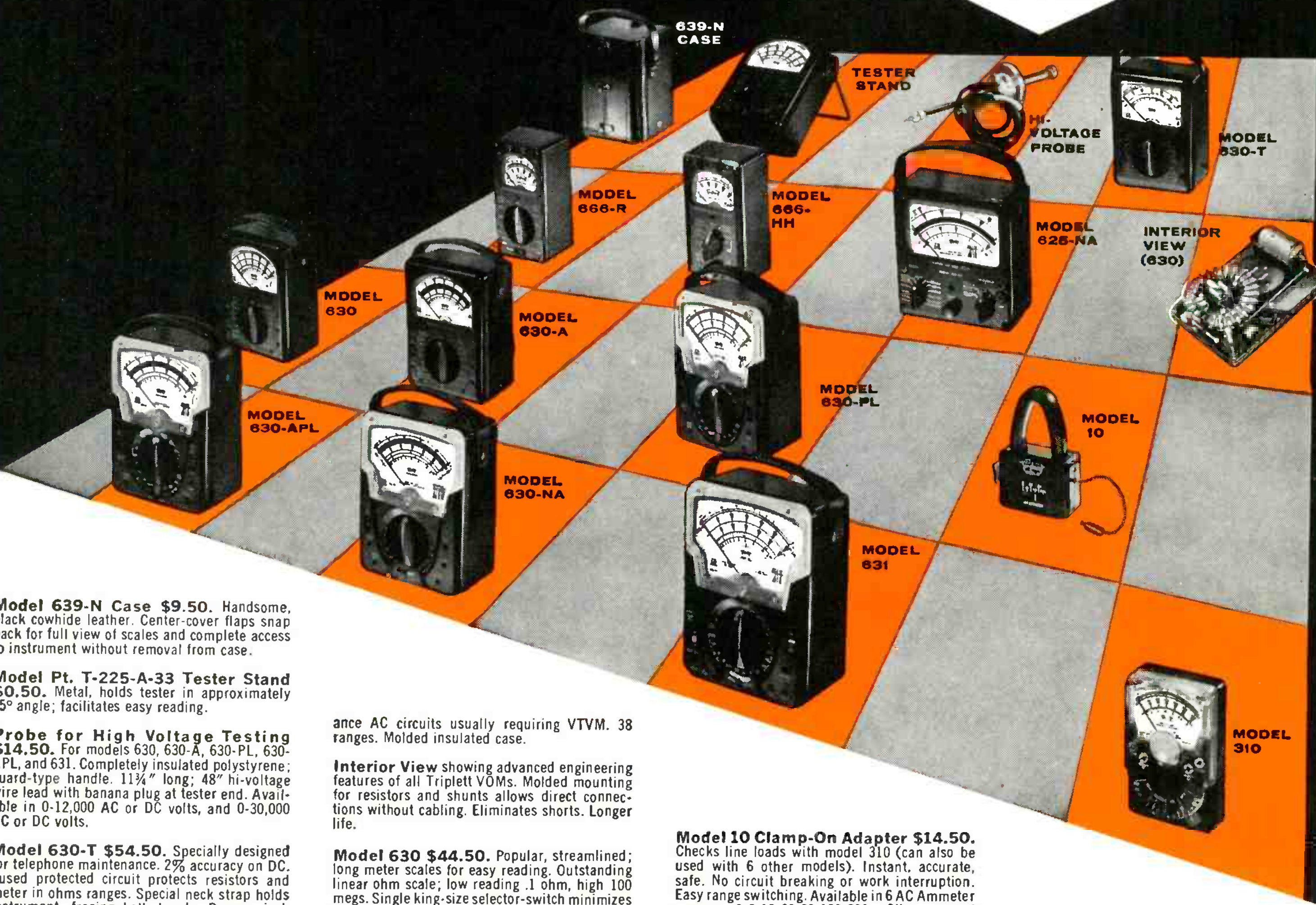
50c

. . . the smartest move you can make

is to TRIPLETT VOMs

. . . the world's most complete line of VOMs for every purpose!

TRIPLETT
Quality . . . First to last



Model 639-N Case $9.50. Handsome, black cowhide leather. Center-cover flaps snap back for full view of scales and complete access to instrument without removal from case.

Model Pt. T-225-A-33 Tester Stand $0.50. Metal, holds tester in approximately 45° angle; facilitates easy reading.

Probe for High Voltage Testing $14.50. For models 630, 630-A, 630-PL, 630-APL, and 631. Completely insulated polystyrene; guard-type handle. 11¾" long; 48" hi-voltage wire lead with banana plug at tester end. Available in 0-12,000 AC or DC volts, and 0-30,000 AC or DC volts.

Model 630-T $54.50. Specially designed for telephone maintenance. 2% accuracy on DC. Fused protected circuit protects resistors and meter in ohms ranges. Special neck strap holds instrument, freeing both hands. Banana jack connectors eliminate all shock hazard. Completely insulated case protects from ground.

Model 666-R Pocket VOM $29.50. Hand size, ideal for electrical maintenance. With recessed range knob it fits easily into case. AC rectifier pre-calibrated unit for easy replacement. Banana jacks at panel top prevent leads falling over meter dial. Single king-size selector switch minimizes incorrect settings, burnouts. 20 ranges. Molded case streamlined, fully insulated.

Model 666-HH Pocket VOM $27.50. Compact, hand-size; 3" meter integral with panel, adjusted to 400 microamperes at 250 millivolts. Only 3 jacks necessary for all ranges. 19 ranges.

Model 625-NA $54.50. Dual sensitivity for extra ranges; large mirror scale for super readability. 3-color meter scale 5" long. 6" instrument, 0-50 microamp. AC volts at 10,000 O/V for checking many audio and high impedance AC circuits usually requiring VTVM. 38 ranges. Molded insulated case.

Interior View showing advanced engineering features of all Triplett VOMs. Molded mounting for resistors and shunts allows direct connections without cabling. Eliminates shorts. Longer life.

Model 630 $44.50. Popular, streamlined; long meter scales for easy reading. Outstanding linear ohm scale; low reading .1 ohm, high 100 megs. Single king-size selector-switch minimizes incorrect settings, burnouts. High sensitivity: 20,000 ohms per volt DC; 5,000 AC. Molded, fully insulated case.

Model 630-A $54.50. Laboratory type; ½% resistors for greater accuracy. Long mirrored scale eliminates parallax. Banana jacks, low resistance connections; high flux magnet increases ruggedness. Single king-size selector switch minimizes incorrect settings, burnouts. Molded fully insulated case.

Model 630-PL $44.50. Instant-vision, wider spread scales; streamlined case; handsome modern design. Unbreakable window. Outstanding linear ohm scale; low reading .1 ohm; high to 100 megs. Single king-size selector switch minimizes incorrect settings, burnouts. 5 to 500,000 cps frequency response in AC measurements. DC Polarity Reversing switch. High sensitivity: 5,000 ohms per volt AC; 20,000 ohms per volt DC.

Model 10 Clamp-On Adapter $14.50. Checks line loads with model 310 (can also be used with 6 other models). Instant, accurate, safe. No circuit breaking or work interruption. Easy range switching. Available in 6 AC Ammeter ranges: 0-6-12-30-60-120-300. Clips around single wire to read AC. Amperes direct. Use with adapter 101 to instantly divide 2-conductor cords. Molded case fully insulated, black plastic with engraved white markings.

Model 630-APL $54.50. Laboratory type with ½% resistors, more accurate movement. Long mirrored scales eliminate parallax. Unbreakable window. Single king-size switch minimizes incorrect settings, burnouts. 5 to 500,000 cps frequency response in AC measurements. DC Polarity Reversing switch. High sensitivity: 5000 ohms per volt AC; 20,000 ohms per volt DC. Molded case fully insulated.

Model 630-NA $74.50. Super DeLuxe with 70 ranges—nearly double conventional types. Frequency compensated from 35 cps to 20 kc. Temperature compensated. Accurate within 1½% full scale reading on DC. Large open front meter easy to read. Unbreakable window. Mirrored scale. Meter protection against overloads. Molded fully insulated case.

Model 631 Combination VOM and VTVM $64.50. Two fundamental units at the price of a single tester. The No. 1 instrument for all electronic men. Battery operation assures VTVM stability and long life. Sensitivity PLUS. 1.2 volt (VTVM) range is equal to more than nine million ohms per volt. Large easy to read meter with unbreakable face. Single king-size selector switch minimizes incorrect settings, burnouts. Molded case fully insulated.

Model 310 $34.50. The only complete miniature VOM with 20,000 ohms per volt and selector range switch. Self-shielded against strong magnetic field. Rugged, high torque, barring instrument. Unbreakable plastic meter window. Converts to common probe—frees one hand—by fitting interchangeable test prod into top. Standard sensitivity 20,000 ohms per volt DC, and 5,000 ohms per volt AC. Accuracy 3% DC. Molded fully insulated case.

BURTON BROWNE ADVERTISING

TRIPLETT
Quality . . . First to last

TRIPLETT ELECTRICAL INSTRUMENT COMPANY
BLUFFTON, OHIO

DECEMBER, 1959

OVER 50 YEARS OF ELECTRONIC PUBLISHING

Radio-Electronics

Formerly RADIO-CRAFT ■ Incorporating SHORT WAVE CRAFT ■ TELEVISION NEWS ■ RADIO & TELEVISION

EDITORIAL

ELECTRONICS

AUDIO-HIGH FIDELITY

INDUSTRIAL ELECTRONICS

WHAT'S NEW

RADIO

TEST INSTRUMENTS

TELEVISION

ON THE COVER

(Story on page 98)

Today's printed-circuit boards have many new features that make them easier to trace and service. The ones on our cover can be found in the 1960 lines of television receivers.

Color original by Habershaw Studios, New York, N. Y.

Average Paid Circulation Over 187,000

MEMBER INSTITUTE OF HIGH FIDELITY MANUFACTURERS INC

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

RADIO-ELECTRONICS. December, 1959. Vol. XXX, No. 12. Published monthly at Mt. Morris, Ill., by Gernsback Publications, Inc. Second-class postage paid at Mt. Morris, Ill.
SUBSCRIPTION RATES: U.S., U.S. possessions and Canada, $4.00 for one year; $7.00 for two years; $10.00 for three years. Pan-American countries $5.00 for one year; $9.00 for two years; $13.00 for three years. All other countries $5.50 a year; $10.00 for two years; $14.50 for three years.
SUBSCRIPTIONS: Address correspondence to Radio-Electronics, Subscription Dept., 154 West 14th St., New York 11, N.Y. When requesting a change of address, please furnish an address label from a recent issue. Allow one month for change of address.
GERNSBACK PUBLICATIONS, INC. Executive, Editorial and Advertising Offices, 154 West 14th St., New York 11, N.Y. Telephone Algonquin 5-7755. Hugo Gernsback, Chairman of the Board; M. Harvey Gernsback, President; G. Aliquo, Secretary.
BRANCH ADVERTISING OFFICES and **FOREIGN AGENTS** listed on page 156.
POSTMASTER: If undeliverable, send Form 3579 to: RADIO-ELECTRONICS, 154 West 14th St., New York 11, N.Y.
*Trademark registered U. S. Pat. Office.

News Briefs

STRATOVISION is planned for late 1960 in six Midwestern states, using an airplane circling Fort Wayne, Ind., to transmit educational TV courses. Flying 5 miles up, a DC-7 will pick up programs from Purdue University, rebroadcasting them on uhf channels to Michigan, Ohio, Indiana and part of Illinois, Wisconsin and Kentucky, a 200-mile radius around Fort Wayne.

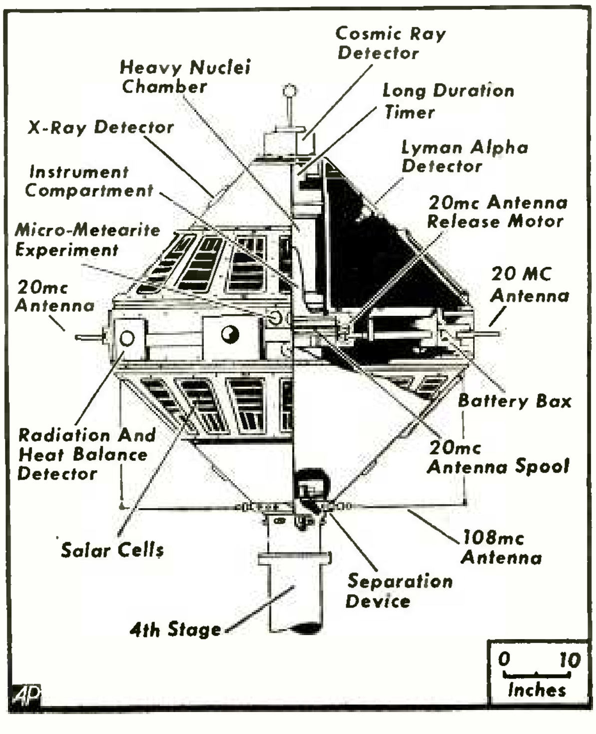
The Midwest Council on Airborne Television Instruction has been formed at Purdue, and the Ford Foundation has promised over $4,000,000 initially. General Dynamics Corp. will provide two DC-7's. The technical adviser to the Council is C. E. Nobles, who originated the idea in the early 1940's. (Radio-Electronics described this proposed system in considerable detail in October, 1945.)

Westinghouse, at the time Nobles' employer, ran tests with a B-29 which covered 225 miles, compared with the usual 50-mile range of that day.

The project will serve about 13,000 schools, and up to 5,000,000 students.

EXPLORER VII satellite will supply valuable data on the radiation belts around the earth. It has antennas for 108- and 20-mc communications, in addition to devices for measuring cosmic rays, micrometeoric density, sun-produced ultra-violet radiation and the heat balance between the sun and the earth.

Explorer VII weighs 91½ pounds and is orbiting between 664 and 346 miles from us, whizzing around earth at 4 miles a second (15,000 mph). Its larger predecessor, Explorer VI, carried more instrumentation, weighed 142 pounds and orbits up to 25,000 miles away. (Radio-Electronics, October, 1959, page 10.)



WORLD-WIDE RADIO NET shared live symphonic music originating in Moscow, Geneva and New York with 20 countries on UN day, Oct. 24. UN radio in New York fed the program to Canada, Mexico and South America, contacting Europe via the Atlantic telephone cable. Listeners in New York report music from Geneva sounded better than many programs fed from other cities here over regular network lines. The program was flat to 8 kc, according to UN radio operations manager Joseph Nichols. Next year it's hoped to do the exchange program in stereo.

WORLD'S BIGGEST TRANSMITTER will go into action at a Navy base in Maine near the end of 1961. Beaming signals to submerged *Polaris* submarines, it will operate at 30 kc or lower because long waves penetrate salt water better than do high frequencies. Four conventional 500-kilowatt push-pull rf amplifiers will be used, allowing any one to be shut down for maintenance while 1,500,000 watts keep pounding out.

Two separate antenna arrays, each with one tower almost 1,000 feet high, and 12 more reaching above 800 feet, will spread over 2 square miles of ground. Either antenna can be turned off while 60-cycle de-icing power is applied to melt ice up to 3 inches thick.

The transmitter will also be useful in detecting hostile missiles as they leave launching sites overseas.

The most powerful known station at present is also a Navy installation, at Jim Creek, Ore., rated at 350,000 watts. The USSR is believed to have a station called Goliath whose output is comparable. It was taken from the Germans after WWII.

FM MULTIPLEX need not be used for storecasting background music, the Supreme Court ruled recently, backing up the Court of Appeals, which voided an FCC order putting background music onto multiplex from previous simplex. In simplex operation everybody gets the same program with subscribers to the storecast service getting the commercials silenced by an ultrasonically triggered tone.

This could be a positive step toward FM-multiplexed stereo, allowing broadcasters to eat their cake (stereo) while keeping it (storecast).

AUDIO ANESTHETIC for dental patients puts music or random noise—at levels selected by the patient—into headphones, blocking out pain sensation during drilling. Ritter & Co., Inc., Rochester, is developing production models of the system for sale to dentists in early 1960.

The principle was worked out by a Boston dentist who found it killed the pain of dental work in about 90% of more than 2,000 test cases. The patient controls the sound level with a gain control in his lap. Ritter says the unit should sell for about $1,600, including phones, amplifier and tape deck.

MARS TECHNICAL NET continues every Wednesday at 9 PM EST on 4030 kc upper sideband: Dec. 2, "Technical Aspects of Satellite Communications," Lowell Smilen; Dec. 9, "The Trans-Atlantic Submarine Telephone Cable," Harold West; Dec. 16, "Determination of Percent Success Expectable in High-Frequency Radio Transmissions," George Krause; "FM Forward-Scatter Tropospheric Communications Systems," Joseph Lesmez; Dec. 30, "Coaxial Cable," Michael Ferber.

ELECTRONIC MAGAZINE, *The Braille Technical Press*, is now available on records for the blind ham, hi-fi enthusiast and electronics technician. It is published monthly on 16⅔-rpm ("Talking Book" speed) discs. Each issue has

(*Continued on page* 10)

6-5-4-3-2-1...

DON'T LET TIME RUN OUT ON YOUR BIG CHANCE

to Prepare At Home for a Profitable Job in

Electronics

Guided Missile Control—Radar—TV—Radio, etc.

NO ADVANCED EDUCATION NEEDED!

A breath-held hush! Dramatically the cold voice completes the count-down: " . . . 3 . . . 2 . . . 1 . . . " And with a mighty roar, a missile rises from its launching pad, picking up speed that quickly lifts it out of sight. Another rocket thunders into space . . . a triumph of ELECTRONICS and ASTRONAUTICS.

You may have a future in this fascinating field—with DeVry Tech's help. *You*—if you are 17-55—can train at home in your spare time. *You,* may be in that picture some day—a trained man with a fascinating job, a good future, making real money. *You,* as an electronic technician, can back the men who launch the missiles!

With DeVry's thorough training, you get on-the-job type of know-how. You handle tools, you build and operate instruments. You learn by following clear-cut directions, by viewing training movies AT HOME! It's thorough. It's proved.

Get into this exciting field without taking your feet off the ground. Send the coupon NOW for details.

TRAIN IN CHICAGO OR TORONTO LABORATORIES

Full time day and evening training programs in our well-equipped Chicago and Toronto Laboratories are also available.

EMPLOYMENT SERVICE

helps you get started toward a good job or your own service shop when you complete the program.

GET THIS FREE BOOKLET!

A copy of "ELECTRONICS IN SPACE TRAVEL" is yours for the asking. Mail the coupon NOW. See for yourself how YOUR future may fit into this exciting field.

No Previous Technical Experience Needed!

☒ **CHECK THESE EXCITING JOB OPPORTUNITIES!**

Communications Technician • Computer Specialist
Remote Control Operator • Instrument Technician
Radar Man • Micro-Wave Technician • TV-Radio Specialist . . . *PLUS MANY OTHERS*

DeVry TECHNICAL INSTITUTE

4141 Belmont Avenue, Chicago 41, Illinois
ACCREDITED MEMBER OF NATIONAL HOME STUDY COUNCIL

MAIL COUPON TODAY!

DeVRY TECHNICAL INSTITUTE 2070
4141 Belmont Ave., Chicago 41, Ill., Dept. RE12P

Please give me a FREE copy of "Electronics in Space Travel" and tell me how I may prepare for a start in the Electronics field.

Name________________ Age ____
Please Print

Address________________ Apt. ____

City________ Zone ___ State________

☐ Check here if you face military service.

Canadian residents address DeVry Tech of Canada, Ltd., 626 Roselawn Ave., Toronto 12, Ont.

NEWS BRIEFS *(Continued from p. 6)*

2 hours of technical information. Yearly subscription is $10 from the Braille Technical Press, Inc., 984 Waring Ave., New York 69, N. Y. This price is for the purchase, not rental, of the records.

The magazine has been used as a textbook in many schools and libraries and has been the electronics Bible for Braille readers all over the world. The new "Talking Book" edition makes it available to all interested, regardless of their ability to read Braille.

PASSIVE SATELLITES—100-foot balloons with aluminized surface—will be orbited about 1,000 miles up as relay stations for microwave communications and intercontinental TV transmission in tests by Bell Labs. Facilities are being built at Holmdel, N. J., and Goldstone, Calif., for experiments next year.

Transmitters using 85-foot parabolic dishes will beam 10-kw signals at the satellites at about 1,000 mc. It is hoped reflection from a satellite will give a usable signal receivable with a parabola 2,300 miles away. The signal will be funneled into a maser amplifier, in this case a ruby crystal bathed in liquid helium. Bell engineers expect extremely low noise figures with this maser and a special horn collector used with the receiving dish—signal-to-noise ratios up to a hundred times better than presently obtainable. In this sort of work, much interference often comes from the heat of the earth.

Where the new transoceanic cables carry up to 160 phone conversations at a time, a single microwave channel of this kind would carry 900 phone circuits, or a full-width TV channel.

About 20 satellites would provide communication across the US 95% of the time. This many would be required because such light, large, passive satellites would drift, failing to stay in the regular orbits of heavy, small, active satellites presently orbiting, or the doughnut-shaped satellite envisioned by others (see What's New, page 54). However, as many microwave channels as desired could be focused on one satellite at one time, providing a virtual infinity of communications lines.

WEATHER-CONTROL network at the Panama Canal will connect 13 stations at spots virtually inaccessible to man which must be periodically checked to predict water level at the canal. The remote stations will automatically telemeter water-level and other data by vhf radio to the main meterological station to aid decisions as to when to open and close the canal locks.

SHORTER-TUBE TREND continues with a new type of 23-inch picture tube which has a 114° deflection angle (uses standard 110° yoke and coils) and is minus the twin-panel bonded-on safety glass which present 23-inchers carry. The 23-114 will thus be shorter than present tubes, and also somewhat cheaper, at least for the set maker. G-E has

how to get an FCC COMMERCIAL LICENSE

YOUR FCC LICENSE OR YOUR MONEY BACK

The Master Course in Electronics will provide you with the mental tools of the electronics technician and prepare you for a First Class FCC License (Commercial) with a radar endorsement. When you successfully complete the Master Course, if you fail to pass the FCC examination, you will receive a full refund of all tuition payments.

Every month our trainees get jobs like these

Top Grade Employers like these Look to CLEVELAND INSTITUTE

Bendix Radio: "We shall look forward to receiving completed applications from your students."

Philco: "We have employed a great number of well qualified electronics personnel who were graduates of Cleveland Institute."

Westinghouse: "We would appreciate your listing our current openings in your monthly Job Opportunities."

Accredited by The National Home Study Council

Cleveland Institute of Electronics

Desk RE-36B, 4900 Euclid Ave., Cleveland 3, Ohio

THESE BOOKLETS FREE

James Glen:

When Jim enrolled, he was a temporary employee of the City of Tacoma, Washington. In the space of 14 months, he completed the Master Course and received his first class license. He is now installing and maintaining mobile and microwave equipment.

James S. Glen, Jr.
2920 Knob Hill Road
Tacoma, Washington

Boyd Daugherty:

"I recently secured a position as Test Engineer with Melpar, Inc. A substantial salary increase was involved. My Cleveland Institute training played a major role in qualifying me for this position."

Boyd Daugherty
105 Goodwin Ct., Apt. C
Falls Church, Va.

Mail This Coupon Now . . . Receive These Booklets FREE

Cleveland Institute of Electronics,
Desk RE-36B, 4900 Euclid Ave., Cleveland 3, Ohio

Please send FREE Booklets prepared to help me get ahead in Electronics. I have had training or experience in Electronics as indicated below:

- ☐ Military
- ☐ Radio-TV Servicing
- ☐ Manufacturing
- ☐ Amateur Radio
- ☐ Broadcasting
- ☐ Home Experimenting
- ☐ Telephone Company
- ☐ Other . . . .

In what kind of work are you now engaged? . . . .

. . . .

In what branch of Electronics are you interested? . . . .

. . . .

Name . . . . Age . . . .

Address . . . .

City . . . . Zone . . . . . State . . . . .

Desk RE-36B

indicated it'll use the new 23; Zenith and Westinghouse are also said to be interested in this new design. Already using 23-inch picture tubes in current production are Admiral, Hoffman, RCA, Westinghouse, Sylvania and others.

Meanwhile, two new low-power picture tubes with—hold your hat—160° and 170° deflection were said to have been demonstrated, using 110° components. If the 170° tube were to work out practically with 170° neck components, it would be only about 5 inches deep!

Calendar of Events

Midwest Symposium on Circuit Theory, Dec. 1–2, Brooks Memorial Union, Marquette University, Milwaukee, Wis.

Eastern Joint Computer Conference, Dec. 1–3, Statler Hotel, Boston, Mass.

National Conference of the IRE Professional Group on Vehicular Communications, Dec. 3–4, Colonial Inn & Desert Ranch, St. Petersburg, Fla.

National Symposium on Reliability & Quality Control, Jan. 11–13, Statler-Hilton Hotel, Washington, D. C.

Hi-Fi Shows

Northwest Hi-Fi, Music and Stereo Show, Dec. 4–6, Hotel Leamington, Minneapolis, Minn.

IHFM Hi-Fi Show, Jan. 13-17, Pan-Pacific Auditorium, Los Angeles, Calif.

National Hi-Fi Show, (sponsored by MIRA) Jan. 23-26, Cow Palace, San Francisco, Calif.

Details on all events supplied by sponsoring organizations.

RUSSIAN MICROWAVE development is seen threatening to catch up with that of the US, according to D. W. Atchley, Microwave Associates, Inc., who recently returned from a visit with the head of microwave research of the Institute of Radio Engineering and Electronics, Moscow. Dr. Zarem Chernov showed Mr. Atchley a traveling-wave tube which promises amplification of millimeter waves. In this "most unusual" tube, the electron beam interacts with a sheath of charged gas particles instead of with a wire helix.

Another important tube he saw is called the Spiratron. This traveling-wave tube is a lightweight, efficient, broad-band amplifier which Mr. Atchley felt could be used in a communications satellite.

RADIO POCKET is predicted for men's clothes by a prominent Chicago appliance dealer. Based on his store's sales of transistor radios during the last World Series, Sol Polk of Polk Brothers believes even women's clothes may have special little pockets designed for tiny personal radios.

SPUTNIK SIGNAL allocations are being discussed at the current Geneva meeting of the International Telecommunications Union (ITU). The United States has asked that seven bands be set aside for space communications. The Russians are expected to oppose this request, saying that frequencies for space communication are available in bands now allocated to fixed and mobile aeronautical services.

Meanwhile, leading astronomers who had earlier expressed concern over the anticipated US request for only one frequency allocation for the new science of radio astronomy were praising the proposal finally made by the American delegation to the ITU. This new position includes a request that 17 bands be set aside for probing interstellar space with huge radio telescopes. Frequencies are requested from 2.5 all the way up to 30,000 mc.

The ITU, meeting for several months once every 10 years, has over 5,000 proposals to deal with.

1,000-FOOT RADAR astronomy dish in Puerto Rico will be a fixed aluminum-mesh basin sending pulses on 400 mc to explore the solar system and help develop defenses against ballistic missiles. Because it can pick up objects only a cubic yard in size at distances of 20,000 miles or more, the huge antenna will be useful in mapping the moon and sun.

3 NEW TV STATIONS brighten TV's slowest year to date (only 20 starters):

KOMC, McCook, Neb.	8
KXGO-TV, Fargo, N.D.	11
WMUB-TV, Oxford, Ohio	14

KOMC picks up NBC-TV via microwave from parent KCKT, Great Bend, Kans., channel 2. WMUB-TV is an educational station and recently began its full time schedule after a period of intermittent programming.

KTES, Nacogdoches, Tex., channel 19, which left the air in July, failed to resume operation this fall as planned.

New total of US operating stations is 562. This figure includes 472 vhf and 90 uhf. The noncommercial group now numbers 43.

ANTI-STATIC devices for keeping dust off discs, or for cleaning them may soon be a thing of the past. RCA-Victor is putting a new "magic ingredient" 317-X, in their stereo discs, producing a staticless record with "Miracle Surface." It really works, costs no more and, RCA says, it'll last permanently.

Unconfirmed but persistent talk is that RCA will license or perhaps even give the secret process to the rest of the record industry. Congratulations to RCA-Victor for solving a long-standing problem!

MUSIC BY MACHINES is a step closer with the installation of an RCA Music Synthesizer at the Columbia University Electronic Music Center. Contained in several huge racks with programming via punched tape consoles, the synthesizer looks like a huge computer. It can simulate all known musical tones, plus virtually any musical (or otherwise!) sound which can be imagined by the "composer."

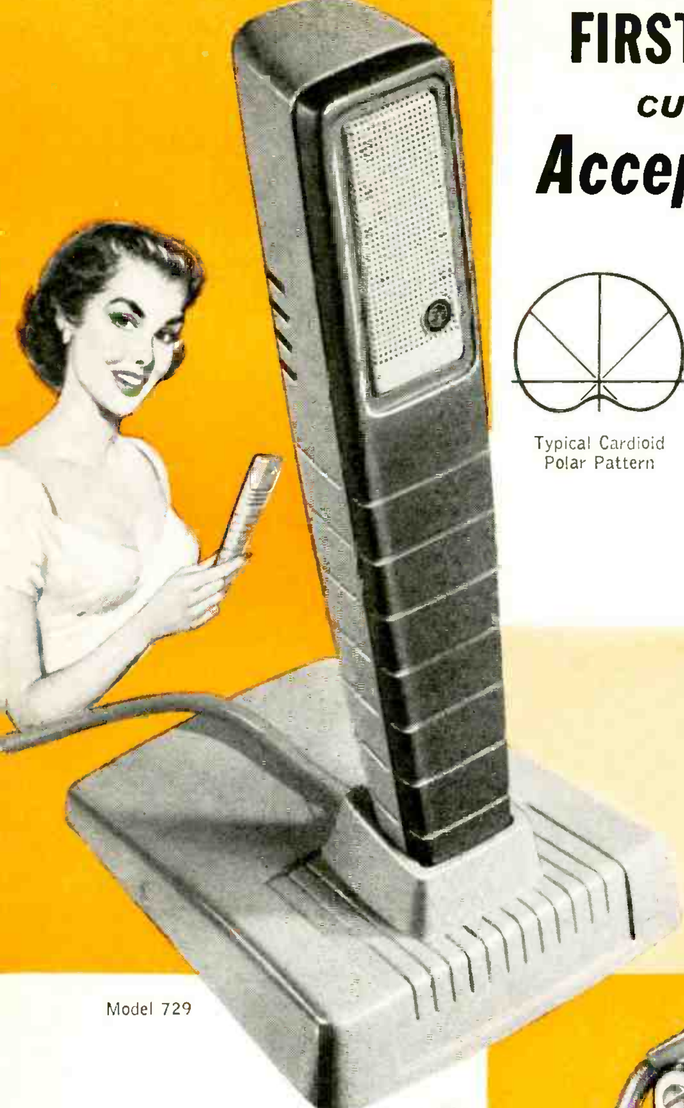
ELECTRICAL ENGINEERS graduating from Lehigh University this year get an average starting salary of $515 a month, exceeded only by beginning

(Continued on page 16)

FIRST CARDIOID AT SUCH LOW COST!

CUTS BACKGROUND NOISE

Accepts Only the Sound You Want



Model 729

IDEAL FOR STEREO RECORDING OR PUBLIC ADDRESS

Typical Cardioid Polar Pattern

Unidirectional pick-up and tailored response of the *new E-V 729 Cardioid* make it economically ideal for many applications in public address, paging, dictating, home recording, amateur communications, and other sound use. The 729 Cardioid *rejects unwanted rear-background noise and room reverberation.* Permits working from nearly twice the distance of conventional microphones. *Reproduces only the sound you want,* more faithfully and distinctly. Instantly slips in or out of desk-base supplied with microphone. Feels good in the hand.

Where economy is a factor, you still have every advantage in selecting *Electro-Voice*. You get the benefit of the same high quality engineering and manufacturing that have made E-V the choice of television networks. You choose from the *most complete line, the most accepted microphone line,* in the world. You are certain of finest value and *guaranteed satisfaction* or your money back.

Model 729 Cardioid Ceramic. Complete with desk-base and floor stand adapter. Ceramic generating element withstands extremes of temperature and humidity. Response 60-8000 cps. Output —55 db. High impedance. Two-tone gray. List Price, $24.50

Model 729S. With switch. List, $26.50

Model 715 "Century" Ceramic. Non-directional. For table, stand or hand. Ceramic element. Response 60-7000 cps. Output —55 db. High impedance. Satin chrome. List, $13.00

Model 715S. With switch. List, $15.00

Model 615 "Century" Dynamic. Has exclusive indestructible Acoustalloy diaphragm. Response 80-8000 cps. Output —55 db. Choice of 50 ohms or high impedance. List, $25.50

Model 718 Ceramic. Non-directional. For hand or table use. Ceramic generating element. Response 60-6000 cps. Output level —55 db. High impedance. List, $12.00

CHOOSE FROM THESE AND OTHER E-V LOW COST MICROPHONES

Model 926 Slim Crystal. For hand or stand use. Non-directional. Moisture sealed crystal. Response 60-8000 cps. Output —60 db. High impedance. Tiltable head. Satin chrome. List, $29.50

Model 920 "Spherex" Crystal. All-direction pick-up. Moisture sealed crystal. Response 60-7000 cps. Output level —50 db. High impedance. Satin chrome finish. List, $27.50

Model 712 Compact Ceramic. Fits comfortably in the hand. Non-directional. Response 70-7000 cps. Output —55 db. High impedance. Gray Styron case. List, $7.50

Model 924 Lavalier Crystal. For chest or hand use. Non-directional. Moisture sealed crystal. Response 60-8000 cps. Output —60 db. High impedance. With neck cord, support clips, and cable. Satin chrome finish. List, $20.00

Model 727 Slim Ceramic. Instantly lifts out of base for hand use. Non-directional. Ceramic generating element. Response 60-8000 cps. Output —55 db. High impedance. Two-tone gray. With desk-base and floor stand coupler. List, $18.00

Model 727S. With switch. List, $20.00

Wide choice of Dynamic models, also available.

See Your E-V Distributor, or Write for Catalog No. 136 to Dept. 99-E

No Finer Choice than **Electro-Voice®**

ELECTRO-VOICE, INC., BUCHANAN, MICHIGAN, U.S.A.

F.C.C. COMMERCIAL OPERATOR LICENSE

Training... for Jobs in Electronics

F.C.C. LICENSE—THE KEY TO BETTER JOBS

An F.C.C. *commercial* (not amateur) license is your ticket to higher pay and more interesting employment. This license is Federal Government evidence of your qualifications in electronics. Employers are eager to hire *licensed* technicians.

WHICH LICENSE FOR WHICH JOB?

The THIRD CLASS radiotelephone license is of value primarily in that it qualifies you to take the second class examination. The scope of authority covered by a third class license is extremely limited.

The SECOND CLASS radiotelephone license qualifies you to install, maintain and operate most all radiotelephone equipment except commercial broadcast station equipment.

The FIRST CLASS radiotelephone license qualifies you to install, maintain and operate every type of radiotelephone equipment (except amateur) including all radio and television stations in the United States, its territories and possessions. This is the highest class of radiotelephone license available.

GRANTHAM TRAINING PREPARES YOU

The Grantham Communications Electronics Course prepares you for a *FIRST CLASS* F.C.C. license, and it does this by TEACHING you electronics. Each point is covered simply and in detail, with emphasis on making the subject easy to understand. The organization of the subject matter is such that you progress, step-by-step, to your specific objective—a first class F.C.C. license.

CORRESPONDENCE OR RESIDENCE CLASSES

Grantham training is available by correspondence or in resident classes. Either way, you are trained quickly and well. Write, or mail the coupon below, to any division of Grantham School of Electronics. Our free booklet will be sent to you immediately.

HERE'S PROOF...

that Grantham students prepare for F.C.C. examinations in a minimum of time. Here is a list of a few of our recent graduates, the class of license they got, and how long it took them:

	License	Weeks
Ron Taylor, 29 S. Franklin St., Chambersburg, Pa.	1st	12
Beri Moore, P.O. Box 169, Opp, Alabama	1st	15
Donald R. Titus, 270 Park Terrace, Hartford 6, Conn.	1st	12
Robin O. Okinishi, P.O. Box 375, Hanapepe, Kauai, Hawaii	1st	12
Billy R. Kirby, Route #3, Smithfield, N. C.	1st	9
J. H. Reeves, 10621 Ruthelen, Los Angeles 47, Calif.	1st	12
Donald H. Ford, Hyannis Rd. (Cape Cod), Barnstable, Mass.	1st	12
James D. Hough, 400 S. Church St., East Troy, Wisc.	1st	12

FOUR COMPLETE SCHOOLS: *To better serve our many students throughout the entire country, Grantham School of Electronics maintains four complete Divisions—located in Hollywood, Calif., Seattle, Wash., Kansas City, Mo., and Washington, D.C. All Divisions of Grantham School of Electronics offer the same rapid courses in F.C.C. license preparation, either by home study or in resident classes.*

Get your First Class Commercial F.C.C. License in 12 weeks by training at

Grantham School OF ELECTRONICS

HOLLYWOOD CALIF. — 1505 N. Western Ave., Hollywood 27, Calif. (Phone: HO 7-7727)

SEATTLE WASH. — 408 Marion Street, Seattle 4, Wash. (Phone: MA 2-7227)

KANSAS CITY MO. — 3123 Gillham Road, Kansas City 9, Mo. (Phone: JE 1-6320)

WASHINGTON D.C. — 821-19th Street, N. W., Washington 6, D. C. (Phone: ST 3-3614)

for FREE Booklet CLIP COUPON and mail in envelope or paste on postal card.

MAIL COUPON NOW

To: GRANTHAM SCHOOL OF ELECTRONICS

1505 N. Western, Hollywood • 408 Marion, Seattle • 3123 Gillham Rd., Kansas City • 821-19th, NW, Washington

Please send me your free booklet telling how I can get my commercial F.C.C. license quickly. I understand there is no obligation and no salesman will call.

Name________ Age____

Address________

City________ State________

I am interested in: ☐ Home Study, ☐ Resident Classes

94T

NEWS BRIEFS *(Continued from p. 12)*

engineering physicists, who are averaging $525. Interest is increasing on the part of industry in young EE's as shown in the number of interviews conducted on the Lehigh campus. This year there were 618 interviews for the 40 graduates; last year's 44 had only 317.

Graduate chemical engineers started at an average of $460. The average for all students graduating was up 4% from the previous year, but the EE's were up 6% and the physics graduates got 12% more to start than in 1958.

FOREIGN TV is growing fast, much the way TV in this country did a few years ago. Over 1,000 transmitting stations and more than 30 million sets are in use outside this country, compared with 554 stations and over 50 million receivers in the US.

In the past 12 months, overseas sets jumped almost half; stations increased by over 60%. Biggest increases were in Italy, West Germany, Japan, Russia and France, but England and Canada still led the other countries in total sets and stations.

LOUDSPEAKING LIGHTHOUSE has a bank of 60 large cone speakers mounted in short horns as its fog warning alarm. Amplifiers in the 130-foot tower being put up at Dugeness, Kent, England, use only 3-kw of power to drive the speakers. Three different frequency tones are used simultaneously, making an alarm which can be heard 8 miles out to sea.

The new lighthouse will also have a small xenon arc discharge beacon about the size of a standard 300-watt bulb. It'll produce over half a million candlepower, three times as much as the present light which has an 8-foot lens. The tower can run unattended. It has an electronic fog-detection system which sets the foghorn into action when a ray of light beamed into the atmosphere is reflected into a photocell, and a dawn-and-dusk sensing setup.

FUEL CELL making 15 kw of electricity direct from propane gas drives an experimental tractor. This latest fuel cell was demonstrated by Allis-Chalmers in Milwaukee. It was also the first full-sized model.

Potential efficiency of the fuel cell is about 90%, compared with only 40% for Diesel engines. Propane, readily available from natural gas and crude oil, reacts in the fuel cell with an electrolyte to create dc.

Other fuel cells using hydrogen and oxygen have been described in this magazine. This particular model is made up of 1,008 individual fuel cells banked in four groups to allow various combinations of voltage and current. They create up to 20 horsepower in this tractor. The attack on fuel cells is through finding new catalysts to aid the reaction of the fuel with the electrolyte. Allis-Chalmers won't say what their catalyst is. In at least one other fuel cell the catalyst is platinum. END

WE'RE MAKING IT EASIER THAN EVER TO BECOME A WELL PAID

RADIO-TELEVISION SERVICE TECHNICIAN

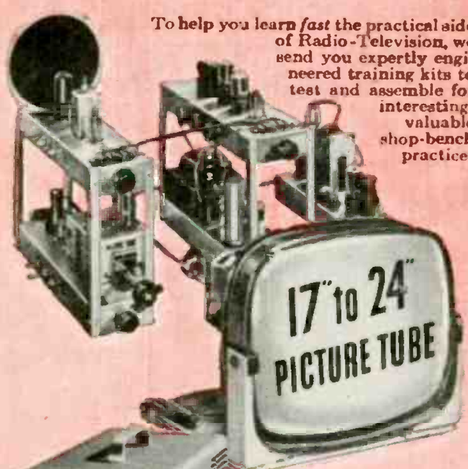
NOW—Just $6 Starts You Training in

RADIO-TELEVISION

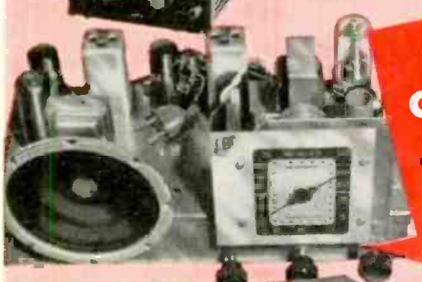
the SPRAYBERRY "Learn-by-Doing" Way . . .

25 BIG, COMPLETE KITS of PARTS & EQUIPMENT

To help you learn *fast* the practical side of Radio-Television, we send you expertly engineered training kits to test and assemble for interesting, valuable shop-bench practice!



- The new Sprayberry Training Television Receiver, built and tested in 5 sections.
- Now offered . . . this fine modern oscilloscope.
- You build this powerful two-band superheterodyne radio receiver.



Big New CATALOG AND Sample Lesson FREE!

You build the new Sprayberry tester—a complete 18-range Volt-Ohm-Milliammeter test meter.

★ ★ ★ ★ This great industry is begging for trained men . . . to step into good paying jobs or a profitable business of their own! Our new plan opens the doors of Radio-Television wide to every ambitious man who is ready to act at once!

Men by the thousands... trained Radio-Television Service Technicians...are needed at once! Perhaps you've thought about entering this interesting, top paying field, but lack of ready money held you back. Now—*just $6 enrolls you* for America's finest, most up to date home study training in Radio-Television! Unbelievable? No, the explanation is simple! We believe Radio-Television *must* have the additional men it needs as quickly as possible. We are willing to do our part by making Sprayberry Training available for less money down and on easier terms than ever before. This is your big opportunity to get the training you need...to step into a fine job or your own Radio-Television Service Business.

Complete Facts Free—Act Now; Offer Limited

Only a limited number of students may be accepted on this liberal and unusual basis. We urge you to act at once...mail the coupon below and get complete details plus our big new catalog and an actual sample lesson—*all free*. No obligation...no salesman will bother you.

HOME STUDY TRAINING IN SPARE TIME

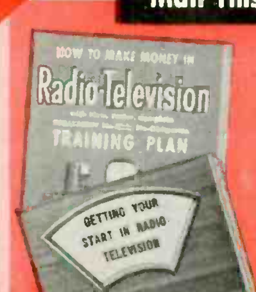
Under world-famous 27-year old Sprayberry Plan, you learn entirely at home in spare time. You keep on with your present job and income. You train as fast or as slowly as you wish. You get valuable kits of parts and equipment for priceless shop-bench practice. And everything you receive, lessons and equipment alike, is all yours to keep.

LET US PROVE HOW EASILY YOU CAN LEARN!

Radio-Television needs YOU! And Sprayberry is ready to train you on better, easier terms, that any ambitious man can afford. *Just $6 starts you!* Mail coupon today... let the facts speak for themselves. You have everything to gain. Let us prove the kind of opportunity that's in store for you!

SPRAYBERRY Academy of Radio-Television
1512 Jarvis Avenue, Dept. 20-E, Chicago 26, Illinois

Mail This Coupon Now—No Salesman Will Call



Sprayberry Academy of Radio-Television
Dept. 20-E, 1512 W. Jarvis Ave., Chicago 26, Ill.
Please rush all information on your ALL-NEW Radio-Television Training Plan. I understand this does not obligate me and that no salesman will call upon me. Include New Catalog and Sample Lesson FREE.

NAME .... Age ....

ADDRESS ....

CITY .... ZONE ..... STATE ....

Correspondence

ELECTROSTRICTIVES

Dear Editor:

Mr. Turner may have confused some readers with his explanation of the operation of "Electrostrictive Ceramics" (September, 1959) through his handling of the voltage, current, power and energy relations involved. It might appear to some from his explanation that electric devices consume less power than magnetic devices due to some fundamental properties. They may have some advantage in this respect, but the reasons are strictly practical, not the result of fundamental properties of the fields involved.

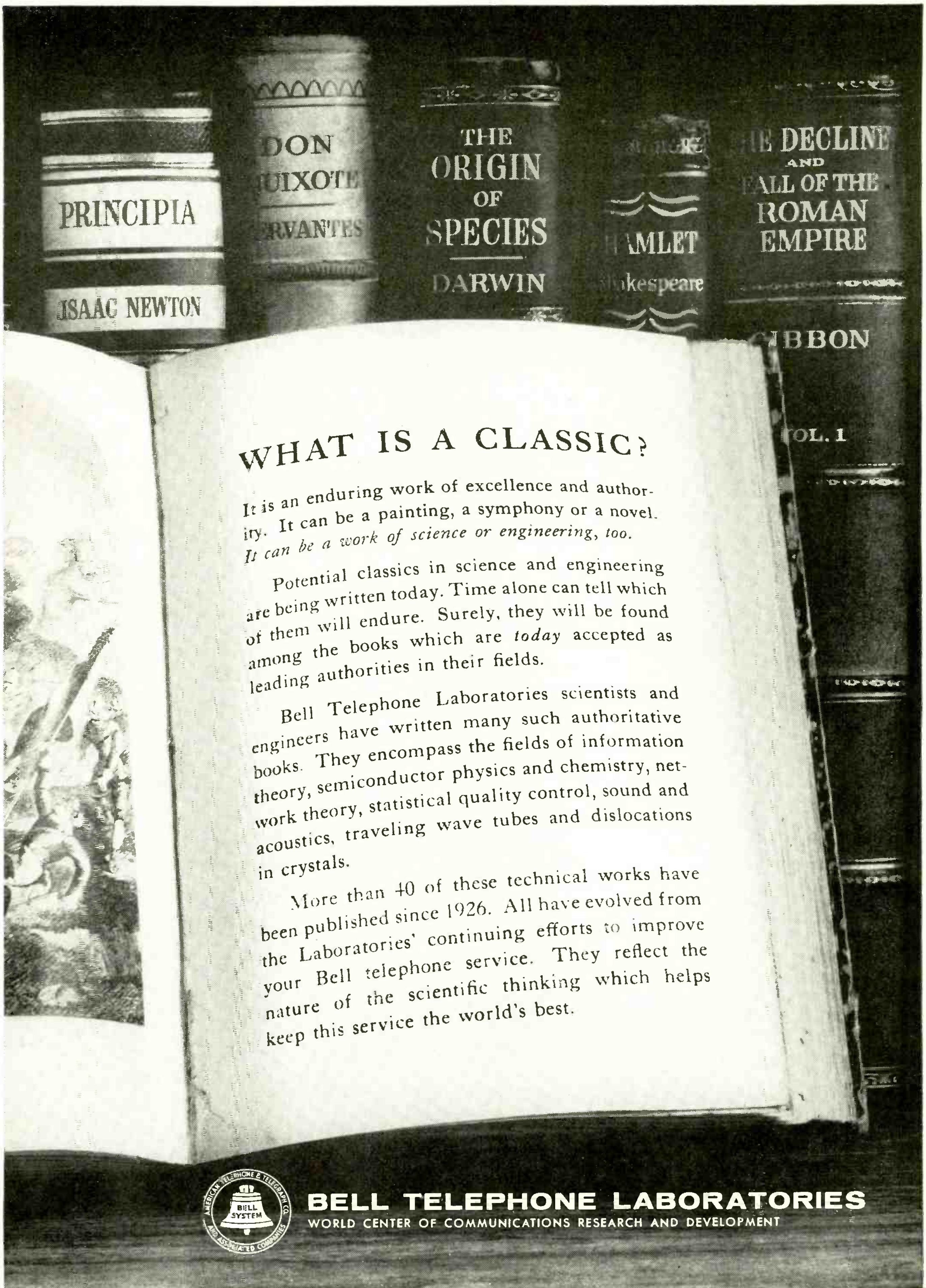
For example, suppose a clamped disc has a voltage applied. Current will flow from the source until it decays to zero. During this changing current flow, power is drawn. If the current is integrated over the entire time interval, we can determine the total *energy* required to produce an electric field in the dielectric. Since no work is done by the disc, the energy is stored in the electric field and may be recovered upon discharge of the capacitor (disc and electrodes).

Now assume that, instead of being clamped, the ceramic disc is free to flex upon application of voltage. If the disc is fixed to some object, such as a speaker cone, and moves against a restraining force, work will be accomplished and this will be reflected in an increased current or, more correctly, in an increase in the total energy.

In either case, clamped or free, after a sufficient time interval the electric-field configuration will be the same under steady-state conditions, and any force produced by the disc may be obtained from the electric field with voltage and without accompanying current flow; therefore with no further expenditure of power. The only difference between the clamped and unclamped disc is the extra energy drawn during the transient state.

Now consider the magnetostrictive case in which setting up a magnetic field distorts a piece of metal, just as the ceramic disc in an electric field. In the magnetic case, with the metal clamped, applying a current will produce a transient voltage while the field is building up. During this time power is drawn from the source. This power is stored in the magnetic field and is recoverable. Once the field reaches a steady state it may theoretically be sustained by current only, without application of voltage, thus costing no

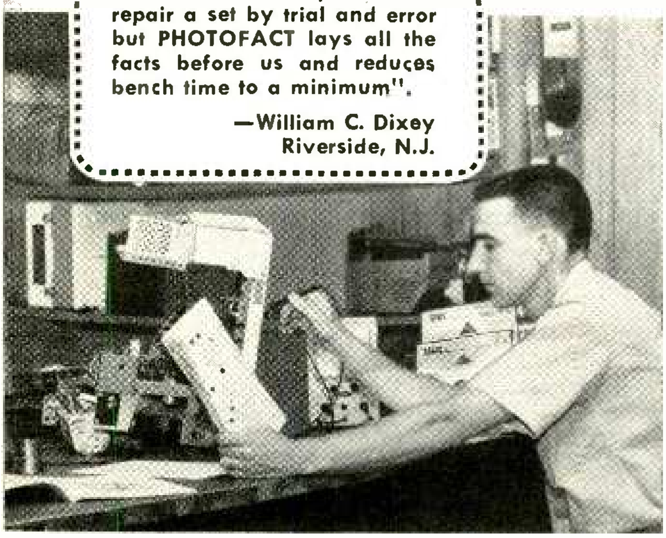
(*Continued on page* 24)


PRINCIPIA
ISAAC NEWTON
DON
UIXOTE
ERVANTES
THE
ORIGIN
OF
SPECIES
DARWIN
AMLET
akespeare
E DECLINE
AND
ALL OF THE
ROMAN
EMPIRE
IBBON
OL. 1
WHAT IS A CLASSIC?
It is an enduring work of excellence and authority. It can be a painting, a symphony or a novel. *It can be a work of science or engineering, too.*
Potential classics in science and engineering are being written today. Time alone can tell which of them will endure. Surely, they will be found among the books which are *today* accepted as leading authorities in their fields.
Bell Telephone Laboratories scientists and engineers have written many such authoritative books. They encompass the fields of information theory, semiconductor physics and chemistry, network theory, statistical quality control, sound and acoustics, traveling wave tubes and dislocations in crystals.
More than 40 of these technical works have been published since 1926. All have evolved from the Laboratories' continuing efforts to improve your Bell telephone service. They reflect the nature of the scientific thinking which helps keep this service the world's best.
BELL SYSTEM
BELL TELEPHONE LABORATORIES
WORLD CENTER OF COMMUNICATIONS RESEARCH AND DEVELOPMENT

Service Technicians! YOU EARN MORE... YOU RATE with the public when you own the PHOTOFACT® service data library!

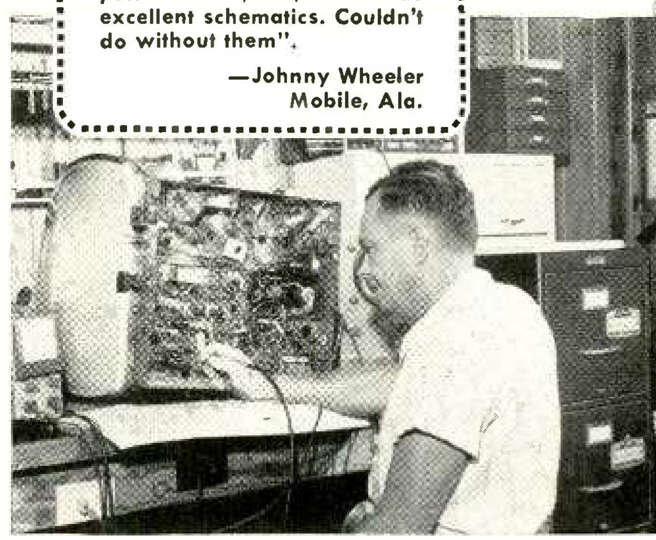
"Time saved is the main reason we feel a real need for the PHOTOFACT Library. We could repair a set by trial and error but PHOTOFACT lays all the facts before us and reduces bench time to a minimum".

—William C. Dixey
Riverside, N.J.



"PHOTOFACT gives us the best and latest information on part numbers, etc., as well as excellent schematics. Couldn't do without them".

—Johnny Wheeler
Mobile, Ala.



Yes, if you are one of the thousands of owners of a complete PHOTOFACT Service Data Library, you are enjoying maximum earnings. It's inevitable, because no matter how expert you are, you can always *save more time* on *any* job, get *more* jobs done daily—EARN MORE, DAY IN AND DAY OUT . . .

Moreover—as the owner of a complete PHOTOFACT Library, *you* know your customers' sets *best!* You can actually show each customer you have the PHOTOFACT Folder covering his very own set. Result: You command public respect and acceptance which paves the way to expanded business for you...

HERE'S HOW TO STAY AHEAD...

Today, the truly successful Service Technicians are those who own the complete PHOTOFACT Library, who can meet and solve any repair problem—faster and more profitably. And these men *keep ahead* because they're on a Standing Order Subscription with their Distributors to receive all new PHOTOFACTS as they are released monthly.

For **PHOTOFACT** Library Easy-Buy Plan details and Standing Order Subscription, see your Sams Distributor today, or write to Howard W. Sams...

BIG NEW PLUS "PEET" PROGRAM

If you now own a **PHOTOFACT** Library, you can apply at once for qualification in the powerful new "PEET" program. Designed to help you gain deserved recognition as a reputable businessman; develop and command public respect; justify better earnings warranted by your business investment and skill; pave the way to expanded business and increased profits for you. Ask your Sams Distributor about "PEET" or write to Howard W. Sams.

HOWARD W. SAMS & CO., INC.
2205 E. 46th St., Indianapolis 6, Ind.

☐ Send me full details on the new "PEET" Program, designed to build prestige and business for the Service Technician who qualifies. Include full information on the Easy-Buy Plan and Free File Cabinet deal.

☐ I'm a Service Technician: ☐ full-time: ☐ part-time

My Distributor is: ____________

Shop Name ____________

Attn: ____________

Address ____________

City ____________ Zone ____ State ____

power. In practice, however, there is resistance in the circuit, and voltage must be used to maintain current flow through the resistance. In addition, if work is done by the metal as the field is established, then extra power will be consumed. If the magnetostrictive device (metal) does the same work the electrostrictive device (ceramic) does, the extra energy beyond that needed to set up the steady field will be identical (neglecting secondary effects such as dielectric or hysteresis losses).

It can be seen that there are two practical (but not theoretical) reasons why electric-field devices are sometimes superior to magnetic-field ones. First, current sources are not available, except as derived from voltage sources, with accompanying power expenditure. Second, resistance causes loss of power.

Convair Instruments A. SILVERMAN
San Diego, Calif.

INDUSTRIAL SERVICE?

Dear Editor:

Many of your articles have been encouraging service technicians to take on more commercial gear to service.

I started servicing radios back in 1925. . . . Often customers have asked me to work on medical and factory electronics equipment. Almost without exception I have met opposition from the manufacturers and supply houses.

I would never advise a radio or TV technician to try to service commercial equipment. The manufacturers prefer to send a salesman to make the service call, so he can persuade the user to replace the faulty gear with new equipment for many thousands of dollars.

As an example I have been attempting for 5 months to get parts and service instructions for a NATCO 3030-1 16 mm sound projector. I have called and even written to several companies, but with no success at all. What would you suggest in a case like this? After every ordeal like this I swear I will never accept a service job for anything but radio, phono or TV.

Fairborn, Ohio LESTER BERRY

This letter expresses the experience of a number of technicians. It is unfortunate that some companies are anxious to have their equipment serviced at the same time that many technicians are interested in servicing it, but they often can't seem to get together.

This situation is improving somewhat of late, but it is still too sticky.—*Editor*

$2 PREAMPLIFIER

Dear Editor:

I have just completed the "Transistor Preamp", on page 46 of the February, 1958, RADIO-ELECTRONICS. This preamplifier does everything Mr. Ladd, the author, says it should. The wiring was easy . . . the audio is terrific. It cost me only $2, and took only an hour to build. I recommend it to anyone interested in an inexpensive preamp for use with mikes. Thank you.

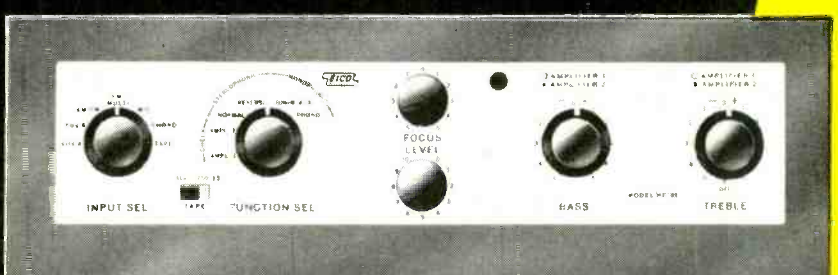
Flushing, N.Y. DOUGLAS WEBER

END

In STEREO and Mono Hi-Fi . . . the experts say your best buy is EICO®

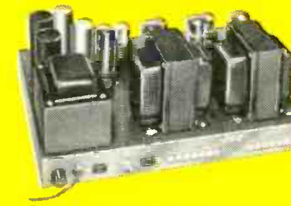
"The overall design of the HF-81 is conservative, honest and functional. It is a good value considered purely on its own merits, and a better one when its price is considered as well."
—Hirsch-Houck Labs (HIGH FIDELITY Magazine)

- Advanced engineering • Finest quality components
- "Beginner-Tested," easy step-by-step instructions
- LIFETIME service & calibration guarantee at nominal cost
- IN STOCK — compare, then take home any EICO equipment — right "off the shelf"— from 1500 neighborhood EICO dealers.



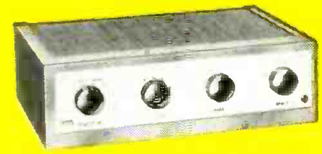
Stereo Amplifier-Preamplifier HF81


Stereo Preamplifier HF85


70W Stereo Power Amplifier HF87
28W Stereo Power Amplifier HF86


FM Tuner HFT90 FM/AM Tuner HFT 92
AM Tuner HFT94


Stereo Integrated Amplifier AF4


12W Mono Integrated Amplifier HF12
Other Mono Integrated Amplifiers: 50, 30, & 20W (use 2 for stereo)


2-Way Bookshelf Speaker System HFS1
3-Way Speaker System HFS3
2-Way Speaker System HFS5

Over 1 MILLION EICO instruments in use throughout the world

Add 5% in the West.

HF81 Stereo Amplifier-Preamplifier selects, amplifies, controls any stereo source & feeds it thru self-contained dual 14W amplifiers to a pair of speakers. Provides 28W monophonically. Ganged level controls, separate balance control, independent bass & treble controls for each channel. Identical Williamson-type, push-pull EL84 power amplifiers. **"Excellent"** — SATURDAY REVIEW; HI-FI MUSIC AT HOME. **"Outstanding quality . . . extremely versatile."**—ELECTRONICS WORLD LAB-TESTED. **Kit $69.95. Wired $109.95.** Includes cover.

HF85 Stereo Preamplifier is a complete, master stereo preamplifier-control unit, self-powered for flexibility & to avoid power-supply problems. Distortion borders on unmeasurable even at high output levels. Level, bass, & treble controls independent for each channel or ganged for both channels. Inputs for phono, tape head, mike, AM, FM, & FM-multiplex. One each auxiliary A & B input in each channel. Switched-in loudness compensator. **"Extreme flexibility . . . a bargain."**—HI-FI REVIEW. **Kit $39.95. Wired $64.95.** Includes cover.

New HF87 70-Watt Stereo Power Amplifier: Dual 35W power amplifiers of the highest quality. Uses top-quality output transformers for undistorted response across the entire audio range **at full power** to provide utmost clarity on full orchestra & organ. IM distortion 1% at 70W, harmonic distortion less than 1% from 20 to 20,000 cps within 1 db of 70W. Ultra-linear connected EL34 output stages & surgistor-protected silicon diode rectifier power supply. Selector switch chooses mono or stereo service; 4, 8, 16, and 32 ohm speaker taps, input level controls; basic sensitivity 0.38 volts. Without exaggeration, one of the very finest stereo amplifiers available regardless of price. Use with self-powered stereo preamplifier-control unit (HF85 recommended). **Kit $74.95. Wired $114.95.**

HF86 28W Stereo Power Amplifier **Kit $43.95. Wired $74.95.**

FM Tuner HFT90: Prewired, prealigned, temperature-compensated "front end" is drift-free. Prewired exclusive precision **eye-tronic®** traveling tuning indicator. Sensitivity: 1.5 uv for 20 db quieting; 2.5 uv for 30 db quieting, full limiting from 25 uv. IF bandwidth 260 kc at 6 db points. Both cathode follower & FM-multiplex stereo outputs, prevent obsolescence. Very low distortion. **"One of the best buys in high fidelity kits."** — AUDIOCRAFT. **Kit $39.95*. Wired $65.95*. Cover $3.95.** *Less cover, F.E.T. Incl.

New AM Tuner HFT94. Matches HFT90. Selects "hi-fi" wide (20c – 9kc @ —3 db) or weak-station narrow (20c–5kc @ —3 db) bandpass. Tuned RF stage for high selectivity & sensitivity; precision **eye-tronic®** tuning. **Kit $39.95. Wired $65.95.** Incl. Cover & F.E.T.

New FM/AM tuner HFT92 combines the renowned EICO HFT90 tuner with excellent AM tuning facilities. **Kit $59.95. Wired $94.95.** Includes covers and F.E.T.

New AF-4 Stereo Amplifier provides clean 4W per channel or 8W total output. Inputs for ceramic/crystal stereo pick-ups, AM-FM stereo, FM-multi stereo. 6-position stereo/mono selector. Clutch-concentric level & tone controls. Use with a pair of HFS-5 Speaker Systems for good quality, low-cost stereo. **Kit $38.95. Wired $64.95.**

HF12 Mono Integrated Amplifier provides complete "front-end" facilities and true high fidelity performance. Inputs for phono, tape head, TV, tuner and crystal/ceramic cartridge. Preferred variable crossover, feedback type tone control circuit. Highly stable Williamson-type power amplifier circuit. Power output: 12W continuous, 25W peak. **Kit $34.95. Wired $57.95.** Includes cover.

New HFS3 3-Way Speaker System Semi-Kit complete with factory-built ¾" veneered plywood (4 sides) cabinet. Bellows-suspension, full-inch excursion 12" woofer (22 cps res.), 8" mid-range speaker with high internal damping cone for smooth response, 3½" cone tweeter. 2¼ cu. ft. ducted-port enclosure. System Q of ½ for smoothest frequency & best transient response. 32-14,000 cps clean, useful response. 16 ohms impedance. HWD. 26½", 13⅞", 14⅜". Unfinished birch **$72.50.** Walnut, mahogany or teak **$87.50.**

New HFS5 2-Way Speaker System Semi-Kit complete with factory-built ¾" veneered plywood (4 sides) cabinet. Bellows-suspension, ⅝" excursion, 8" woofer (45 cps res.), & 3½" cone tweeter. 1¼ cu. ft. ducted-port enclosure. System Q of ½ for smoothest frequency & best transient response. 45-14,000 cps clean, useful response. HWD: 24", 12½", 10½". Unfinished birch **$47.50.** Walnut, mahogany or teak **$59.50.**

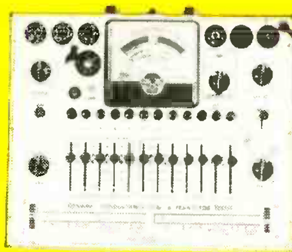
HFS1 Bookshelf Speaker System complete with factory-built cabinet. Jensen 8" woofer, matching Jensen compression-driver exponential horn tweeter. Smooth clean bass; crisp extended highs. 70-12,000 cps range. 8 ohms. HWD: 23" x 11" x 9". Price **$39.95.**

HFS2 Omni-Directional Speaker System (not illus.) HWD: 36", 15¼", 11½". **"Eminently musical"** — HIGH FIDELITY. **"Fine for stereo"** — MODERN HI-FI. Completely factory-built. Mahogany or walnut **$139.95.** Blond **$144.95.**

IMPORTANT NOTE: All EICO kits built according to our instructions, and all EICO factory-assembled equipment, conform to the high standards and specifications as published in EICO literature and advertisements. All EICO factory-assembled equipment is completely and meticulously hand-wired throughout — no printed circuitry; each factory-assembled unit is 100% final-tested throughout for each feature and function — no "spot" or "partial" checking. In EICO's final-test techniques, nothing is left to chance.

Fill out coupon on other side for FREE CATALOG. Ask your dealer about EICO'S exclusive Stereo Records Bonus.

The specs prove it...your best buy is EICO®

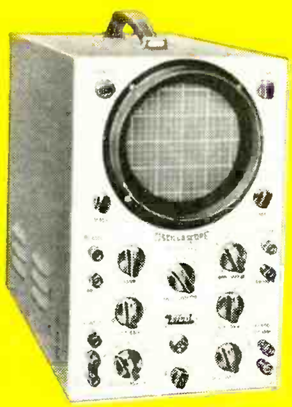


A
DYNAMIC CONDUCTANCE TUBE & TRANSISTOR TESTER #666
KIT $69.95 WIRED $109.95
Complete with steel cover & handle

B
TV-FM SWEEP GENERATOR AND MARKER #368
KIT $69.95 WIRED $119.95

C
RF SIGNAL GENERATOR #324
KIT $26.95 WIRED $39.95

D
PEAK-TO-PEAK VTVM #232 & UNIPROBE (pat. pend)
KIT $29.95
WIRED $49.95



E
COLOR & MONOCHROME DC TO 5 MC LAB & TV 5" OSCILLOSCOPE #460
KIT $79.95 WIRED $129.50

5" PUSH-PULL Oscilloscope #425:
Kit $44.95 Wired $79.95

A **Tests all receiving tubes** (picture tubes with adapter), n-p-n and p-n-p transistors. Composite indication of Gm, Gp & peak emission. Simultaneous selection of any one of 4 combinations of 3 plate voltages, 3 screen voltages, 3 ranges of continuously variable grid voltage (with 5% accurate pot.). Sensitive 200 ua meter. 10 six-position lever switches: freepoint connection of each tube pin. 10 pushbuttons: rapid insert of any tube element in leakage test circuit. Direct reading of inter-element leakage in ohms. New gear-driven rollchart. **CRA Adapter $4.50.**

B **Entirely electronic sweep circuit with accurately-biased increductor** for excellent linearity. Extremely flat RF output. Exceptional tuning accuracy. Hum and leakage eliminated. 5 fund. sweep ranges: 3-216 mc. Variable marker range: 2-75 mc in 3 fund. bands, 60-225 mc on harmonic band. 4.5 xtal marker osc., xtal supplied. Ext. marker provision. Attenuators: Marker Size, RF Fine, RF Coarse (4-step decade). Narrow range phasing control for accurate alignment.

C **150 kc to 435 mc with ONE generator** in 6 fund. bands and 1 harmonic band! ±1.5% freq. accuracy. 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. mod. amplifier: only 3.0 v needed for 30% mod. Turret-mounted, slug-tuned coils for max. accuracy. Fine and Coarse (3-step) RF attenuators. RF output 100,000 uv, AF output to 10 v.

D **Uni-Probe — exclusive with EICO** — only 1 probe performs all functions: half-turn of probe tip selects DC or AC-Ohms. Calibration without removing from cabinet. Measure directly p-p voltage of complex & sine waves: 0-4, 14, 42, 140, 420, 1400, 4200. DC/RMS sine volts: 0-1.5, 5, 15, 50, 150, 500, 1500 (up to 30,000 v. with HVP probe, & 250 mc with PRF probe). Ohms: 0.2 ohms to 1000 megs. 4½" meter, can't-burn-out circuit. 7 non-skip ranges on every function. Zero center.

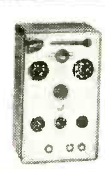
E **Features DC amplifiers!** Flat from DC to 4.5 mc, usable to 10 mc. Vert. Sens.: 25 mv/in.; input Z 3 megs; direct-coupled & push-pull throughout. 4-step freq.-compensated attenuator up to 1000:1. Sweep: perfectly linear 10 cps — 100 kc (ext. cap. for range to 1 cps). Pre-set TV V & H positions. Auto sync. lim. & ampl. Direct or cap. coupling; bal. or unbal. inputs; edge-lit engraved lucite screen with dimmer control; plus many more outstanding features.

FREE CATALOG shows you HOW TO SAVE 50% on 65 models of top quality professional test equipment. MAIL COUPON NOW!

New Transistor Portable Radio RA-6
Kit $29.95
Wired $49.95
Incl. F.E.T.; less 9V batt. Prealigned RF, IF xfmrs; push-pull audio; 6" spkr.

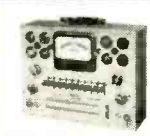
*PAT. PEND.

NEW Power & Bias Supply for Transistorized Eqpt. #1020 *
Kit $19.95
Wired $27.95



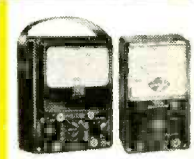
NEW Tube & CRT Fil. Tester #612
Kit $3.95
Wired $5.95
Fast-checks radio/TV tubes, pilot lamps, etc.

Series/Parallel
R-C Combination Box #1140
Kit $13.95
Wired $19.95



Tube Tester #625
Kit $34.95
Wired $49.95
• tests 600 mil series string type tubes
• illuminated roll-chart
Pix Tube Test Adapter $4.50

6V & 12V Battery Eliminator & Charger #1050
Kit $29.95
Wired $38.95
Extra-filtered for transistor equipt.
#1060 Kit $38.95
Wired $47.95



20,000 Ohms/Volt V-O-M #565
Kit $24.95
Wired $29.95
1000 Ohms/Volt V-O-M #536
Kit $12.90
Wired $14.90

EICO®

33-00 Northern Blvd. L.I.C. 1, N.Y.

Add 5% in the West. © 1959

◀ TURN PAGE FOR MORE EICO VALUES

R-C Bridge & R-C-L Comparator #950B
Kit $19.95
Wired $29.95
Reads 0.5 ohms-500 megs, 10 mmfd-5000 mfd, power factor

VTVM Probes

	Kit	Wired
Peak-to-Peak	$4.95	$6.95
RF	$3.75	$4.95
High Voltage Probe-1		$6.95
High Voltage Probe-2		$4.95
Scope Probes		
Demodulator	$3.75	$5.75
Direct	$2.75	$3.95
Low Capacity	$3.75	$5.75

EICO **C-12**
33-00 Northern Blvd.
L.I.C. 1, N.Y.

Show me HOW TO SAVE 50% on ☐ Test Instruments ☐ Hi-Fi ☐ Ham Gear. ☐ Send free Stereo Hi-Fi Guide. Send me FREE Catalog, name of neighborhood dealer.

Name..
Address..
City.......................Zone......State....................

Radio-Electronics
Hugo Gernsback, Editor

BILLIONS OF ELECTRONIC FACTS

... Astounding Growth of Electronics Calls for New Strategy ...

AN important government official, commenting on the chaos of electronic research, recently rebuked American research scientists for failing to make use of available Russian data. This occurred in early October, during the Chicago meeting of the National Electronics Conference, and was described in a news report:

"John C. Green, director, Office of Technical Services, Department of Commerce, said his office began translating Soviet scientific reports more than a year ago and, because of the impact of Russia's sputniks, had expected these translations to total 25% to 50% of its sales of science papers. Actually, he said, they amounted to only $50,000 out of the total of $500,000, or 10%.

"Mr. Green offered several reasons—researchers don't want new sources of information because they are already floundering in reports; some still discount the worth of Russian data, and others simply don't know the Russian translations are available.

"What scientific research needs, Mr. Green declared, is a new professional—an 'information scientist'—to peruse the mountain of information and dispense relevant data to working researchers."

"Floundering in reports" is stating the condition far too mildly—"drowning in reports" would, in our opinion, be more to the point.

How could it be otherwise in an industry that mushrooms at such a fantastic rate of growth that it doubles its new inventions and devices every few years? What will the electronics field be in 10 years, 25 years, 50 years hence?

Today we have millions of electronic facts available to our researchers. Soon there will be billions of facts—what then?

Several times in recent years, research teams have developed "new" devices, only to find that identical ones had been in use elsewhere for a different purpose. They had been fully described in technical papers, too.

Let us cite a specific example, which we may call The Great Electronic Cigarette Hoax. Recently, full-page ads in newspapers throughout the country announced the "new" "electronic," "ventilated," "aerated" or "air-conditioned" cigarettes—a breakthrough in smoking. Just how new and revolutionizing is this?

In the early 1890's, when the present writer was a young boy in Europe, one of the most hilarious jokes went as follows: You asked a friend to lend you his cigarette-paper book—usually Riz-La Croix brand. You then proceeded to roll your own cigarette. But instead of returning *his* book of cigarette papers, you substituted your own. This one you had "prepared" by placing it on a metal plate, wired to the hot side of a spark coil. The other side went to a sharp probe, which you carefully guided for 5 minutes over the cigarette book while the spark coil was "on." Result: every one of the fine cigarette papers was punctured with thousands of invisible holes.

Now, when your victim tried to smoke his cigarette with such a "super-aerated" paper, there was no smoke forthcoming no matter how furiously he drew and puffed, simply because the paper acted as an excellent sieve. All your friend got was air and frustration!

The idea was described in French and German books in the 90's, as well as in *Practical Electrics*, one of the writer's magazines (May, 1922, page 279).

Now the hoary old idea has been re-invented—as happens so often—by the cigarette manufacturers, who play the same, albeit attenuated, joke on their customers, simply using *fewer holes* in the cigarette paper. Carefully regulating the frequency of the holes along the shaft of the cigarette causes the smoker to get less smoke and more air—also less nicotine and tar. This really gives you a cigarette with an *electronic carburetor*. Of course, you no longer get your money's worth in tobacco, but then—sh-h—the cancer risk is less, too. This makes everybody happy—manufacturer and consumer as well. Hurrah for electronics!

Let us give cigarette manufacturers the benefit of the doubt and admit that they probably never heard of the ancient spark-coil–cigarette-paper joke; which is precisely the point of this article.

Useless, uncoordinated research is dogging *every* industry today. Duplication of research, effort and money is the order of the day. Will it stop before all of our progress is engulfed?

There seems to us only one sensible remedy—*a National Facts Center* of the Federal Government. Only the Government is big enough to build and run such a center. It would be far larger than even the Pentagon. Nor would the information which it supplied be free—not any more free than the US Patent Office services. Whatever information was demanded by any industry or individual would cost a statutory fee, determined by various schedules.

The Center would be equipped with possibly the largest array of electronic computers in existence. Every important scientific, electronic and industrial fact would be coded and carded, cross-indexed for various industries. All these billions of facts would be fed to the computers in such a manner that, upon inquiry, the proper information could be given, often within seconds.

These facts and information would not come solely from American sources. That would defeat the whole purpose. Facts would be culled from every country of the world, because only in this manner could the Center be all-comprehensive.

The Center would have to be closely allied with the Patent Office for intimate reciprocal information of every kind—indeed each would be dependent upon the other.

But industry, researchers, inventors and others would not have to waste their time any longer in useless research, when the *key* to their problem would be forthcoming within minutes from the Center. To be sure, the key itself would solve no problems—it would state, however, *where* your vital information could be had. It would be an immense shortcut to all research.

How long does electronic computer information—on magnetic tape and memory magnetic cores—last? Remember the Center would entrust to the computers thousands of billions of vital facts.

The experts in the field assure us that magnetic Mylar tape—the tape itself and the magnetic iron oxide—will last, at the present state of the art, as least 100 years. It may, with improvements to come, last much longer.

Magnetic cores and the magnetism impressed on them, we are informed, will probably last hundreds of years.

All this need not worry anyone, because the thousands of scientists and technicians of the future National Facts Center would continuously replace old magnetic tapes and memory cores with new ones as a routine procedure. —*H.G.*

A Merry Christmas And A Happy New Year From The Editors

Traveling-wave tubes which can reach beyond 25,000 mc efficiently spell increased power and range for shf communications. Here's how these unusual devices operate

LOWDOWN ON TRAVELING-WAVE TUBES

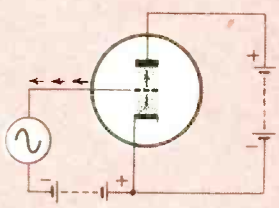


Fig. 1—With an increasing signal there are more electrons between the grid and cathode.

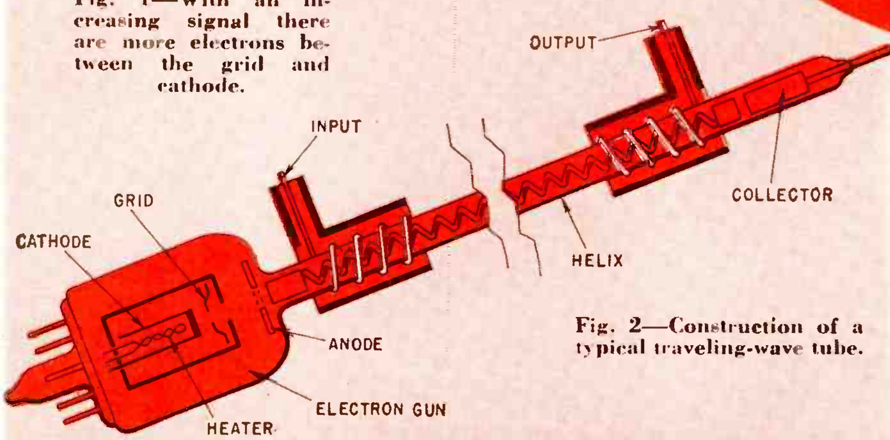
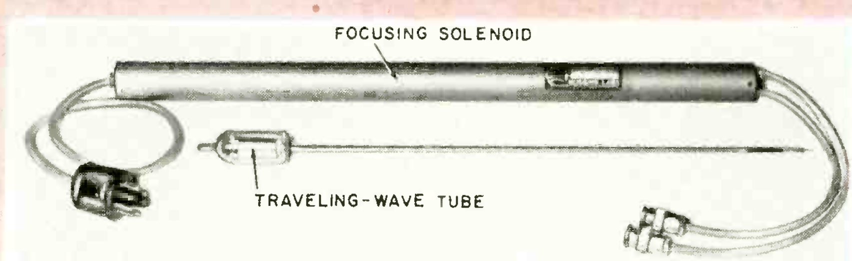


Fig. 2—Construction of a typical traveling-wave tube.



(Courtesy Huggins Laboratories Inc.)

Fig. 3—Typical traveling-wave tube and the solenoid used for focusing.

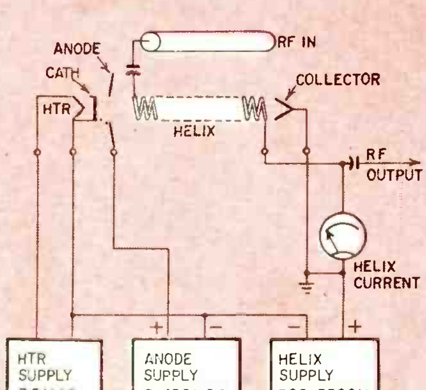


Fig. 4—The circuits needed to operate a traveling-wave tube.

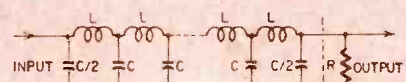


Fig. 5—Typical delay line with lumped components.

By TOM JASKI

ONE of the most difficult tasks in electronics is amplifying rf voltages above 1,000 mc. Yet here we find the most important and versatile applications of communications, long-distance remote control and military defense measures.

Special tubes with very closely spaced electrodes, such as the lighthouse and pencil triodes, solve some of the problems up to 3,000 mc. Above this, on the transmitting end we just oscillate up a storm with bigger and better klystrons and magnetrons, and on the receiving end we heterodyne the feeble signals with a local oscillator and use a lot of if amplification.

The disadvantages of such a system are obvious. We depend on the brute force of a signal which can easily be interrupted by interfering conditions and distorted by noise, or we have to make the transmitting range so small that we can hardly miss.

Traveling-wave tubes offer a new approach to the problem. How they do this is what this story is about. But to understand the tubes, we must first understand the problem we are dealing with.

Transit-time problem

The core of the trouble is *transit time*. It takes electrons a finite time to travel from the cathode to the plate. In the tubes in your radio or television receiver the transit time is about .001 μsec. One millimicrosecond (1 mμsec) doesn't seem like a lot of time and at broadcast frequencies it isn't. At 1 mc the transit time is just 1/1,000 cycle. But at 1,000 mc, this would be as long as a whole cycle. The ordinary tube would long ago have ceased amplifying. Let's see why.

Fig. 1 helps explain the situation. Here we have a triode with a negative grid bias. As we apply an input signal, the grid becomes less and less negative on the positive swing of the signal. Because of this the number of electrons in the stream from the cathode becomes greater, and we find a much denser electron population between grid and cathode than between grid and plate, because a number of the electrons haven't had time to get through the grid to the plate side yet. Because more charges (electrons) are approaching the grid than are leaving, the approaching mass of electrons, slowed down by the grid (still negative with respect to the cathode), imparts energy to it—actually does work in repelling electrons from the grid out into the external grid circuit. When the input signal passes its positive peak and start to decrease, more electrons will be between the grid and plate—leaving the grid—and electrons flow back into the grid from the external circuit. When the signal reaches a negative maximum, this capacitive grid current reverses itself, reaching zero well before the voltage.

In other words, we have a *phase shift*. The grid current leads the signal voltage, and we have a capacitive reactance in the grid circuit. Now, you know that the higher the frequency the lower the capacitive reactance becomes, so the tube draws current from the input circuit, loads it and lowers the input signal because of lowered grid-circuit impedance. The phase shift is proportional to the frequency and the transit time.

Second, we can regard the tube's dynamic plate resistance as a complex quantity, made up of the resistive characteristics of the electron stream and the interelectrode capacitance in series. This, too, decreases plate resistance at higher frequencies. The lowered grid impedance lowers the transconductance. The amplification of the tube is the product of the transconductance and the plate resistance. Thus the amplification of the tube is very drastically reduced at these higher frequencies.

This then is the transit-time problem—how to increase amplification which has been reduced because the electrons are slow. All the foregoing is pertinent to our discussion of traveling-wave tubes. For they are a good practical example of the proverb "If you can't lick them, join them." Instead of fighting transit time in traveling-wave tubes, we turn it to our advantage.

First, let us look at the construction of the traveling-wave tube (TWT). Fig. 2 shows a schematic section of one (and in Fig. 3 you can see what it looks like). At the left is an electron gun, similar to the type used in cathode-ray tubes, which is capable of producing a collimated beam of electrons in the order of 1/8 inch in diameter. The anode serves the usual purpose of accelerating the electrons. Then comes a long thin glass tube with a wire helix inside. The helix may have as many as 50 turns per inch. At the far right is the connection to the helix, and at two points on the tube we see a spiral wound outside the glass. Then, finally, at the far right there is a positive collecting electrode. Typically the whole assembly is about 12 to 15 inches long (although much shorter tubes are being made experimentally) and the helix is about 9 inches long. The diameter of the helix should be about 11/64 inch and the glass tube around it somewhat under 3/8 inch.

The electron gun is not very special, except for the shape of the beam, which is of uniform thickness. Fig. 4 shows the connections to the tube's elements. There is a heater supply, an anode supply and a variable high-voltage supply for the helix. Then there are the input and output connections which, as we see, are made by the spiral around the glass and not by direct connection to anything.

How it works

We talked about transit time, and we know that the electrons take a certain finite time to travel from the cathode to the collector electrode. To make use of the ability of this electron beam to impart energy to a wave, we must try to make a wave travel at about the same speed as the electrons. This is the purpose of the helix. The next logical question is, "How does the helix work?"

Let's assume for the moment that we manage to introduce a wave on the helix from the input spiral. (How this is done is explained later.) A wave normally travels through space or along a path in a waveguide or, in the simplest terms, along a wire, with about the speed of light. But if we wind the wire into a helix, we create capacitance between the turns, and the turns themselves are in effect inductances. Now if you know what a conventional delay line consisting of series inductances and parallel capacitors looks like (see Fig. 5), you can see the analogy between the helix and the delay line. In fact, the helix is enough of a delay line to slow the wave down by a factor of maybe as much as 30.

As the slowed-down wave travels the length of the tube, we shoot the electron stream down through the center of it. Now what happens? The wave has both an electrostatic and a magnetic component. The magnetic component isn't useful to us. In fact all *it* does is try to scatter the electrons and break up our nice tight stream. However, we counteract this effect.

The electrostatic component is what we use. We represent the instantaneous pattern of the field due to the wave in the tube as in Fig. 6, where the arrows indicate (by convention) the acceleration in a positive direction (the field will try to accelerate positive charges in the direction of the arrows, and electrons—which are negative charges —in the opposite direction). Thus some electrons will be speeded up and some slowed down, under the influence of the wave, and the beam of electrons will alternately be made denser and less dense (Fig. 7), depending on which part of the wave they are nearest to (whether they are moving toward a more positive or more negative area).

We have produced bunches of electrons all along the beam. By changing the relative collector voltage we can change also the average speed of the electrons, and by choosing our velocities just right we can assure that the bunches of electrons we form with the wave field are either always in a *retarding* or an *accelerating* field. (Arrows pointing to the left accelerate, and to the right retard, electrons moving along the tube from left to right.)

If we retard an electron (or anything else), we make it give up some of its kinetic energy. This energy must go somewhere, for it cannot be lost. In our case the energy is imparted to the wave, which then becomes a little stronger each time a bunch of electrons gives it some energy. To do this we make sure that our bunches are always in the retarding part of the field (in

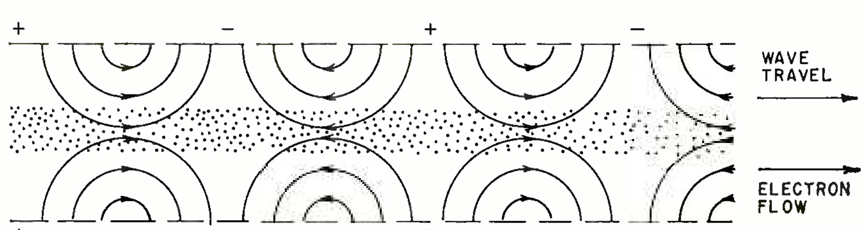


Fig. 6—The field pattern of the traveling wave at any one instant.

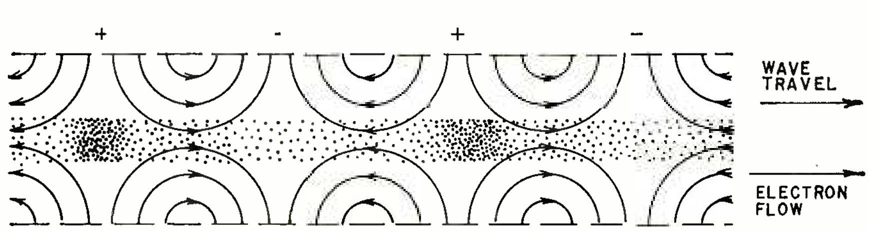


Fig. 7—The field interacts with the electron stream, bunching the electrons.

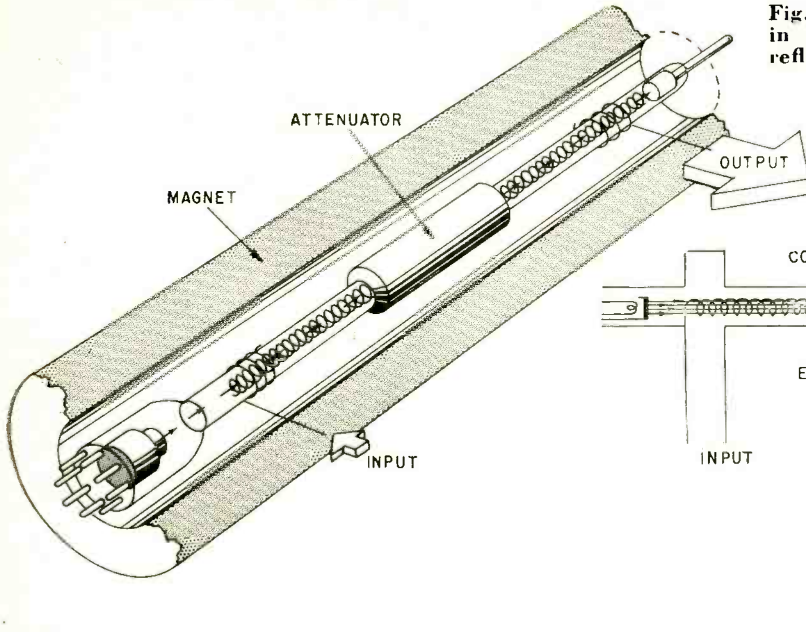


Fig. 8—Simplified diagram showing the tube mounted in its focusing solenoid. The attenuator helps keep reflected energy from traveling back down the tube in shf amplifiers.

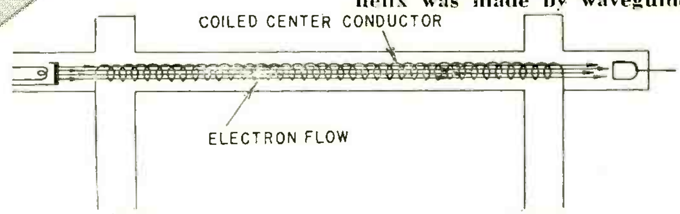


Fig. 9—In early models coupling to the helix was made by waveguide sections.

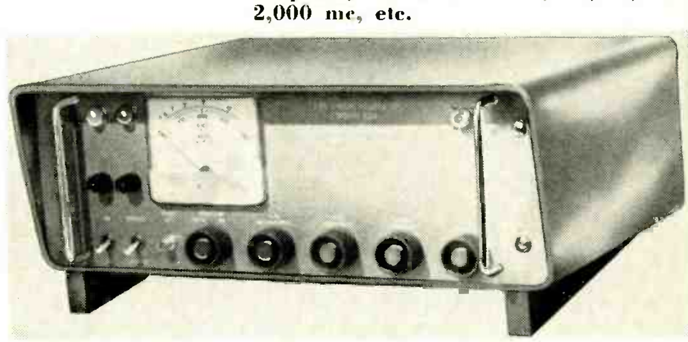


Fig. 10—One of a series of signal generators made by Wave Particle Corp. The individual units cover the 500–15,000-mc spectrum in a series of 2-to-1 frequency bands: 500–1,000, 1,000–2,000 mc, etc.

Fig. 7, area where the arrows point to the right). Thus, the wave we put in comes out with much more energy—it has been amplified.

To counteract the magnetic component which tends to scatter the electron beam we use a magnetic focusing field around the tube. This can be done with a solenoid (Fig. 8) or with a structure of permanent magnets spaced along the length of the tube.

Input and output circuits

What we have left to explain is how we get the wave on the helix in the first place, and how we get it out again with something which does not even touch the wire. To understand this, you must grasp how a waveguide can be energized by a simple stub antenna (or simply accept the fact). Actually the development of waveguides followed the use of coaxial lines, and a waveguide can be regarded as a coaxial line with the center conductor removed except at the very ends, where for purposes of putting the energy into the guide and taking it out we have left the center conductor, or something which acts like a center conductor. This can take many forms, and it need not be parallel to the walls of the waveguide.

In early traveling-wave tubes, input and output were handled by a short section of waveguide (see Fig. 9) which had to surround the helix for a short section. The helix was then functioning as the abbreviated center conductor. However, as the development of waveguides progressed (delivering such new concepts as the G-string and the flat printed-circuit guides), the builders of TWT's understood that an actual conventional waveguide section was not required and that a simple wire wrapped around the glass would be just as good. Essentially, this is the idea of how we get the wave in and out of the helix with the simple outside spiral.

The electrons' velocity in their long journey through the helix has to be very high if they are to reach the collector electrode. By putting a high voltage on the helix, we have some control over this velocity. So by controlling the helix (and collector) voltage we can make the tube suitable for waves which travel at different speeds. Since a delay line acts differently upon voltages of different frequencies, in effect we have a tube which we can use for various frequencies.

Actually the traveling-wave tube is a wide-band device, but it need not always be. If we make the tube too efficient, we may end up with a very-narrow-band tube. Here's why. If we take out the wave from the helix, say in a waveguide fashion, the waveguide in turn can reflect energy into the helix. With the reflected wave traveling backward in the tube, the efficiency will be lowered a bit. However if the reflected wave reaches the other end at all, it will again be reflected, now forward, and will then be in the right phase for amplification. The amplified, twice-reflected wave will be added to the original, and so we have positive feedback and oscillation. Tubes designed for amplification only are so designed that the reflected portion never reaches the front end again. This is done by building losses into the helix or placing an attenuator consisting of a split graphite cylinder around it. Tubes made for oscillators use the reflection. But with *the helix voltage constant*, this tube will oscillate only in a *narrow band of frequencies, no matter what we do to the rest of the circuit.* Thus we have the apparent contradiction that we have a narrow-band device, which can be swept (by changing the helix voltage) over its possible range (of narrow bands).

Some readers might have difficulties visualizing a "traveling" wave when there isn't anything really moving, like particles or such. I found it useful to think of a childhood game played with a rope. If you lay the rope on the ground and vigorously wag one end up and down, the whole rope will soon be in motion, although not running away from you. Progressively the "bulges" in the rope will seem to travel forward. These traveling "bulges" illustrate the idea of a traveling wave. It isn't going any place, it's just an amplitude which appears in different places. If a rope (or, better, a violin string) is wagged hard enough, particularly when it is stretched, you get the opposite or "standing" wave, which shows the same amplitude in the same place and seems to have a "bulge" which stands still. And before we forget, the backward "traveling" energy in the oscillator tube does of course cancel, in its first reflection down the tube, some of the effect of the first "forward" wave, but it is only a small percentage and more than made up for by the amplified second reflected "forward" wave. We

MYSTERY LIGHT

Point at it and it lights. Walk away and it goes out again

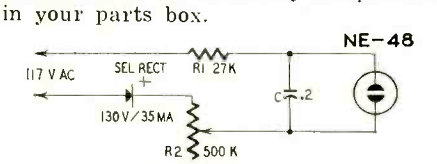
By GEORGE P. PEARCE

EVERY member of the family will have fun with this lamp. You'll all get a kick out of seeing it light when you point at it. You can set it to remain on and use the lamp for a night light. Set it to flash about 100 times a minute and you will have a twinkling star which is better than a night light for putting the kids to sleep.

Slow the flashes down to about 60 a minute and hang it on the porch any time you're expecting guests who may not know exactly where your house is. Just tell them, "It's the one with the flasher."

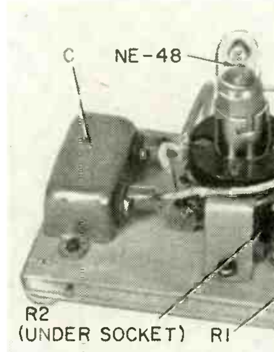
If you don't like light in the bedroom at night but want to be able to see what time it is if you wake up while it's still pitch black out, set the lamp for the mystery-light effect and position the box where it will illuminate your watch. Whenever you want to know the time, you poke your hand in the general direction of the light and it will promptly flicker to show you where it is. Place your finger on the bulb and you will get enough light to see your watch or clock without disturbing anyone else. When you pull your hand away, the light goes out.

The mystery lamp uses about one-fifth the current drawn by an electric clock and that only when it is actually lit. It is easily built and you probably have most of the necessary components in your parts box.

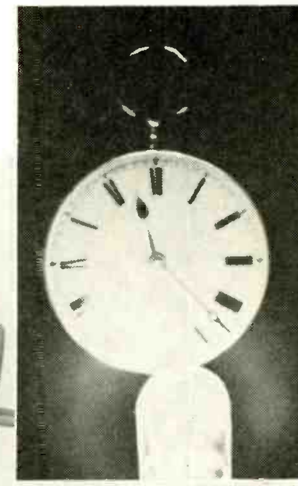


R1—27,000 ohms, ½ watt
R2—pot, 500,000 ohms, screwdriver set
C—0.2 µf, 400 volts
Rectifier, selenium, 130 volts, 35 ma
Neon bulb, NE-48
Double contact bayonet candelabra socket for NE-48
Case, 5 x 3 x 2¾ inches
Miscellaneous hardware

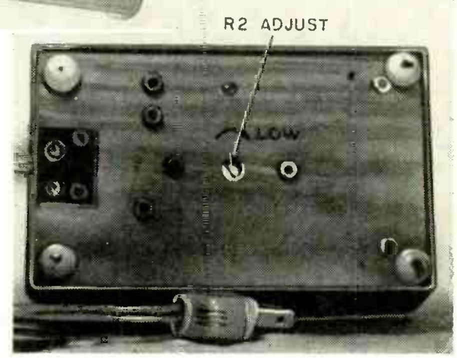
Mystery-lamp circuit uses a few easily obtained parts.



Breadboard type layout leaves plenty of room for components.



(Top right) See your clock at night without disturbing anyone.



Bottom of chassis, showing potentiometer adjustment.

For a case I used a strong cardboard box 5 x 3 x 2¾ inches. A piece of ⅜-inch plywood (3 x 5 inches) just small enough to let the box cover slide over it serves as a chassis. *Do not use a metal case or chassis unless an isolation transformer is added to the circuit.* This will avoid hot-chassis dangers. The diagram shows the circuit.

Potentiometer R2 is fastened to a sheet-steel plate so it can be mounted flat on the plywood base, in the center of which a ¼-inch hole is drilled so the slotted stub-shaft setting can be adjusted with a small screwdriver without opening the case. Use an insulated screwdriver as the potentiometer's shaft may be hot. R2 varies the circuit's resistance between 27,000 and 527,000 ohms.

The lamp socket is mounted on a support made from a strip of 18-gauge steel and holds the lamp's bulb so it sticks up about ⅝ inch through a 9/16-inch hole in the top of the case. For further details see the photos.

The box is painted a glossy black (mystery boxes should always be black). Four rubber feet are tacked to its base to prevent bolt ends and nuts from scratching the table the box sits on.

When you are ready to use the lamp, plug it into any wall outlet and set it for the desired use. When R2 is set for minimum resistance, the lamp will glow steadily. As more resistance is added, the lamp will begin to flicker. For the mystery-lamp function, increase the resistance until the lamp just goes out. Now just point your finger at it and it will start to flicker. Touch the bulb with a couple of fingers and it will go much faster. Should the flashing fail to occur, reverse the plug at the wall outlet. END

Lowdown on Traveling-Wave Tubes (Continued)

take a portion of the output, manage to get some of it back down the tube, and amplify this to add to the original output, and we take a portion of the now bigger output and send it back down the tube, etc., etc. To put it in simple terms, that's how it oscillates.

What can they do?

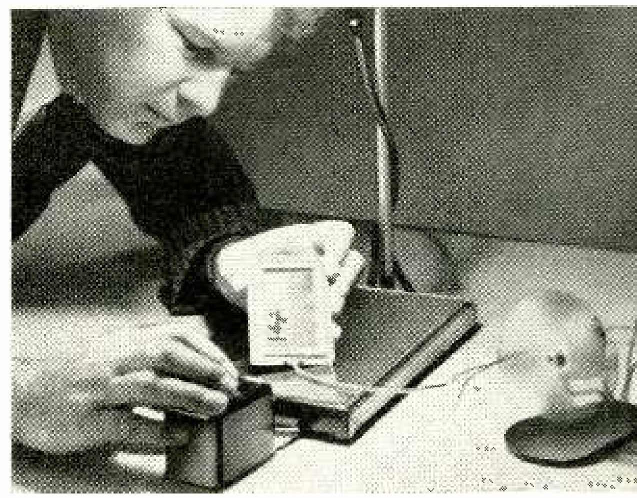
Traveling-wave tubes can have a gain of as much as 70 db. By helix voltage control, TWT oscillators can be made to oscillate over a range of 2 to 1. Thus some tubes are available which will cover the band from 1,000 to 2,000 mc and so on all the way up to tubes which reach over 25,000 megacycles. This is not necessarily the limit of TWT's; we just haven't much practical application for higher frequencies, yet.

At present, the practical applications for TWT's are enough to keep the manufacturers quite busy. They are used first as broad-band, low-noise radio-frequency amplifiers. They are used as tunable oscillators. Fig. 10 shows a signal generator using a TWT as oscillator. Because of a feature which we haven't discussed (the "grid" shown in Fig. 2, which can turn the electron beam on and off or modulate the electron stream, thus controlling its density and its ability to impart energy to the wave) we can amplitude-modulate the output. This "grid," which is really more like a "gate," operates like the grid of a cathode-ray tube for beam modulation. Therefore, TWT's can also be used as modulators at microwave frequencies.

Telemetering, missile guidance, microwave voice communication, television program relays are present applications for the tubes. Scatter propagation, cable amplifiers for coaxial lines and radar systems are possible future applications. You can be sure that they will be playing an important part, for right now they are the only high-gain voltage amplifiers available for the microwave regions. END

SOLAR POWER *now and tomorrow*

Part II—The solar battery in industry; both low- and high-power applications



US Army Signal Research and Development Laboratories.

Fig. 2—A 16-cell solar-power converter generates enough electricity to power a small fan.

Fig. 1—A solar-power converter in the side of this flashlight charges a nickel–cadmium battery.
Hoffman Electronics Corp.

By JORDAN McQUAY

LAST month we looked into the history and theory of solar batteries. Now we will see how they are used.

One of the simplest devices employing solar power is a flashlight (Fig. 1). During 5 hours' exposure to sunshine, enough energy is stored in its nickel-cadmium battery to provide a minimum of 1 hour of continuous electrical power. The converter consists of 9 silicon solar cells, connected in series. A diode keeps the batteries from discharging during periods of no exposure to sunlight.

A slightly larger converter, composed of 16 rectangular type cells, can operate a small electric fan (Fig. 2) for almost indefinite periods of time.

Clocks, perpetually powered by the sun, give continuous and unlimited operation. Because of the low power drain of dc clocks, a 20-cell solar-power converter is sufficient for continuous operation.

A highway flasher unit (Fig. 3) uses an array of 32 solar cells and a nickel–cadmium battery. Two isolated silicon cells operate a relay that diverts charging current to the battery during daylight, and turns on a periodic flasher during darkness. This device is useful for marking highway construction work as well as airstrip emergency runways.

Simple but effective broadcast type radio receivers have been designed to operate with sm·ll solar power converters*. Commercial broadcast receivers are also available. Using a solar-power converter with four penlight-size rechargeable batteries, the radio consists essentially of six transistors and a diode, printed circuit wiring, and a push-pull output feeding either a 2½-inch speaker or earphones. The set operates either directly from the solar cells or indirectly from the nickel–cadmium batteries.

Portable low-power uhf and vhf transmitters can also operate with solar-power converters. With a larger power converter and appropriate antenna system, efficient communication well beyond line-of-sight distances can be expected.

Army engineers have developed a two-way voice-operated FM transmitter–receiver radio contained almost entirely within a combat helmet. It uses a solar-power converter and miniature nickel–cadmium batteries. *Two* banks of 38 silicon solar cells are imbedded in the top of the helmet. These connect with the nickel–cadmium batteries to provide a power supply. The batteries, subminiature transmitter and receiver are all in the combat helmet, and weigh about 1 pound. Only the microphone is external.

An eyeglass type hearing aid uses a four-cell solar power converter with a tiny nickel–cadmium battery. Converter, battery, microphone, amplifier and volume control are all in the sidebar or temple housing of the eyeglass frames. The subminiature amplifier uses four transistors, and feeds a plastic earpiece. Binaural sound is also possible. Just use two complete and independent units, one in each sidebar.

High-power applications

This category of solar-power application includes all devices drawing more than about 5 watts.

A rural telephone (type P) carrier system has been powered successfully by the Bell System with a solar-power converter using 432 silicon cells. It provides nearly 10 watts of electrical power and is used in conjunction with 22-volt nickel–cadmium batteries. Amplifiers and repeaters of the system are all-transistor units to minimize power consumption. With this type of converter, electrical energy derived from the sun during daylight hours operates the carrier system and charges the storage batteries which take over during inclement weather and at night.

A radio repeater station of the US Forest Service, atop Santiago Peak in Southern California, is powered by batteries kept charged by a 504-cell solar power converter. This is an unattended, automatic repeater station using a transistor radio transmitter and receiver. Energy from the converter is transferred to the storage batteries at the rate of about 125 watts per day. The installation needs virtually no maintenance or repair.

*See "Build a Solar-Powered Radio" by Edwin Bohr, RADIO-ELECTRONICS, March, 1956.

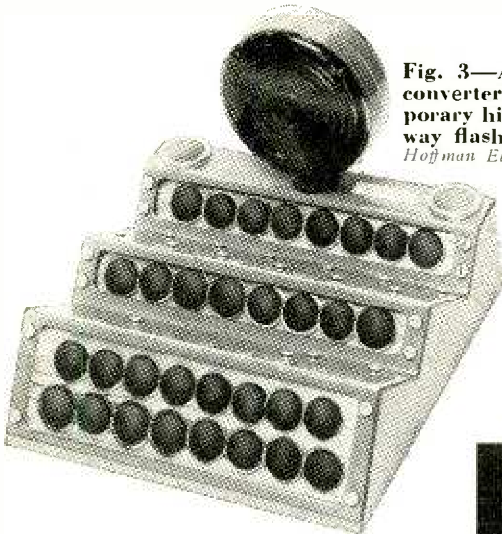
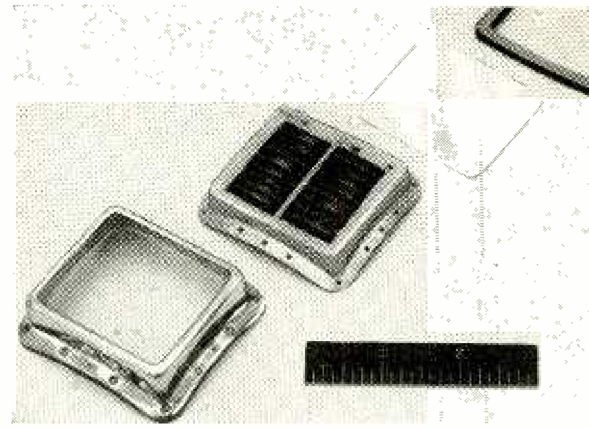


Fig. 3—A 32-cell solar converter powers temporary highway and airway flasher.
Hoffman Electronics Corp.



US Army Signal Corps.

Fig. 4—Construction of one of six solar-power converters used on first US space satellite. (Left to right) Cover housing, 10 solar cells imbedded in cement, glass and gasket.

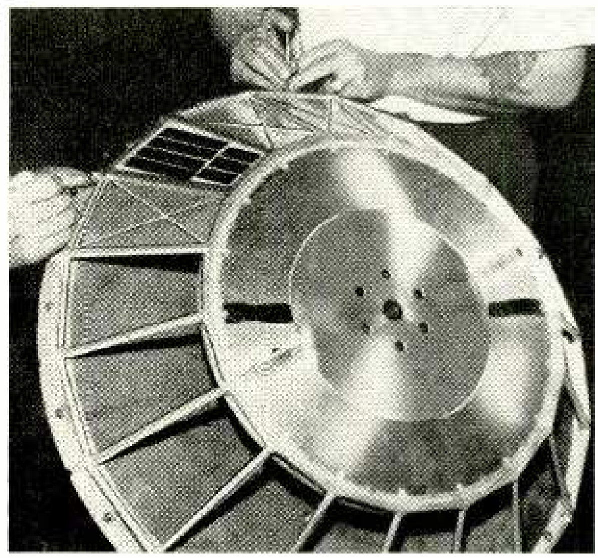


Fig. 5—Ultimate in solar-power converters is ring type. This will have nearly 3,000 silicon cells for use aboard such US earth satellites as recent Explorer VII.

US Army Signal Corps.

Another use for solar power is at the Los Angeles Harbor lighthouse of the US Coast Guard. Here, a 360-cell converter and storage batteries provide continuous power for harbor navigational aids and channel markers. Installations have also been made at other critical locations throughout the world.

Probably the most inaccessible locations where solar power converters are proving their worth are in outer space, where they function as either the primary or the only source of power in satellites.

The first US satellite to be launched successfully was a 6.4-inch metallic sphere, which is still orbiting in space after nearly a year. Distributed over its shell are 6 converters, each containing 18 silicon solar cells imbedded in ceramic cement and cushioned in a special, glassed housing (Fig. 4). At such high altitudes, the satellite is exposed to direct sunlight more than half the time of travel around the world. Producing all necessary power for one of the radio transmitters aboard the satellite, the 108 silicon solar cells will function indefinitely.

Russian satellites have also been equipped with some type of solar power converters, but no specific technical data concerning construction and operation are available.

As new and improved satellites are launched into outer space, each will probably contain a solar power converter to assure continuous electrical operation of its data transmitters.

As the physical size of satellites increases, their internal workings become more and more sophisticated, requiring additional power for operation of the various telemetering devices and radio transmitters. This requirement led to the development of ring type converters, composed of several hundred silicon cells.

An even more advanced outer-space US project uses an entire missile as a satellite. To provide for the extensive power requirements of such a device, mammoth ring-type converters have been developed. These utilize nearly 3,000 silicon cells (Fig. 5) arranged in two rings, one at each end of the missile. Although larger and more powerful than the tiny solar clusters used on early US satellites, these advanced converters are electrically similar.

Without solar power, satellites would soon become ineffective as they orbit around the earth. With it, they can continue to broadcast scientific and other data concerning either outer space or the surface of the earth. Solar power is especially important for global surveillance and reconnaissance, using television equipment to view all parts of the world while in flight, and to transmit such information to receiving sites on the earth below.

Although exposed to a variety of astral elements—meteorite bombardment, cosmic dust, intense heat and cold, X-rays, and gamma rays—unless they are physically damaged, the silicon cells of solar-power converters aboard US satellites will probably outlast the radio transmitters they power as well as the satellites themselves.

Future applications

Current experiments by leading laboratories and manufacturers with large-area solar cells suggest many extensive, future applications of solar power.

In many of the under-developed regions of the earth, the introduction of inexpensive solar power would have a tremendous sociological and political impact.

In areas where commercial electricity is not available, houses and buildings could be literally covered with solar-power converters to provide all necessary household operating electricity.

Airway beacons in almost-inaccessible regions can be powered for continuous operation, as can highway markers and other aids to navigation on land, on sea or in the air.

Remote weather stations, in some isolated spot or in space, could make meteorological measurements and transmit the data back to civilization by means of solar-powered and unattended radio transmitters.

Manned space stations could get enough electric power from vast clusters of solar power converters. These are but a few of the many possible, future applications of solar power.

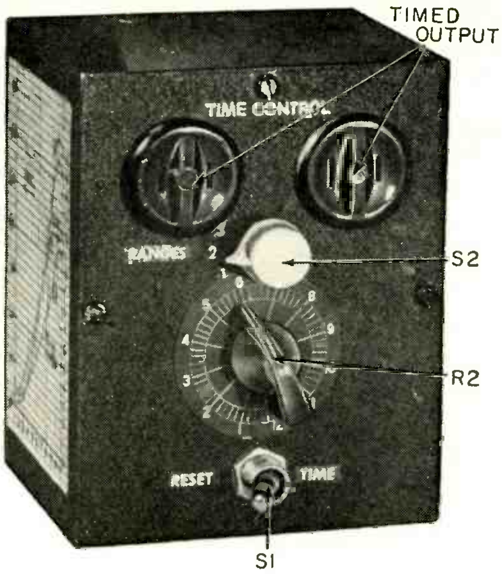
As greater amounts of electrical power can be converted from sunlight, even wider, more extensive and more exciting applications can be expected in the challenging years ahead.

Future applications of solar power are almost unlimited, because of the average stability and regularity of sunlight in the temperate regions of the world. END

This compact timer has three ranges.

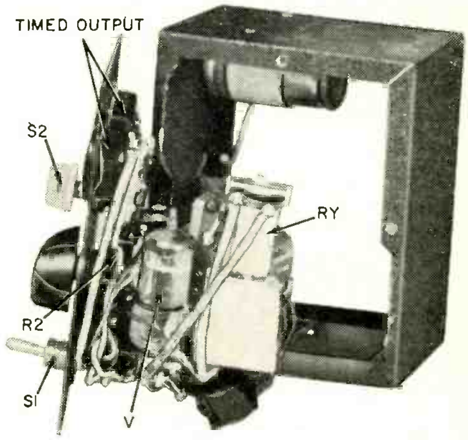
A Stable Photo Timer

By HENRY A. KAMPF



Stable phototimer in its small case.

Inside view shows compact construction.

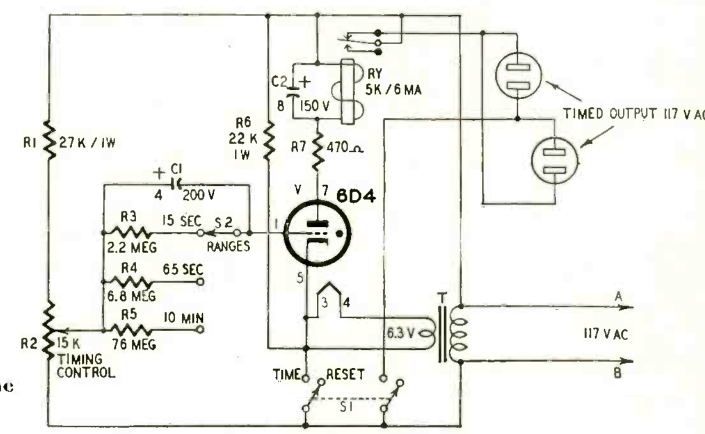


HERE is a phototimer that gives constant performance and maintains accurate calibration for long periods of time. The three ranges which fill most timing requirements are 0 to 15 seconds, 5 to 65 seconds and 0.75 to 10 minutes. Tests have shown that preset timing periods are unchanged for line-voltage variations over a range of 90 to 140 volts.

Most timing circuits are dependent upon a capacitor discharging slowly through a large resistor. As the voltage across the capacitor reaches a critical value a relay circuit is actuated to give the desired timing. The three factors which may affect the stability of timing are the time constant of the R-C timing circuit, the starting voltage of the capacitor at the beginning of the timing period and the critical voltage to which the capacitor discharges.

The first cause of instability is precluded by using paper capacitors instead of electrolytics whose capacitance varies with changes of temperature, age and applied voltage. Metallized capacitors can be used even though their change of capacitance with age is larger than that of the paper type. The other two factors affecting stability are more or less controlled by line voltage. Line-voltage variation troubles can be lessened by using voltage-regulator tubes to supply the plate and capacitor charging voltages. The added expense of voltage-regulator tubes can be eliminated without affecting timing stability if the line-voltage variation effects in the timing circuit can be made to cancel each other. The circuit shown here uses this principle (see diagram).

The timing circuit is controlled by S1. The length of the timing period is controlled by R2 and S2. When S1 is in the RESET (open) position and ac line A is negative with respect to line B, grid current flows through R6, R3 and the bottom part of R2. C1 will then charge to a voltage determined by the setting of R2. With S1 switched to the TIME position, a sinusoidal voltage from the movable arm of R2 is fed to the grid



Circuit of the phototimer.

R1—27,000 ohms, 1 watt
R2—potentiometer, 15,000 ohms
R3—2.2 megohms, ½ watt
R4—6.8 megohms, ½ watt
R5—76 megohms, see text
R6—22,000 ohms, 1 watt
R7—470 ohms, ½ watt
C1—4-μf 200-volt paper, see text
C2—8-μf 150-volt electrolytic
RY—5,000 ohms, 6 ma (Potter Brumfield LS5 or equivalent)
S1—dpst toggle
S2—1-pole 3-position rotary
T—filament transformer (Stancor P6134 or equivalent)
V—6D4 thyratron
Cabinet—3 x 4 x 5 inches (ICA 3817 or equivalent)
Socket—7-pin miniature
Socket—(2) ac female, chassis mounting
Line cord
Knobs
Miscellaneous hardware

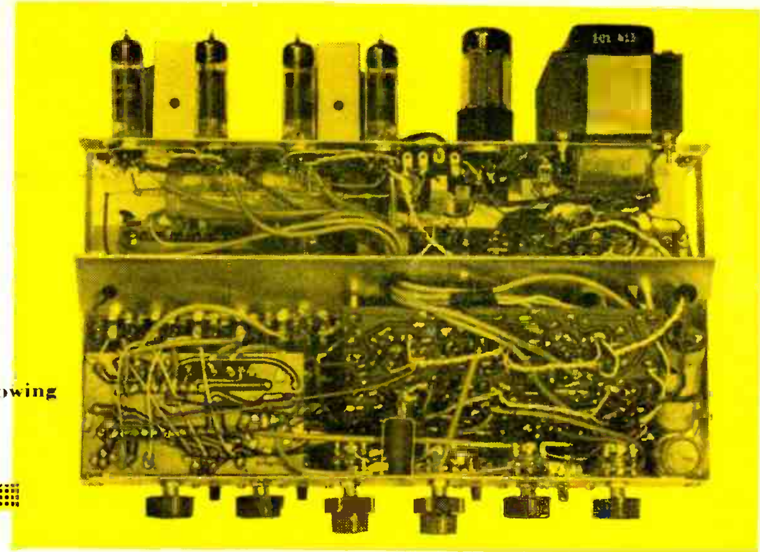
of the thyratron which is in phase with the plate voltage. This would normally cause the tube to conduct on half-cycles of the line voltage when line A is positive with respect to line B. However, the large voltage to which C1 is charged keeps the thyratron from firing. As C1 discharges through R3 (or R4 or R5, depending on the range), the negative grid bias lowers to the point where the instantaneous grid–cathode voltage allows the tube to fire. The tube current energizes the relay and turns off the apparatus being timed. Capacitor C2 is connected across the relay to keep it from chattering and R7 is used to prevent excessive current surges when the tube first fires.

As the plate voltage of the thyratron increases, a larger negative grid bias is required to keep it from conducting and allow the circuit to give the same timing period as before the increase. This increase of negative bias voltage is automatic since the voltage furnishing the charge for C1 is the same line voltage that is applied to the thyratron grid and plate. The same cancellation effect in a reverse sense occurs with a reduction of line voltage.

The timer is constructed along conventional lines. C1 is made by connecting four 1-μf 200-volt paper capacitors in parallel, and the 76-megohm resistor is made up using four 18-megohm resistors in series. All the other components are readily available. Should timing periods longer than 10 minutes be required, either C1 or R5 can be increased in value to include the desired range. S1 must be left in the RESET position long enough to charge C1 completely—2 seconds should be adequate.

The dial indicating the position of R2 is calibrated with a watch having a sweep second hand. The longest timing range is calibrated by connecting an electric clock into the timed output of the timer. The dial calibration should be rechecked at several points whenever the tube is replaced. END

Derived third channel puts an end to the hole in the middle



Top view of completed amplifier showing wiring and printed circuit boards.

By NORMAN KRAMER *

STEREO AMPLIFIER for 3-CHANNEL SOUND

MUCH is being said these days about three-channel stereo—pro and con. Some people say that when a two-channel system is properly adjusted and the audience is seated ideally with respect to the speakers, there is no conscious feeling of sound separation and the listener is magically enveloped in the curtain of stereo realism.

Unfortunately, because of recording defects, inadequacies of speakers or difficulties in their placement, or perhaps even the psychological effect of being able to see two speaker systems, this ideal is not always achieved. The result is frequently referred to as the "hole in the middle." This region between the speakers is seldom a completely blank area. More often it is a sort of no man's land, in which center-stage performers seem to be moving about from side to side.

Various schemes have been devised to correct the hole which stands in the way of ideal two-channel listening pleasure. These methods make use of a third channel which is recovered from the two-channel source. For example, if two microphones are correctly located with respect to each other and with respect to the plane of the sound source, their combined output will be the same as that of a single microphone placed exactly midway between them. The hole in the middle can be perfectly plugged by recovering this third channel through combination of the two stereo signals. Recovery and reproduction of the third channel focuses center-stage soloists and provides the final tonality of the original sound.

Adding the third channel

Third-channel systems are generally of either the L–R difference of L + R sum signal types. Fig 1 shows a popular approach to the difference signal method. Because of the nondirectional quality of bass frequencies, they tend to reach the two recording microphones with substantially equal magnitude. This results in equal signals in both amplifiers, and the center-channel output is zero. Treble frequencies, however, result in different signals through both amplifiers and produce a difference signal in the center-channel speaker system. Aside from inability to phase the center speakers and the loss of bass frequencies, this method could be used to fill the hole in the middle.

Obviously, this system cannot be used to reproduce a monophonic signal, since the center speaker remains mute when left and right amplifiers are balanced. Furthermore, dissimilar power amplifiers connected in this fashion could develop serious instability problems. Also, the center channel cannot be used as a remote monophonic reproducer of a stereophonic input because of the drastic reduction of bass frequency response in the mixing process.

Fig. 2 shows another way to get a third channel—this

*Assistant chief engineer, Allied Radio Corp., Chicago, Ill.

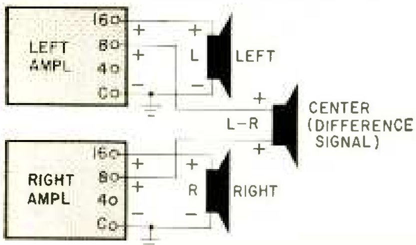


Fig. 1—Center speaker reproduces a difference signal.

time by a summation process. Here the mixing takes place in the preamp outputs by a resistance mixing or by mixing in a tube. Though this method has the obvious advantage of full frequency response in the center channel and can be used remotely as a monophonic reproducer, it requires a separate preamp and a dual basic amplifier plus a third-channel amplifier or three basic amplifiers. This could be prohibitive from a standpoint of space and cost.

The Knight-Kit 40-watt stereo amplifier eliminates the need for the separate preamp and the third power amplifier by using the output transformers in a somewhat different configuration. Fig. 3 shows this setup—with the 4-ohm taps grounded instead of the transformer common leads. Since the 4-ohm tap, electrically, is the secondary center tap, the output transformers are connected in an additive arrangement which resembles push-pull. Correct phasing of the center speaker is no problem. A T-pad is shown on the center speaker because the acoustic output of the center speaker is virtually the same as the other two in a balanced condition and need only be set as high as necessary to augment the center.

When using the output transformers

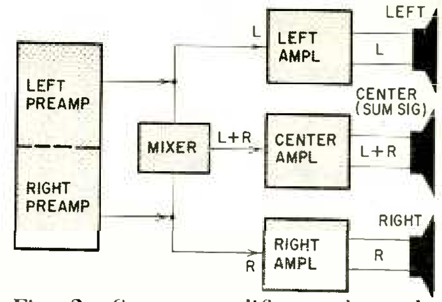
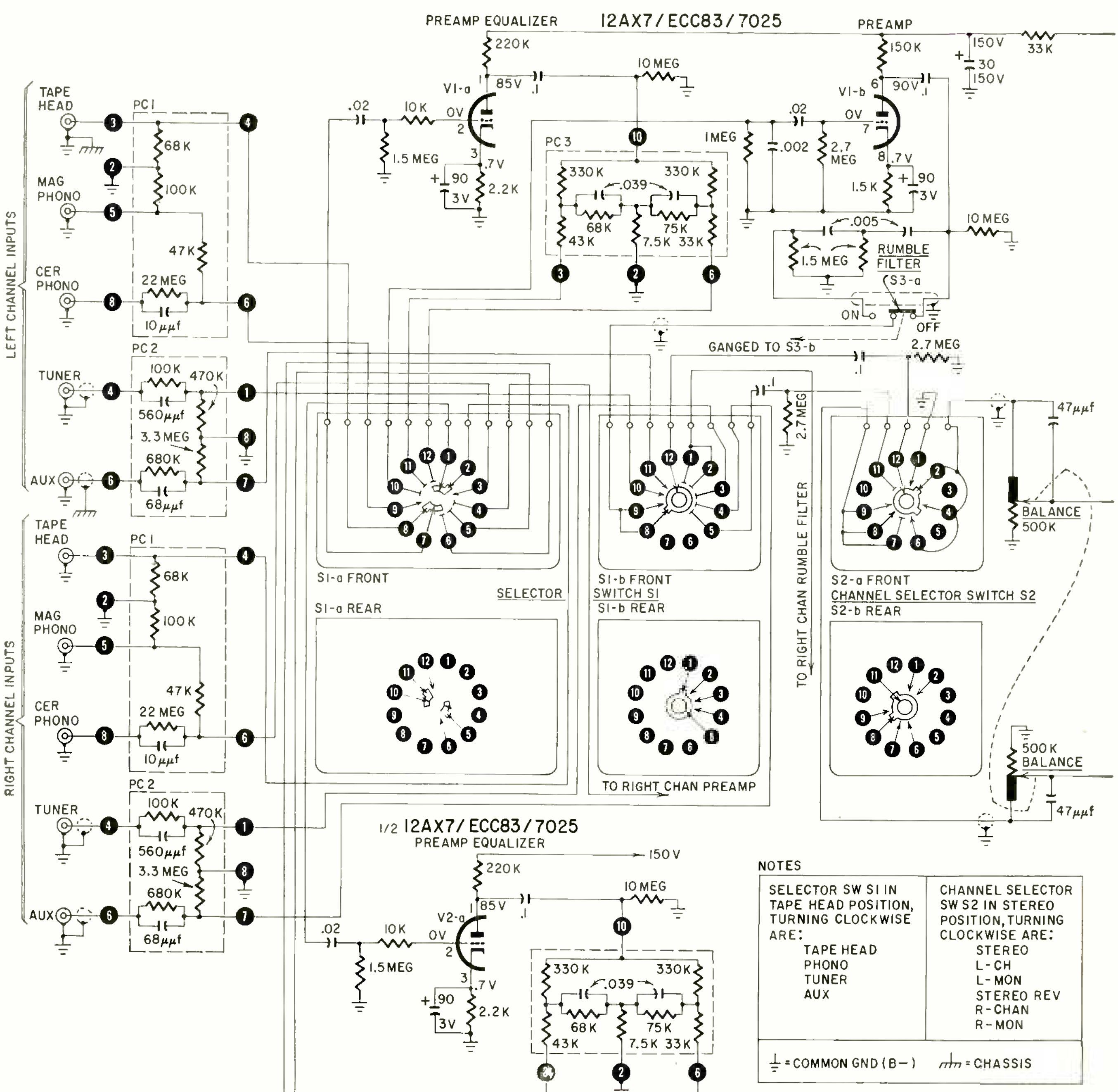


Fig. 2—Center amplifier and speaker required to reproduce a sum signal.

in this unusual manner, stability must be insured under all conditions. As a matter of fact, the entire amplifier was designed around the output circuit to insure good frequency response and an extremely high stability margin. A true test of the stability of this amplifier is that when the center channel is loaded



with a 4-, 8- or 16-ohm speaker and both other channels are unloaded, there is no tendency toward instability at either the high or the low end.

Amplifier specs

The output stages use 6973 tubes with fixed bias and can deliver 20 watts per channel to the load with less than 0.5% total harmonic distortion (see Fig. 4).

This low distortion is due in part to 38 db of negative feedback in each channel.

The phase inverter uses a 12AX7 in the "long-tailed pair" circuit because of the desirable effect on frequency response and phase shift, in addition to its ability to provide gain.

The preamp consists of another 12AX7 with passive equalization located between the two triode sections.

There are five pairs of stereo inputs,

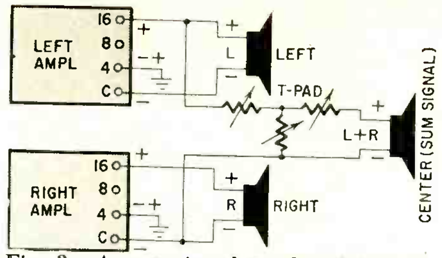


Fig. 3—A sum signal produced by mixing in the output transformers.

including tape head, magnetic phono, ceramic phono, tuner, and auxiliary.

Frequency response at a 10-watt output level is within 1 db from 15 to 40,000 cycles into the tuner input for all three channels. Hum and noise figures, based on 10-mv and 1-volt input reference levels, are 60 db below 20 watts into the tape and phono inputs and 75 db below 20 watts into the tuner and auxiliary inputs. There are hum balance controls in the heater circuits of both channels with 50 volts of filtered dc to raise the heaters above ground.

The tone controls are dual-concentric pots with clutch drive, and are capable of a full 15 db of boost or cut on both bass and treble at 20 and 20,000 cycles.

Harmonic distortion at 20 watts per channel is less than 0.5% and intermodulation distortion at 60 and 7,000 cycles, mixed 4 to 1, is less than 1% at rated power.

Isolation between channels is better than 40 db in all stereo positions, and 34 db with the third speaker connected.

The amplifier is being marketed in kit form by Allied Radio Corp., 100 N. Western Ave., Chicago 80, Ill., for approximately $80. It comes complete in a stylish case with full instructions for assembling the unit. END

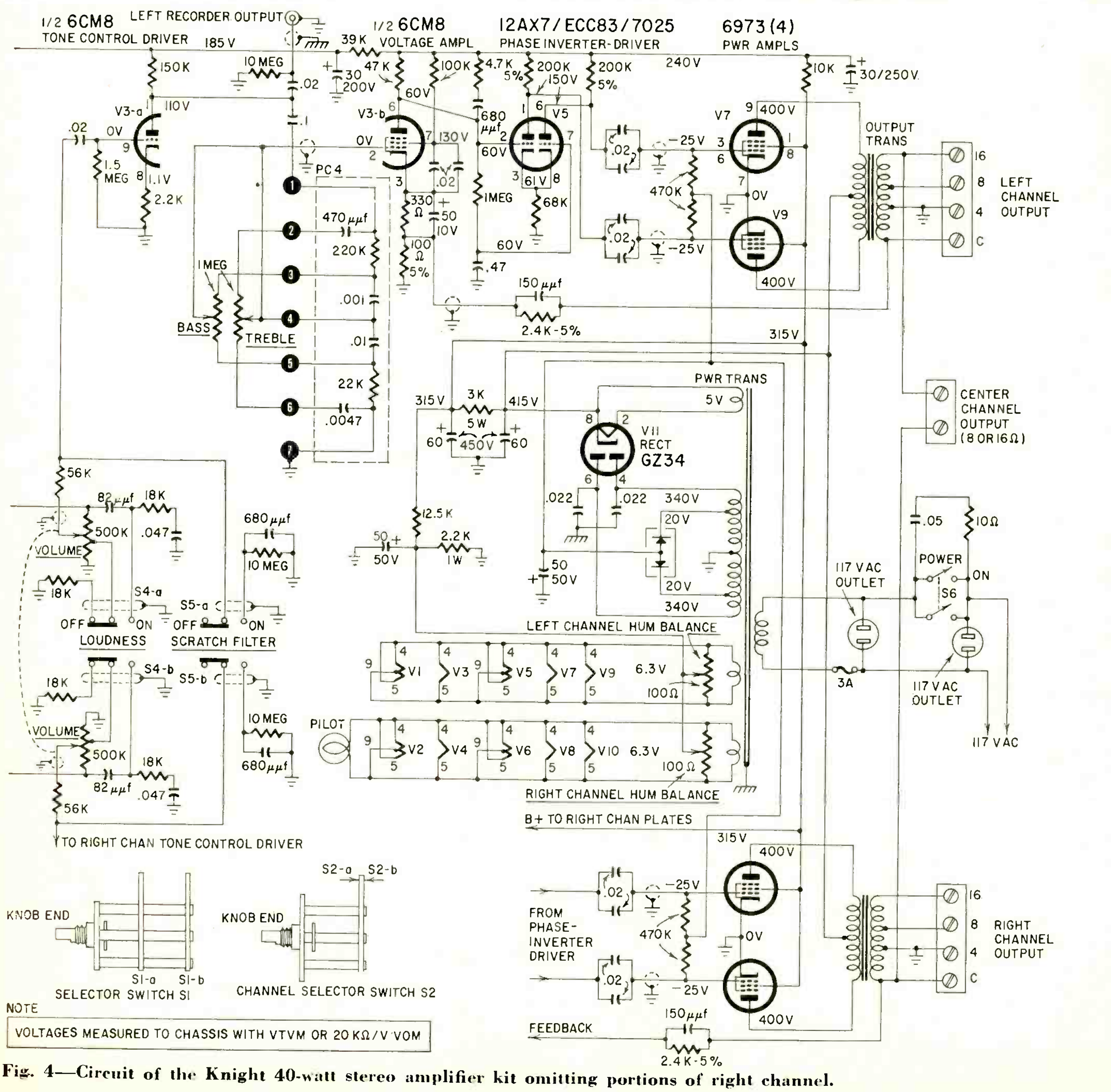
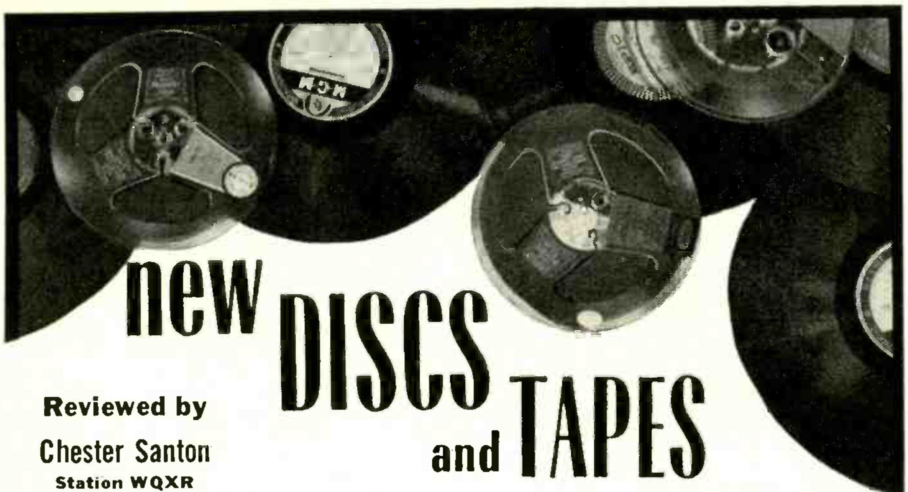


Fig. 4—Circuit of the Knight 40-watt stereo amplifier kit omitting portions of right channel.



new DISCS and TAPES

Reviewed by
Chester Santon
Station WQXR
New York City

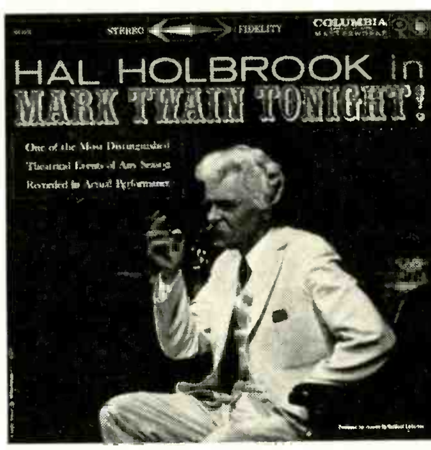
STEREO and MONO

STEREO recordings on open-reel tapes are regaining popularity as the ultra-narrow-gap playback head comes into wider use. Originally developed for playback of 3.75 tapes, the 90-micron head meets audiophile standards in frequency response on quarter-track stereo at 7.5 ips. The present signal-to-noise ratio on quarter-track involves factors other than the playback head. Tape fans with two-track recorded tapes in their collection will find that the new head delivers improved upper-frequency response. I've been discovering this for myself in recent weeks. Having replaced the unit used for the past 2 years in reviewing tapes in this column, I find that the same manufacturer's four-track unit brings out highs on some two-track tapes I hadn't suspected were there. Listening to a variety of two-track tapes, I noticed a condition we've all encountered after upgrading the response of a sound system. Recorded material that used to sound reasonably flat to 10,000 cycles retains flatness above that figure following installation of the new component. But recordings, tape or disc, that once exhibited peaks in the upper middle sound artificial when playback response includes frequencies above 10,000 cycles. No matter what the future of two-track, good tapes in this form have not been made obsolete.

TCHAIKOVSKY: ***Francesca Da Rimini***
Hamlet
Leopold Stokowski conducting New York Stadium Symphony Orchestra
Everest Stereo 4-Track Tape STBR-3011
(7-in; playing time, 42 min. $7.95)
***Technical Rating:* EXCELLENT**

Considering the sonic demands of these powerful scores, this is an encouraging entry in quarter-track stereo. Evidence has been lacking so far that the average master tape could be reduced to quarter-track and still retain the wallop of half-track stereo. Everest, however, is the first outfit to release a sizable group of classical four-track 7.5-tapes that deliver the solid sound we took for granted on two-track stereo. Lows are very impressive. Highs are cleaner and more extended than those heard in the four-track Bolero tape reviewed last month. On a flat system, tape hiss is no problem. Stereo separation is no wider than that of a good disc but the depth illusion is better. The fantastic thing is the price—only a little more than a symphonic tape cartridge of this duration.

Normally, this space is reserved for demonstration recordings being used by audio component dealers. The stereo discs mentioned this month were featured at the recent New York High Fidelity Music Show by leading manufacturers of stereo pickups. Exhibits stressing response in the upper frequencies showed off their cartridges with the London disc "More Ros on Broadway" and Counterpoint's "Memories of Pee Wee." A brand new moving-magnet job was demonstrated at ½-gram pressure while playing RCA's *Bob and Ray Spectacular* (LSP-1773). One of the top amplifier firms exhibited forethought as well as tasteful sound by tailoring the music and acoustical quality of the records to the size of a small room, playing the Vanguard *Virtuoso* Oboe record and a Concert-Disc Mozart album by the Fine Arts Quartet.



Hal Holbrook in Mark Twain Tonight
Columbia Stereo Record OS-2019
***Technical Rating:* GOOD**

In transferring to records Hal Holbrook's masterly characterization of Mark Twain recently seen on Broadway, Columbia uses stereo to emphasize the rambling informality of the great American humorist's platform manner. As the performance unfolds before an alert audience, Mr. Holbrook is free to move about as he chooses. Twain's witticisms then seem much funnier when delivered at the spur of the moment.

Lavalle in Hi Fi
Paul Lavalle—His Woodwinds and Band
RCA Victor Stereo Tape Cartridge KPS-3006
(Playing time, 31 min. $5.95)

Now that dealers are beginning to stock 3.75 RCA tape cartridges, owners of conventional four-track machines may be curious about the results obtained when the tape is transferred to open reels. The easiest way to do this is to cut the tape at the point where the exposed strip re-enters the magazine on its way to the takeup wheel. In the majority of cases, it may be advisable to splice leader tape immediately. Turn over the cartridge to put the business side of the tape on the inside. Then release the brakes that grip the edge of the wheels. If the inside of the cartridge has been disturbed, the safest winding speed is 7.5 ips. The fast forward speed of some tape machines may emphasize the play in the loosely seated unwinding wheel of the cartridge. I stretched my first tape that way when the wheel shuddered to a virtual halt before I could stop the takeup reel. After transfer, the major problem is equalization. These bright novelties by Paul Lavalle's group sounded lost on an open reel. Lows were there but little else could be heard with the playback equalization I had used for open-reel 7.5 four-track. Top end closed shop at a point about 4,000 cycles below the high end of the open-reel *Francesca Da Rimini* Everest tape reviewed this month. (A new grade of blank tape with response improvement of 4 db above 12,000 cycles is scheduled for use in tape cartridges.) Signal-to-noise ratio in this release was adequate on open reel due to the uniformly high level of the music.

Symphony of the Air
Concertapes Four-Track Stereo 4T-4002
(7-in.; playing time, 39 min. $7.95)
***Technical Rating:* FAIR**

Two recent Concertapes releases are reviewed side by side this month to underline how inconsistent can be the present audio quality of quarter-track tapes. Originally recorded in 1954 at Carnegie Hall without a conductor on the podium, the former members of the NBC Symphony are heard in a tape that is below par in frequency response and presence. Neither the *Nutcracker Suite* nor the overtures by Wagner and Berlioz approach the Concertapes standard for four-track tape.

LOEWE: ***Gigi and My Fair Lady***
Caesar Giovannini Orchestra
Concertapes Four-track Stereo 4T-4001
(7-in.; playing time, 33 min. $7.95)
***Technical Rating:* EXCELLENT**

The selections from *Gigi* and *My Fair Lady* are an entirely different story although the tape catalog numbers are adjacent. The piano and string orchestra come right into the room with singularly wide range and exceptionally clean sound. If we assume that the duplicating process was the same for both tapes, the quality of the master tape takes on a new importance in quarter-track releases.

RAVEL: ***Introduction and Allegro***
DEBUSSY: ***Danses Sacree et Profane***
Marcel Grandjany, Harp
Hollywood String Quartet and Concert Arts String Orchestra
Capitol Stereo Record SP-8492
***Technical Rating:* EXCELLENT**

Here's ideal fare for end-of-the-day listening. If sound were visible, you could see through this music as recorded by Capitol. There are louder and more pungent demo discs available today, but anyone upgrading his stereo rig is advised to include a record of this type when auditioning components. A particularly devilish test is found in some of the delicate transients of the harp. Very delicious.

Note: Records below are 12-inch mono LP and play back with RIAA curve unless otherwise indicated.

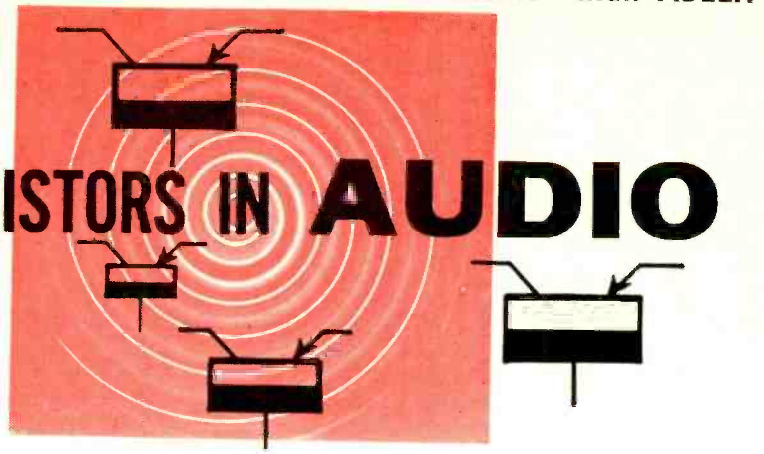
Eydie Gorme on Stage
ABC-Paramount ABC-307
***Technical Rating:* FAIR**

The arena of the vast Convention Center at Las Vegas was the scene of this recording. Careful listening uncovers a hint of the acoustical freedom possible under such conditions. Songstress Eydie Gorme and the band were miked at very close range, and the master tape was equalized for maximum effectiveness on small phonos. Despite these factors, enough of the free-soaring acoustics come through to whet the appetite for further experiments of this type under a flatter recording curve.

Swinging the '20's
Benny Carter Quartet
Contemporary M-3561
***Technical Rating:* EXCELLENT**

In this outstanding release, some of the best tunes of the 1920's are brought to life by two jazz "greats" who knew them when. Benny Carter, playing sax and trumpet, is joined by veteran pianist Earl Hines. Leroy Vinegar, bass, and drummer Shelly Manne take care of their assignments with customary ease. Carter and Hines, inventive as ever, dispense more ideas in one tune than some jazz men display on a whole side of an LP. The sound is on the top side of excellent. END

Name and address of any manufacturer of records mentioned in this column may be obtained by writing Records, RADIO-ELECTRONICS, *154 West 14 St., New York 11, N.Y.*



TRANSISTORS IN AUDIO

Part I—The first in a series of articles intended to guide you down the road toward designing your own transistor equipment. This month, the methods used to select optimum circuit values for a transistor amplifier stage are presented

By HERBERT RAVENSWOOD

BUILDING transistor equipment can lead to problems in a variety of ways. Either you can find full details of all kinds of equipment, except the one type you happen to want; or you find one that looks exactly like it was published only a few months back, but one of the transistors it calls for is already obsolete; or the circuit published used one battery voltage and the one convenient for your use is different.

Before you vent your spleen on the publisher for any of these shortcomings, realize what a rapidly growing industry transistors represent. If you happen to be on the mailing list of several transistor manufacturers, you know that a type current this month may no longer exist next month. Usually there is a substitute—an improved type—but can you use it without making circuit changes? Even if it can be used without changes, would variations in circuit values make it perform better?

Work up your own circuit

The solution is easy—just work out your own circuit from the information you have. But if you intend one of the more ambitious projects, using several transistors, don't be too hopeful at first—get one stage working at a time. You can guard against burning out one transistor until you get the right values for it and then you can tackle the next. If you make up the complete circuit, you may have one or more transistors burn out on you.

Always be sure the collector supply voltage is lower than the maximum rating for the transistor you are using. If your voltage supply is higher than the transistor's maximum rating, use a voltage divider that will keep you from exceeding the maximum voltage even when the transistor draws no current (as it does at cutoff). Make sure the voltage is right before you put the transistor in circuit.

Next, adjust the transistor's operating point to an optimum for the purpose in hand. Early stages in a multiple-stage amplifier—whether for a hearing aid, an audio stage for a radio receiver or a stage in an audio preamp or power amp—are operated for maximum gain and in some instances for minimum noise (but this we shall come to later). Later stages trade a little of the maximum gain for current or voltage swing.

If you're like me—used to working with tubes for several years—the need for thinking about current swing *as well as* voltage swing may be a little difficult at first. But, believe me, it comes easy as soon as you start working with one of the little beasts in front of you. The important thing to remember is that a transistor acts as a *current* amplifier.

This is complicated a little because it is more convenient to *measure* voltages. But if we measure voltage across a resistance, it is easily converted into current. Let's give a transistor a workover to illustrate. The 2N109 is a good choice. It is readily available, is a good general-purpose type and probably it will not be obsolete tomorrow!

We set it up in the simple circuit of Fig. 1. Two resistors can be adjusted in this setup, the collector load and bias resistors. For convenience the input resistor is kept a constant value, making current gain easier to figure. At any chosen value of collector load resistor, the bias can be adjusted in one of two ways.

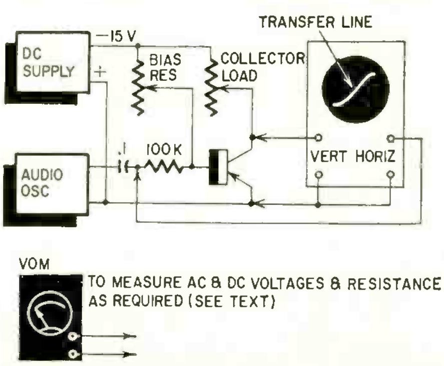


Fig. 1—Setup for making tests described in this article.

TABLE I—TEST RESULTS OF SIX 2N109'S

Transistor No.	1	2	3	4	5	6
Collector volts (10K)	7	7.5	7.3	3.5	4.5	3.8
Collector current, ma	0.8	0.75	0.77	1.15	1.05	1.12
Volts out (1 volt in)	4.8	4.4	4.7	5.3	5.2	5.0
Current gain	48	44	47	53	52	50
Collector volts (1K)	7	7.6	7.5	5	6	5
Collector current, ma	8	7.4	7.5	10	9	10
Volts out (5 volts in)	3.4	3.2	3.4	3.6	3.6	3.5
Current gain	68	64	68	72	72	70

The first is to watch the output on the scope and adjust the bias so both ends of the transfer line begin to bend over at the same time as input level is brought up. This is a little involved, because you have to juggle the bias resistor value and the audio oscillator's output control together until the right point is found.

The more direct way is to adjust the bias with a voltmeter set to read dc collector volts, so the voltage on the collector is half the supply voltage. For the test figures tabulated, I used a supply set to 15 volts. Maximum swing, with both ends bending over at the same point, invariably occurs when the collector voltage is set to about 7.5. Incidentally, the available voltage swing under this condition invariably measured nearly the full 15 volts peak to peak, or a little more than 5 volts rms, which shows the transistor is a more efficient voltage amplifier—for giving swing—than any tube amplifier. Do you know a tube that will give 250 volts peak-to-peak swing with only 250 volts on its plate, R-C-coupled?

This adjustment to mid-supply voltage gives the maximum *voltage* swing without the collector load coupled to a following stage. Under normal R-C-coupled conditions, as we shall soon see, we are concerned with getting maximum *current* swing, which requires different biasing. But meanwhile we need to find out how a single stage works by itself.

Let's figure the current gain

Now let's see how we figure the current gain, and what it means in regard to what can be done with the transistor. First it's a good idea, unless you plan to use just one transistor and set your circuit to suit that one, to run through half a dozen and see how they compare. For this purpose I went through a bunch of six 2N109's with two values of collector and bias resistors. The results are tabulated in Table I. With a 10,000-ohm collector resistor the bias resistor is 1 megohm. With a 1,000-ohm collector resistor the bias resistance is 160,000 ohms.

With a 1-megohm bias resistor, bias current is 15 μa, and the collector voltage varies between 3.5 and 7.5. This corresponds with a drop across the 10,000-ohm collector load resistor from 11.5 volts or 1.15 ma, to 7.5 volts or 0.75 ma. With a 160,000-ohm bias resistor, the collector voltage varies between 5 and 7.6. This, across a 1,000-ohm collector load represents a drop of 10 volts with 10 ma to 7.4 volts with 7.4 ma.

Current gain is measured by checking the voltage gain and converting to current. For example, with the 10,000-ohm collector load, 1 volt rms is fed into the input end of the 100,000-ohm input resistor. This means the input current is 10 μa rms. If we then measure an output of 4.8 volts rms, in the collector load of 10,000 ohms, the output current is 0.48 ma, or 480 μa, representing a current gain of 48.

At higher-current operating conditions, the input voltage will have to come up (or an appropriately lower input resistance could be used). With a 160,000-ohm bias resistor and a 15-volt supply, the bias current must be 94 μa. So we can use 50 μa rms, which, with a 100,000-ohm resistor, requires an input voltage of 5. If this yields an output of 3.4 volts rms across the 1,000-ohm coupling resistor, it represents an output current of 3.4 ma, or a current gain of 68.

Now which transistor would you pick to make further tests on? If you are planning to make a reliable piece of equipment, I would suggest you take one of the samples with current gain near the lowest. You may not be able to rely on high values repeating. For the rest of these tests I used the 2N109 identified as No. 3 in Table I. And the spread on these transistors is small compared to some I have tried! Of course, the fact that different transistors produce different collector voltages with the same bias resistor, or need a different resistor value to get the right collector voltage, means we shall need to do something to make the bias produce the right collector voltage automatically. But more about that later.

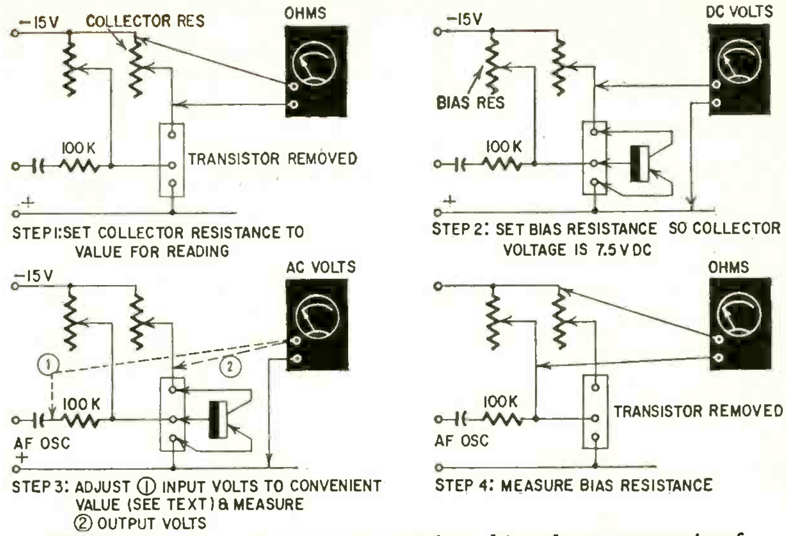


Fig. 2—Sequence of measurements for taking the current gain of a transistor at each of several collector load-resistor values.

TABLE II—CURRENT GAIN OVER A RANGE OF COLLECTOR LOAD RESISTORS

Collector Load Res	10K	8K	6K	4K	3K	2K	1K	500	250
Input volts	1	1.25	1.67	2.5	3.33	5	5	10	10
Output volts	4.7	5	5	4.8	4.9	5.1	3.4	3.4	1.45
Current gain	47	50	50	48	49	51	68	68	58
Bias resistor	1 meg	800K	630K	440K	350K	250K	160K	90K	48K
Base current, μa	15	18.7	24	34	43	60	94	167	312
Collector current, ma	0.75	0.94	1.25	1.87	2.5	3.75	7.5	15	30

Picking one of the transistors, the next step was to check its current gain over a whole range of collector load resistances, which are tabulated in Table II. The procedure for each reading is as follows (see Fig. 2 for the hookup used in this test):

1. Set collector resistor to the value required for the reading. Start with 10,000 ohms.

2. Adjust the bias resistor so collector voltage is 7.5.

3. Adjust the input voltage so the output voltage across the collector can be a convenient multiplier of current gain. For 10,000 ohms the input voltage was 1 volt rms. Then the 0–6-volt rms range reads current gain of 0–60—4.7 volts means a current gain of 47. (This can be verified this way: 1 volt into 100,000 ohms delivers 10 μa; a current amplification of, say 50, will produce 500 μa, which, in a 10,000-ohm load, will develop 5 volts.) For 8,000 ohms, the input voltage can be raised to 1.25 when the same conversion can be used. Since 1.25 volts into 100,000 ohms delivers 12.5 μa, a current amplification of 50 will yield 625 μa, which,

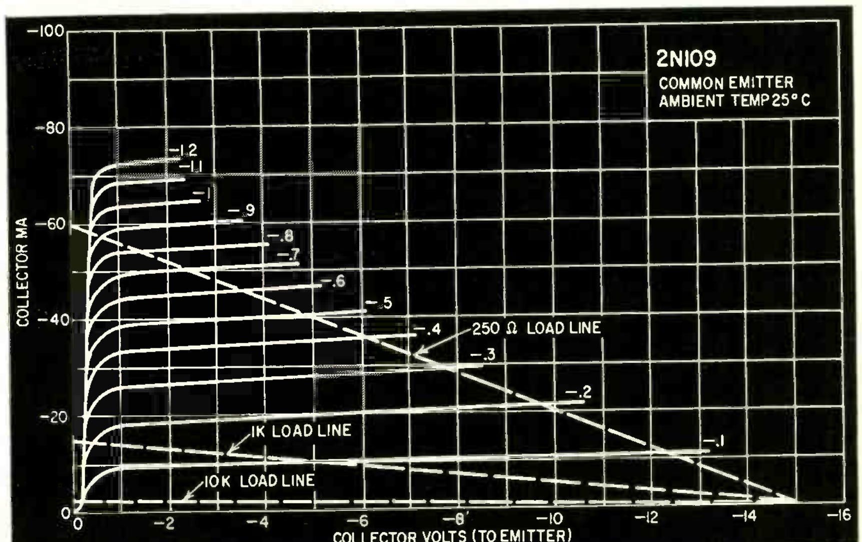


Fig. 3—Collector characteristics (common emitter) of a 2N109, to show the various collector load lines set up for this article.

TABLE III—EFFECT OF COLLECTOR VOLTAGE ON CURRENT GAIN, COLLECTOR RESISTOR 1,000 OHMS

Collector volts	1.5	6	7.5	10	12	13
Collector current, ma	13.5	9	7.5	5	3	2
Volts out (1 volt in)	0.5	0.72	0.75	0.8	0.82	0.8
Current gain	50	72	75	80	82	80

TABLE IV—EFFECT OF COLLECTOR VOLTAGE ON CURRENT GAIN, COLLECTOR RESISTOR 250 OHMS

Collector volts	1.8	7.5	10	12	13
Collector current, ma	53	30	20	12	8
Volts out (4 volts in)	0.32	0.6	0.72	0.75	0.72
Current gain	32	60	72	75	72

across an 8,000-ohm load, will develop 5 volts again. For a 6,000-ohm collector load, the input can come up to 1.66 volts and still use the same conversion.

This series of inverse input voltages can be used on up to a 2,000-ohm collector resistor, in this case, requiring 5 volts input. But at 1,000 ohms, current gain takes a jump, so a 10-volt input would overload the output. A 5-volt input can be used again, using the scale to represent a current-gain range of 0–120, where a 3.4-volt reading means the current gain is 68. Higher current readings can be taken in the same proportion.

4. Disconnect the battery, unplug the transistor and measure the bias resistor, from which you can calculate the bias current.

An important thing to watch at higher currents (collector resistor lower than about 2,000 ohms) is the transistor's temperature. It should never get more than slightly warm. Of course, tests can be made quickly under conditions that would not be permissible for continuous operation.

Effect of varying the bias

Another thing we can investigate while we have this setup is the possibility of getting better gain at different bias values. Turning the input down until the output is only about 1 volt rms and adjusting the bias without changing the input, we can find how the output varies, indicating differences in current gain, at different bias points. Using a 10,000-ohm collector load, the gain stays very nearly constant—as near as can be told from the readings.

But with a 1,000-ohm collector load we find quite a deviation at various bias points. This can be understood by looking at the published characteristics (Fig. 3). The 10,000-ohm load line lies across only the lower area of the diagram, while the 1,000-ohm load line cuts up across a section a little higher up the curves. Table III gives the results at various bias points for a 1,000-ohm collector resistor and Table IV for 250 ohms. At low collector-voltage (high-current) operation, current gain is lowest. It rises to a maximum around 12 volts, 3 ma on the collector (for the 1,000-ohm load), and drops off a little again at lower currents.

The figures given apply only to the particular 2N109 used and probably only at the temperature of the day I took the readings. While it is indicative of the kind of curvature you will find with all of them, they vary considerably from sample to sample in this respect and some types are worse than others.

But what have we learned about using the transistor in a *practical* hookup? The high 100,000-ohm input resistor is not directly applicable to any amplifier circuit. We used it here as a convenience, for three reasons:

1. By using a high input resistance we can use a paper capacitor without phase troubles to provide dc isolation, avoiding the small leakage that occurs with electrolytics which alters the bias slightly. A practical circuit using electrolytics must allow for this leakage, but for test measurements it is easier to avoid it.

2. The high input resistance lets us use an ac input voltage that can readily be measured.

3. We insure that the input current has the same waveform as the applied voltage. This makes the transistor

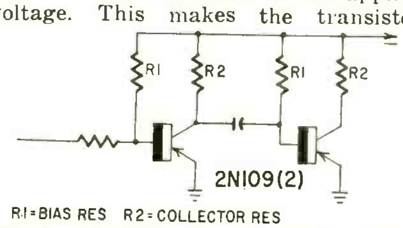


Fig. 4—Coupling the stage, with values from the text, to a following transistor stage.

reasonably linear as an amplifier. Even though we may have a sensitive voltmeter to measure input voltage at the base, its waveform will be poor, because of the transistor's nonlinear input resistance. This way everything behaves as linearly as possible, so the transistor's basic properties can be measured in a straightforward manner.

In practice, of course, the input resistance will be much lower than 100,000 ohms. If we come down to 10,000 ohms for a collector load, we need only 0.1-volt rms input to give the full 4.7-volt rms output, representing the same current gain. We could possibly drop to lower value input resistors and realize a *voltage* gain much larger than the current gain.

But in a practical R-C-coupled stage, we are limited to the *current* gain of the transistor per stage. If the collector is coupled directly through a capacitor to the following base (Fig. 4), best efficiency is obtained if *all the current swing* is fed to the following base. This means the collector *voltage* will cease to swing, because of the low impedance coupled in parallel with its collector resistance. Any current swing that still goes through the collector load resistor can be regarded as a coupling loss.

The collector resistance (ac) of a transistor is high. (The collector voltage/current curves for a transistor are very similar to the plate voltage/current curves for a pentode.) Consequently it is a constant-current generator. Our objective is to get the current swing from the collector transferred to the base of the following stage.

Suppose the first stage yields a current gain of 50 (Fig. 5). An input swing of 10 μa rms yields an output swing of 500 μa rms. But now, if the collector load resistance is 10,000 ohms and the following stage's base input resistance is 500 ohms, the available current swing divides, 1/20 into the 10,000 ohms and 19/20 into the 500 ohms. So the effective current gain from the base of the first transistor to the base of the second is 19/20 of the ideal, or 47.5.

We could measure this as a voltage gain. If both transistors have an input base resistance of 500 ohms, the voltage gain measures the same as the current gain, 47.5, but the waveform will be very poor due to the nonlinearity of the base input resistance. Therefore, how is it that R-C coupling, without any additional resistance, does not similarly produce considerable distortion?

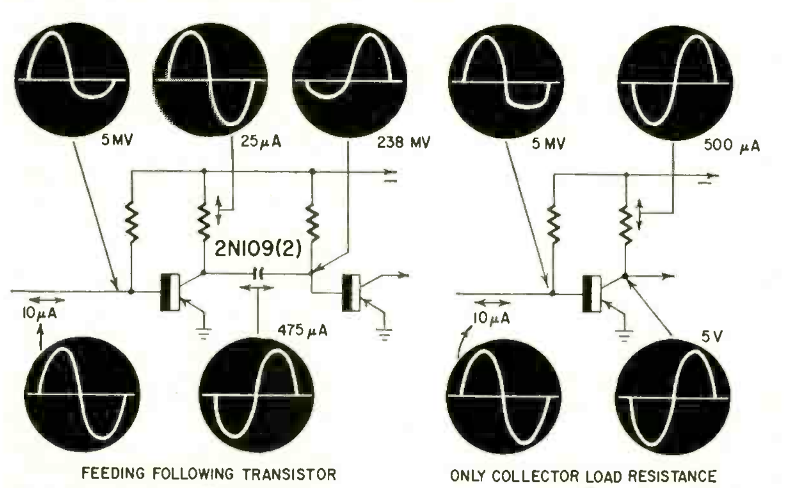


Fig. 5—Voltages, currents and waveforms associated with a 2N109 stage: a—R-C-coupled to another similar stage; b—as a single stage.

The answer is simple: because the collector, with its load resistance, supplies current, rather than voltage. A total 500-μa swing is supplied by the collector, whether 475 μa goes through the load resistor, or all 500 μa goes through the load resistor. When it supplies 475 μa to the base of the following stage, the voltage waveform goes awry because the current waveform is driven linearly. But when the whole 500 μa goes into the load resistor, which can be done by pulling the following transistor out of its socket, the voltage rises and has good waveform (provided it does not swing too far).

Improving the gain figure

Across the 475-ohm collector load (10,000 ohms in parallel with 500 ohms) when feeding the following transistor, a 500-μa swing produces about 238 mv of poor waveform. But when the following transistor is pulled, the voltage jumps to 5 volts of good waveform, because the 500 μa is now fed through the linear 10,000-ohm resistor.

But this seems rather wasteful. We are only getting an active gain of about 47.5 when the transistor seems to be capable of amplifying the current swing by about 50 while, at the same time, working from an input impedance of about 500 ohms with an input swing of 10 μa or 5 mv, into a 10,000-ohm collector load it yields a 5-volt output, representing a gain of about 1,000

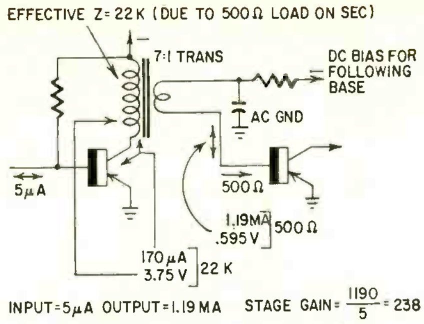


Fig. 6—How transformer coupling can increase current gain by avoiding excessive current drop when the following stage is coupled, without losing the current coupling (as would occur if a resistor were inserted in series with the coupling to the following base).

(disregarding possible nonlinearity for the moment). Then when it is R-C-coupled to a following stage, only the gain of 45–50 can be realized.

Using a low value collector load resistor, say 1,000 ohms, yields a higher current gain. By suitable choice of bias it can be pushed up to about 80. But then the current gain is divided between 1,000 ohms collector resistance and 500 ohms base input resistance, leaving only about two-thirds of the 80 value, or about 53. As the effective source resistance for the following base has dropped from about 10,000 to 1,000 ohms, this will be accompanied by some loss of linearity. Steps which we detail later could overcome this, but they also lose their slight advantage in gain.

A more successful method of improving gain is to use an interstage transformer (Fig. 6). We have seen that going from a low collector load resistor up to 10,000 ohms reduces wide-swing current gain from about 68 to about 47. A calculation based on these figures shows the effective (internal) collector resistance to be about 22,000 ohms in this region. So using an *effective* collector resistance of about 22,000 ohms should leave us with a current gain of about 34 (half the maximum value of 68). This can be provided by a transformer, working stepdown, so the input resistance of the following stage is stepped up to about 22,000 ohms from its actual value to 500 ohms. This is an impedance ratio of almost 50 to 1, or a turns ratio of about 7 to 1. As the voltage is stepped down, the current is stepped up. So the overall current gain will be about $34 \times 7 = 238$, which is a considerable improvement.

Now we have some good basic figures from which to start in figuring out the best values to use for any particular job. We have found that transistors vary somewhat and that there are nonlinearities that can prove troublesome. In following articles we shall show how to tackle these problems at different stages and for different purposes, and end up with the circuit that best suits the job. TO BE CONTINUED

Simple Attenuation Network

By A. G. SYDNOR

T-PADS usually take care of the majority of attenuation problems the electronic technician has to handle. In such an attenuator, three resistors are connected to give the proper matching load to the impedances it is connected between, and the desired loss. A conventional T-pad is shown in Fig. 1. The formulas for determining the values of the resistors in the pad are:

Asymmetrical or unbalanced T (different input and output impedances): For example, 3,000 ohms input to 500 ohms output with 15-db attenuation:

N = power ratio (15db = 31.62)

$$R3 = \frac{2\sqrt{N \times Z_{in} \times Z_{out}}}{N - 1}$$

$$R3 = \frac{2\sqrt{31.62 \times 3{,}000 \times 500}}{31.62 - 1} = 450\Omega$$

$$R1 = Z_{in}\left(\frac{N+1}{N-1}\right) - R3$$

$$R1 = 3{,}000\left(\frac{32.62}{30.62}\right) - 450 = 4{,}745$$

$$R2 = Z_{out}\left(\frac{N+1}{N-1}\right) - R3$$

$$R2 = 500\left(\frac{32.62}{30.62}\right) - 450 = 82\Omega$$

Symmetrical or balanced T (input and output impedances are the same): For example, for 500 ohms input to 500 ohms output with 18-db attenuation:

$Z = Z_{in} = Z_{out} = 500\Omega$

When $Z_{in} = Z_{out}$ $K = \sqrt{N}$

N = Power ratio

18 db = 63.1

$K = \sqrt{N} = \sqrt{63.1} = 7.94$

$$R1 = R2 = Z\left[1 - \frac{2}{(K+1)}\right]$$

$$R1 = R2 = 500\left[1 - \frac{2}{(7.94+1)}\right]$$

$R1 = R2 = 388.5\Omega$

$$R3 = \frac{2Z}{K - \left(\frac{1}{K}\right)}$$

$$R3 = \frac{2 \times 500}{7.94 - \left(\frac{1}{7.94}\right)} = 128\Omega$$

This covers the standard T pad. But in non-critical spots there is a simpler method. If we rearrange the legs of the network we come up with the arrangement of Fig. 2. Here we have taken one of the T pad's legs and moved it to the opposite end of the parallel leg. We call this arrangement a Z pad, as its appearance resembles the letter Z.

In effect, all resistors in Fig. 2 are in series, though not with the input or load, and it is obvious that a single tapped resistor can be used. Fig. 3 is a sketch of such a resistor and shows the terminals for both input and output connections. The sections of the resistor are marked for comparison with other types of pads.

For attenuation pads with identical input and output impedances, one 1,500-ohm resistor covers all attenuations between 4–48 db and provides 50–600 ohms input and output impedance.

Say we need 18-db attenuation in a 500-ohm line. From the equations, we found a T pad uses 388 ohms for R1, 388 ohms for R2, 128 ohms for R3. With an ohmmeter we measure section AB of our resistor (see Fig. 3) and set the first slider for 388 ohms (R1). Then we measure from B to C for 128 ohms (R3) and from C to D for 388 ohms (R2). Total resistance needed is 804 ohms.

For different input and output impedances use the standard T pad formulas and let section AB of the resistor (Fig. 3) equal R1, section BC equal R3, and section CD equal R2.

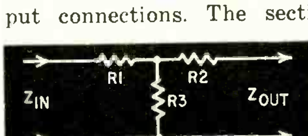


Fig. 1

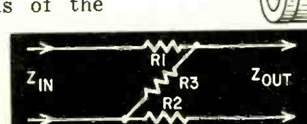


Fig. 2

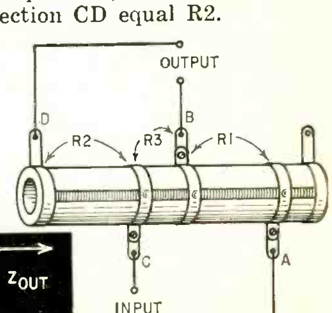


Fig. 3

Complex electronic equipment isn't needed to check your hi-fi system—use a test record or tape and your own two ears

ALL ABOUT STEREO TEST RECORDS and TAPES

By CHARLES B. GRAHAM
ASSOCIATE EDITOR

ONE of the best aids for technicians and audiophiles in checking out hi-fi systems, especially stereo versions, is the specially prepared test recording. Test records are better than music (demonstration records) because they furnish for reproduction precise definable bits of sound whose pitch and loudness are carefully controlled.

All test recordings have accompanying descriptive notes so the listener will know what to expect to hear if equipment is working properly. If it is not, the test record will be imperfectly reproduced, giving one an idea where the equipment falls short.

In addition to testing the response of a system to changes in pitch and loudness, it is desirable to check the dynamic range, signal-to-noise ratio, transient response, distortion and equalization.

Using a test record

We measure the ability of a system to respond to changes in pitch by taking a frequency run from, say, 30 to 15,000 cycles. Dynamic range and signal-to-noise ratio are functions of the loudest undistorted volume the system can handle taken together with the system noise, tube and component hiss, hum, recording-medium noise (stylus on vinylite, or tape hiss). Turntable noise (largely rumble) is also a factor here. Distortion can be checked roughly by listening or, better still, by observing waveshapes on an oscilloscope screen. Good transient response can be indicated (though not measured) because smooth high-frequency response and gradual rolloff can often be correlated with good transient response.

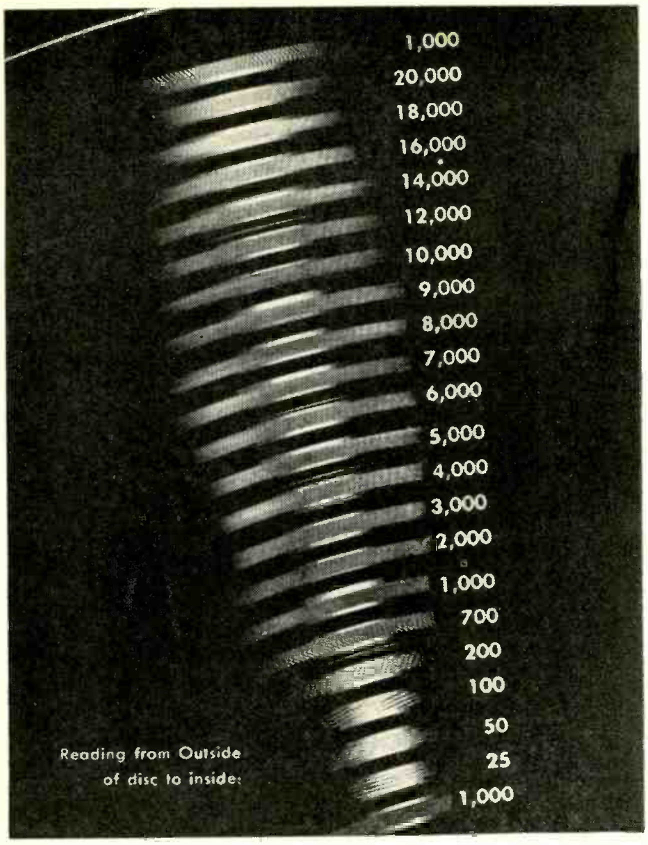
In addition to the preceding characteristics, there is one which we do not have in monophonic reproduction, but do run into with stereo—crosstalk, or its reciprocal, channel separation.

Since stereo discs always involve mechanically coupled elements, both when cut and when played back, there is always some mechanical leakover, some crosstalk between channels. When this is at least 20 db down from the level of the desired material, it is pretty well masked. But channel separation of say, 20 db on the recording may be demolished by the playback cartridge, since many pickups have less than 15 db of separation over most of their ranges. The separation in pickups decreases as the frequency goes up.

Stereo disc cutters also have finite limitations on their separation and tend to have less separation as frequency increases. The Westrex 3-C cutter, most widely used today, has channel separation of perhaps 25 db or so up to about 10 kc, and between 10 and 15 db up to beyond 15 kc. William Miltenburg, chief engineer for RCA-Victor Records in New York, says that RCA is at present recording most discs to the limits of audibility. According to recording engineers, the earlier Westrex 1-A cutter was flat only to about 10 kc. Many improvements remain to be made.

Stereo test discs are sold by seven companies in this country, and two or three more expect to release one about the time this appears. They can be divided into two groups—those best suited to shop or home use because they have a variety of tests and those intended for checking frequency response and channel separation. The first group consists of the Audiotester 30-200, Audio Fidelity FCS 50,000, Components H-58 (7-inch) and Ziff-Davis Stereo–Mono Test Record. They may be joined before long by test records from Vanguard and Westminster, and probably Fairchild Recording. The second group includes the London PS-131, RCA-Victor 12-5-71 and 73, Teldec TP 217/T and Westrex 1-C. (Mono test discs are also available. They are made by Components, Cook, Clarkstan, Electra, Gotham, Lafayette Radio, Popular Science Magazine and Urania.)

With few exceptions test tapes and discs are not widely available at local record stores or hi-fi showrooms. Sometimes they can be purchased only direct



Light reflected from Gotham - Grampian (mono) disc reveals slight rolloff from 9 kc to 20 kc. Below 1 kc, RIAA curve is used. Light ratio of 2:1 in width equals 6 db

from the manufacturer. Others are listed in mail-order catalogs. At the end of this article are listed the addresses of the makers of these items.

Test discs and tapes may be used without any equipment except the gear under check, using one's ears to compare the actual sound output with the sound described in the notes accompanying the test material. An ac meter is helpful, and an oscilloscope is even better. If the meter is not an audio vtvm, it should have a low scale—preferably 1.5 volts—since it must be connected across the voice coil of the output transformer where the impedance is so low that the signal voltages may be small. A vtvm can go at any convenient point in the circuit, for example, across the tape recorder output or across the input to the power amplifier.

A scope is especially useful in observing the waveforms produced when playing high-level test tones. Distortion can often be easily observed visually when it cannot be identified with certainty by ear. A scope is also very helpful in rumble tests since the reference tone, usually 1,000 cycles, will show up on the scope as a small but steady shape, whereas the random noise along with possible unsteady rumble will shift and change continually. The scope can be connected right across the voice coil output. It should be calibrated, if it does not have a graticule, by sticking two pieces of paper or tape on the screen just far enough apart to mask the part of the screen not traced by the 1,000-cycle reference tone.

On the discs

Certain discs and tapes have previously been described in these pages. Westrex 1-C (issued in limited quantities and no longer available), London PS-131 and RCA 12-5-71 (1 kc–20 kc) stereo test discs are detailed in RADIO-ELECTRONICS, March, 1959, page 90. Ampex, Audio Devices and Livingston test tapes are discussed on page 46 of May, 1958, and Westminster's earlier SWB-AL 101 and Stereophony's tape on page 43, June, 1958.

Typical of the most useful stereo test discs is Components' stereo Hi-Fi Test Record (this company is responsible for the actual engineering of several test discs released by other companies). This 12-inch LP has 13 cuts or bands. Side A for stereo testing only, has band 1 recorded at medium level; a single tone, announced for the right channel first, then the left one, for channel identification. Band 2 has a metronome recorded equally in both channels, to allow balancing the sound coming from the two speakers.

Band 3 feeds tone in phase to both speakers for 15 seconds, then out of phase for 15 seconds. If the speakers (and the cartridge and amplifiers) are correctly phased, the second tone will be noticeably lower in volume than the first. If the speakers (or other units) are not phased properly, the second will sound louder than the first. This is because they aid each other when they come out of speakers phased together (cones going in and out at the same time). They tend to cancel sound partly in the second cut if the speakers are properly phased, fairly closely balanced, and if there isn't too much reverberation and reflection in the room. If the speakers are not properly phased, then the in-phase signals of the first band would come from the speakers out of phase, and the out-of-phase signals of the second band would come from the non-phased speakers in phase. However, in each case the signals must be balanced beforehand and the room must be pretty dead. We had a lot of trouble with this test, finally solving it by turning the gain down low on both channels and putting the two speakers close together and listening very close in front of them. Vanguard Records has apparently worked this out, for the instructions accompanying their forthcoming test record suggest placing the two speakers side by side.

Band 4 is a gliding tone in one channel, starting at 10 kc and coming all the way down to 50 cycles. This is repeated in band 5 for the other channel. It will show how smooth (or bumpy) the response is, and is excellent for testing channel separation. Band 6 has numerous unusual stereo sound effects, including a wall-shaking reproduction of the whistle of the Queen Mary.

The second side of the disc is useful for both stereo and mono testing. It has the familiar stylus wear test in bands 1 and 7. If the test tone sounds smooth in both of these bands, the stylus is in good shape. If inside band 7 sounds distorted when compared to band 1, the stylus is bad. Band 2 is a glide tone from 35 kc down to 1 kc, with tiny audible (and visible, if scope is in use) beep markers every 3–4 kc. This will show up pickup (and arm) resonances. Band 3 checks RIAA equalization by playing 15 kc to 30 cycles in graduated steps, with announcements. Band 4 is a rumble test using a 30-cycle note. There are three cuts, one at 20 db down from the normal level of band 1, and others at 30 and 40 db down. This is used in conjunction with the quiet groove, band 6 serving as calibration for rumble heard when the gain is turned up in band 6. Band 5 is a glide tone from 100 cycles down to 5. This tests turntable and arm resonances. Some arms today have very-low-frequency resonant points, but those resonances are strong ones. Incidentally, the 5-cycle note at the end of this band is believed to be the lowest frequency ever recorded on a commercial disc.

Other test discs have similar groups of tests, many of which are very well thought out and executed. One especially good one on the Audio Fidelity disc is that for channel separation and intermodulation. It provides a 3,000-cycle tone on one channel at the same time that it has 800 cycles on the other. Then it reverses the tones. By turning the gain down on first one channel, then the other, one can easily note any crosstalk.

Other tests on the Audio Fidelity disc are: band 1, metronome, for balancing speakers; band 2, 1,000 cycles at 5 cm/sec (reasonably high "zero" level) in both channels; band 3, silent grooves, for rumble test; band 4, high-frequency test tones; band 5, low-frequency test tones; band 6, glide tone, 70–15 cycles; band 7, 440 cycles—musical note A; bands 8 and 9, 3,000 and 800 cycles for crosstalk test. Reverse side of disc, excerpts from five symphonic marches (with labeling for first two reversed).

Audio Fidelity FSC 5890 is a superior demonstration disc, which includes some incredibly live sound effects. Giant steam and Diesel locomotives thunder and grind across the living room; racing cars roar past, skid and screech, and various cannon and gunfire shots ricochet and echo into the distance.

Audiotester 30-200 test disc has these stereo tests on side B: bands 1 and 3, pickup alignment and channel separation, 1,000 cycles at 5 cm/sec on each channel, then 1,000 cycles at 2.5 cm/sec; bands 2 and 4, frequency runs from 10 kc down to 50 cycles, equalized for RIAA curve; band 5, stereo balance—metronome recorded equally on both channels; band 6, 1,000 cycles 40 db down, to calibrate rumble. On side A there are monophonic and stereo tests: bands 1 and 6, 8,000 cycles at 3.5 cm/sec for stylus wear checking; band 2, frequency run for RIAA curve; band 3, IM distortion (100 and 7,000 cycles); band 4, rumble test; band 5, sweep from 50 to 10 cycles at 7 cm/sec (very high level) to find pickup and tone arm resonances.

The RCA-Victor 12-5-71 and 73 (both are needed for full frequency coverage) have only frequency runs. 12-5-71 is at 78 rpm to record the highest frequencies better. It goes from 20 to 1 kc in 1-kc steps at 3.8 cm/sec. One side has only channel 1 recorded, the other side has channel 2 recorded. The second disc (12-5-73) has low frequencies recorded at 33⅓ rpm. It goes from 1 kc down to 30 cycles, one channel a side. Recording level is low, stated as 0.42 cm/sec, but adequate. The surfaces of these discs are quiet.

The Teldec record made in Europe by English Decca and Telefunken has frequency bands from 12 to 1 kc in 11 steps, alternating channels. Then it runs 500 to 60 cycles in octaves, four steps. Teldec also has a 45-rpm disc—940 cycles at high velocity, 11 cm/sec for factory calibration of pickups.

Ziff-Davis Publishing Co. has issued a 7-inch LP test disc on which side A has these tests for stereo: band 1, channel identification and separation, 1,000 cycles, medium level, first one channel, then the other; band 2, metronome for channel balancing; band 3, speaker phasing, 100 cycles recorded in-phase (lateral) then out of phase (vertical cut); band 4, rumble test, 100 cycles recorded 20 db down, then 30, 40, and 50 db down from standard level for calibrating player and system noise. Side B has mono and stereo tests on bands 1 and 3, 100 cycles for estimating stylus wear; band 2, 15 kc to 40 cycles equalized RIAA, lateral cut.

Test tapes

Presently nine test tapes are available, sold by six companies, with RCA producing tapes for standard two-track stereo machines as well as the new four-track slow-speed cartridge machines. NCB-Technicor has two tapes also, one for 7½ and one for 15 ips. Audio Devices' tape was originally intended for 15 ips, but can be used at the 7½-inch speed since at 15 inches it goes out to 15 kc. Thus at 7½ ips it will check the playback heads up to 7,500 cycles. In addition to these tapes there are the Livingston LX-1E, Ampex 5563 and Audiotester 30-208. The material on these is much less varied than on the discs described earlier.

Test tapes can measure the performance of only the playback function of a tape machine and assist the technician in correcting playback problems. They cannot measure the performance of the machine in recording.

Some time ago a particularly effective test tape (D-110) was produced by the Dubbings Co., who duplicates stereo tapes commercially on a large scale for many record companies. The tape is no longer made, but is still available for $12.50 from some mail-order houses and distributors.

This tape, which runs for 14 minutes, includes precisely calibrated signals and voice announcements in a number of places to measure recorder wow and flutter, head alignment, frequency response, signal-to-noise ratio, maximum signal level and tape speed. The 66-page instruction book accompanying it is an education in itself. The Dubbings tape has a much more complete series of tests than any of the presently more widely available tapes.

Audiotester tape 30-208 includes seven sections recorded at 7½ ips on a 5-inch reel. It checks head alignment at 7,500 cycles, frequency response and equalization in 10 spots from 30 to 10,000 cycles; has a section for checking IM distortion (which is most effective only with an IM analyzer, but which can be useful if a scope is used), a flutter test (3,000 cycles), a stereo balance test (metronome sound) and a number of piano chords.

RCA-Victor 12-5-64T test tape for the four-track 3.75 ips cartridge has four sections recorded on two of the four narrow tracks. They include head height (position adjustment), head azimuth alignment, 1,000 cycles at standard recording level, and a frequency run 15,000 to 50 cycles, and a phasing tone—2,000 cycles—and voice.

One final caution—these test discs, although usually produced under conditions of quality control at least as rigid as those used in regular production of musical recordings, cannot possibly be absolutely uniform from one disc to the next. The best pressing is a mass-production proposition, and small production variations are inevitable. Therefore results using test discs, much more than using test tapes, should be regarded as *indications*, not necessarily as *measurements*, or qualitative results.

Even such a small random and generally uncontrollable factor as the twist of the connecting wires at the rear of the arm can alter the amount of crosstalk of the system, changing from one day to the next.

Too, different pickups may alter the response of the system to test-disc material due to high-frequency resonances set up between the disc vinyl and the effective mass of the stylus. This point is often 12 to 17 kc. Three stereo test discs were received from Cook Laboratories too late for inclusion in this article. These, along with discs announced by Vanguard and Westminster, will be reviewed in a forthcoming issue. END

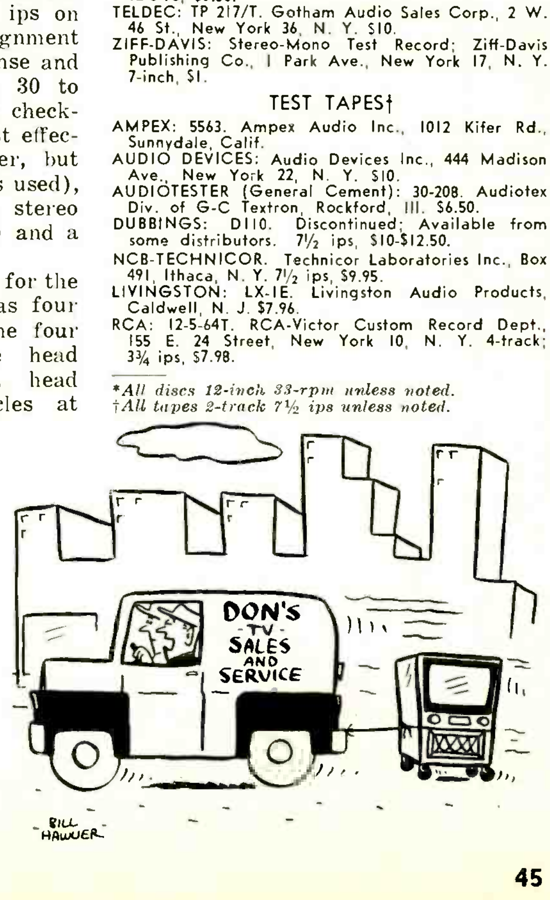
STEREOPHONIC TEST DISCS*

AUDIO FIDELITY: FCS 50,000. Audio Fidelity, 770 11 Ave., New York 19, N. Y. $6.95.
AUDIOTESTER (General Cement): 30-200. Audiotex Div. of G-C Textron, Rockford, Ill. $5.
COMPONENTS: Components Corp., Denville, N. J. $4.98 (tentative); 7-inch, $1.
LONDON: PS-131 Stereo. London Records, 539 W. 25 St., New York 1, N. Y. $4.98.
RCA: 12-5-71. 78 rpm; RCA-Victor Custom Record Dept., 155 E. 24 St., New York 10, N. Y. $6.50. 12-5-73, $6.50.
TELDEC: TP 217/T. Gotham Audio Sales Corp., 2 W. 46 St., New York 36, N. Y. $10.
ZIFF-DAVIS: Stereo-Mono Test Record; Ziff-Davis Publishing Co., 1 Park Ave., New York 17, N. Y. 7-inch, $1.

TEST TAPES†

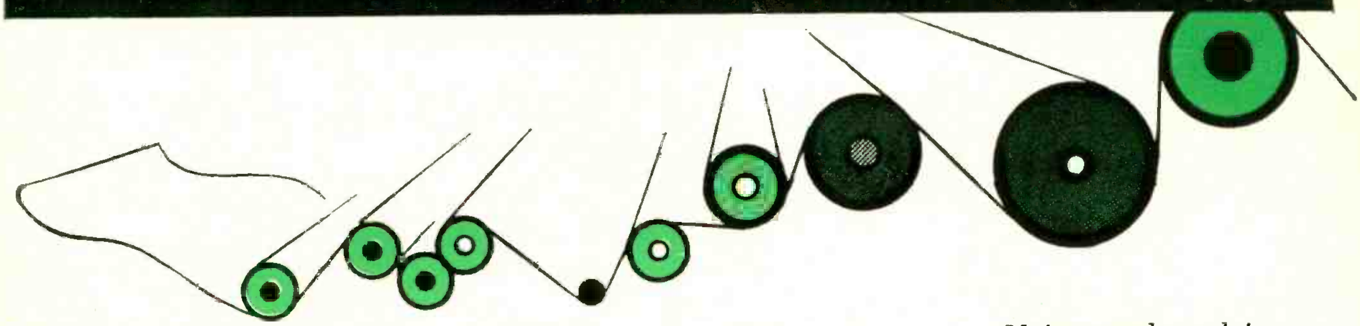
AMPEX: 5563. Ampex Audio Inc., 1012 Kifer Rd., Sunnydale, Calif.
AUDIO DEVICES: Audio Devices Inc., 444 Madison Ave., New York 22, N. Y. $10.
AUDIOTESTER (General Cement): 30-208. Audiotex Div. of G-C Textron, Rockford, Ill. $6.50.
DUBBINGS: D110. Discontinued; Available from some distributors. 7½ ips, $10-$12.50.
NCB-TECHNICOR. Technicor Laboratories Inc., Box 491, Ithaca, N. Y. 7½ ips, $9.95.
LIVINGSTON: LX-1E. Livingston Audio Products, Caldwell, N. J. $7.96.
RCA: 12-5-64T. RCA-Victor Custom Record Dept., 155 E. 24 Street, New York 10, N. Y. 4-track; 3¾ ips, $7.98.

**All discs 12-inch 33-rpm unless noted.*
†All tapes 2-track 7½ ips unless noted.

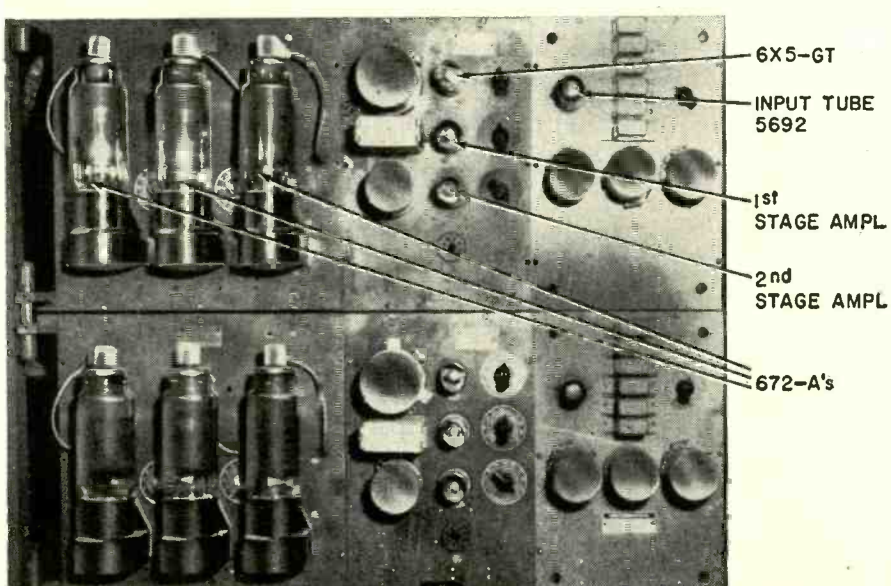


"We're lucky this last one has casters!"

ELECTRONICS in a PAPER PLANT



Relay panel which controls section motors and transfers them from starting generator to running generator. Board is about 7 feet tall and 20 feet long.



Power, input, and amplifier panels that make up the electronics part of the regulator system.

Motor speed regulators are another field open to the enterprising electronic service technician

By W. G. CULPEPPER

IN paper manufacturing it is essential to keep the speed of several dc motors constant during the process. Several electronic equipment manufacturers have developed successful electronic speed regulators. This article is primarily concerned with a specific one developed by Westinghouse for the St. Regis Paper Co. and now in operation at its Pensacola plant.

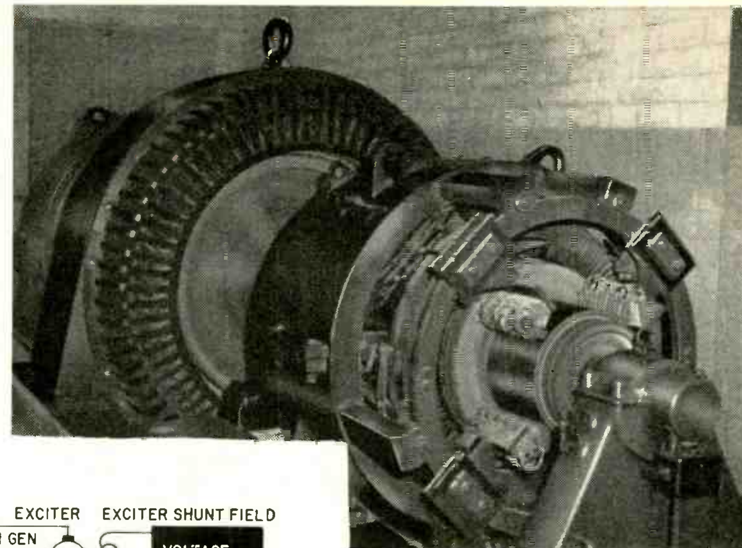
The regulator that supplies field current to a shunt-wound dc motor, which has a preselected regulated armature voltage, consists of three sections or panels: the input, amplifier and power panels. Motor speed is controlled by its field-current regulator. As the operation of the regulator is better understood by getting an overall picture of the machine components, let's take a look at Fig. 1.

The chief operator selects the desired speed of the paper machine with a motor-operated rheostat in the field circuit of the running generator. The machine drive this controls consists of 11 dc motors, ranging in horsepower from 50 to 400. These motors are individually brought up to the desired speed by a starting generator and transferred to the running generator bus. Each section motor drives a small ac tachometer or cue tach generator whose output is fed to the input stage of its speed regulator. There is also a master motor (which is also started with the starting generator and transferred to the run generator). It drives a reference ac tachometer whose output is fed to the input stage of all speed regulators. At each dc motor control station there is a rheostat in series with the reference voltage which enables an operator to vary speed to get the desired tension (draw) of the paper sheet between sections. This rheostat (draw control) must be cleaned frequently because of the gases, vapors and dust to which it is exposed.

One problem we encountered—poor contact between the movable arm and its terminal—was corrected by soldering a piece of voice-coil wire between the arm and terminal. A later model of this regulator system uses an enclosed rheostat.

Input stage

The input stage rectifies and filters the cue and reference voltage and is connected as shown in Fig. 2. A difference between master speed and section speed results in a voltage output at A and B. The output of cue and reference tachometers ranges from 20 to 90 volts, depending upon the speed selected by the machine operator. For good operation at all speeds, the rectifiers must track together. Experiments were carried out by Westinghouse engineers and plant personnel using crystal diodes, 6X5's, selenium rectifiers, 6SN7's and 5692's to determine which was best for this application. In addition to tracking, the rectifiers are exposed to temperature changes, contaminated air and a certain amount of vibration. The 5692's with grid tied to plate, have proved very successful, provided they are pretested for tracking ability. In pretesting input tubes, a circuit similar to the input stage is used and equal voltage is applied to both sections of the tube. This voltage is varied throughout the normally encountered range (20 to 90 volts). If the unbalance is 0.5 volt or less and does not vary more than 0.2 volt, the tube will be satisfactory.



1250 kw running generator supplies power to all section motors. The starting generator is shown in the foreground.

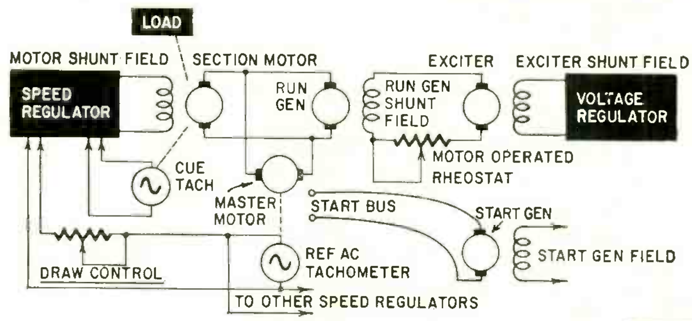
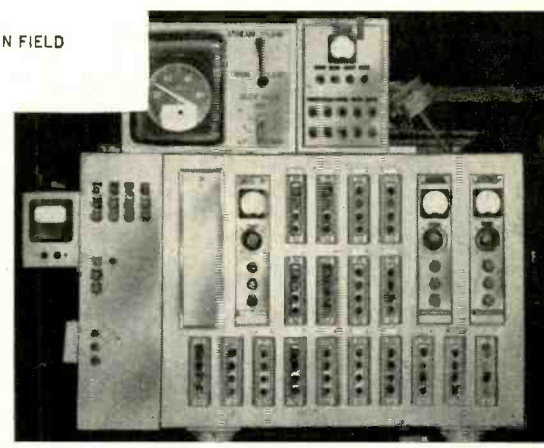


Fig. 1 — Block diagram gives an overall picture of the regulator system.



Control station at wet end of paper machine. Draw controls, motor ammeters and various pushbuttons for pump motors can be seen.

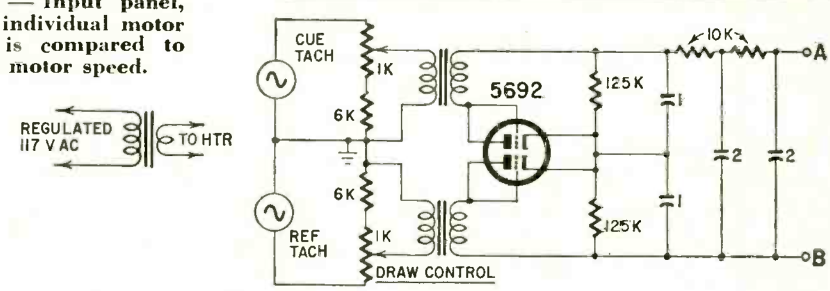


Fig. 2 — Input panel, where individual motor speed is compared to master motor speed.

Amplifier panel

The voltage at points A and B is the error voltage which results when drive motor speed and master speed are unequal. This error voltage is amplified in two stages to provide the grid power needed to control the thyratrons in the power panel. This amplifier panel (Fig. 3) also includes the damping circuit which takes a portion of the change in output from the thyratrons, amplifies it and opposes the action which caused the change in thyratron operation. Potentiometer R2 controls the amount of anti-hunt or damping signal and is adjusted under normal load conditions. R1 controls the amplifier's sensitivity and is operated in maximum position. The tubes used in the amplifier panel originally were 6SN7's but have been replaced with 5692's. These tubes are pretested for unbalance and microphonics, and it is not unusual for them to give 8,000 to 9,000 continuous hours of service. The amplifier's B-plus is supplied by a 6X5 used as a full-wave rectifier.

Power supply

The power panel (Fig. 4) has three grid-controlled thyratons (672-A) supplying the field current of the dc drive motor. Their output is determined by preset phase-shifted grid voltage, and superimposed dc voltage from the voltage amplifier panel. Grid voltage of the thyratrons lags the anode voltage by approximately 120°, and the dc voltage is determined by error voltage.

During starting and accelerating the motor, the regulator supplies rated field current, and only after transferring to the running generator does the regulating action begin. The starting, acceleration and transfer of the motor from starting generator to running generator is handled by a relay panel.

In the thyratrons' output circuit and in series with the motor field is a field-failure relay to drop the motor off the run generator bus should there be a

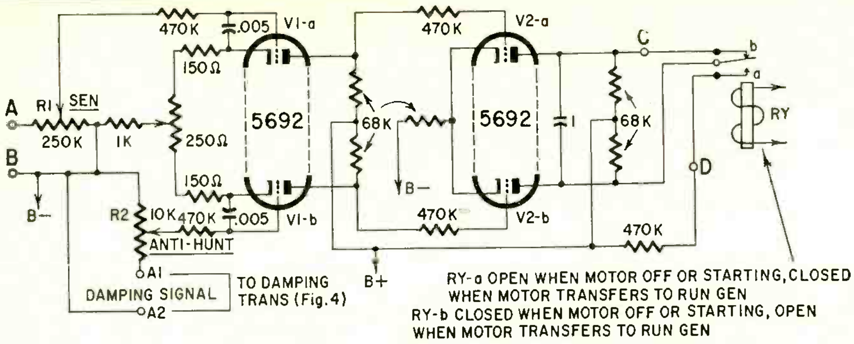


Fig. 3—The amplifier panel boosts the signal produced by the input panel to a usable level.

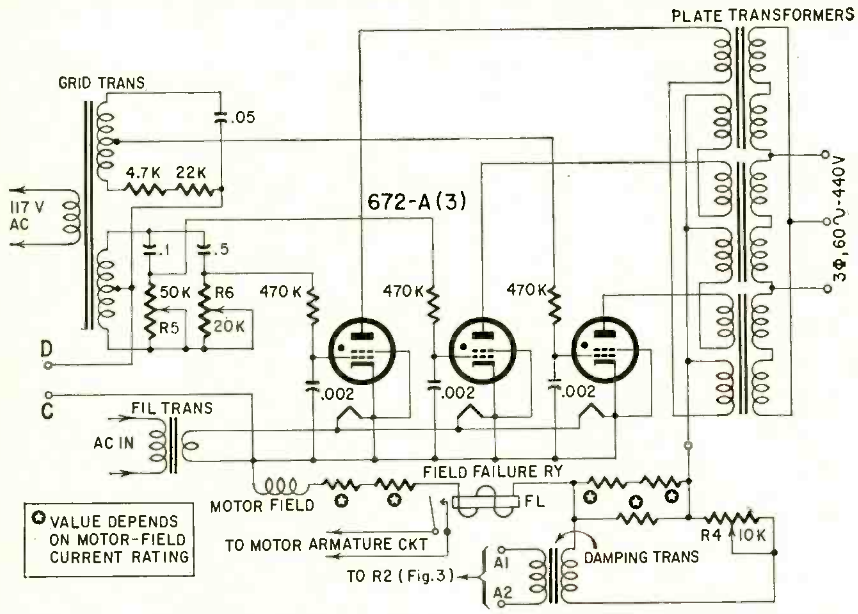


Fig. 4—The power panel which converts three-phase 440-volt input to regulated dc. This supplies field voltage to the paper-mill's drive motors.

fault in thyratron operation or a loss of field current.

Primary power to the power panel is 440-volt 3-phase 60-cycle, and three single-phase transformers with dual primary and secondary windings are used. The primary windings of each transformer are connected in series and delta-connected with the other transformers. The secondaries are zig-zag-connected so the regulator will still function if one of the thyratrons should fail. The operational life of the thyratrons averages between 12 and 18 months of continuous use.

The whole system

Briefly, here's how the regulator works:

Assume normal operation with the section motor cue-tach output matched to master reference-tach output. A friction load or work load increase would cause the section motor speed to drop. Therefore, the cue-tach generator output would drop and result in a voltage output at A and B, with A positive. Positive voltage applied to V1-a's grid (Fig. 3) causes a drop in its plate voltage (E_p).

V1-a's lowered E_p decreases V2-a's plate current, V2-a's plate voltage rises, and point C becomes positive or less negative with respect to point D. Point C is connected to the thyratron's cathode circuit and point D to their grid circuit. A positive cathode (negative grid) drops the amplitude of ac grid voltage (see Fig. 5), the tube conducts less, the motor's field current decreases and its speed increases until it matches the master speed.

When tube current decreases, this change in current through field and damping resistors causes an output from the damping transformer. This damping signal is applied to the grid circuit of V1-b, the first stage of the damping amplifier section. This signal, under the above conditions makes V1-b's grid positive, and its plate voltage drops. V2-b's plate voltage or point D goes positive, which opposes the original change between C and D.

Properly adjusting the anti-hunt potentiometer keeps hunting at a minimum. R4 (Fig. 4) determines, in part, the time constant of the damping circuit, and its setting varies in each regulator due to the type of load of each section motor. R5 and R6 vary the phase of the grid voltage of two of the thyratrons, and these adjustments are for equalizing the load on the thyratrons.

Other adjustments also have to be made in initial installation or when major components are changed. Two of these are setting the motor field resistors for maximum and minimum field current, and setting the cue-tach generator output voltage for proper calibration of the paper-machine speed.

Regulator troubles

Run-of-the-mill regulator troubles are common to electronics: open resistors, shorted capacitors, tube and transformer failure. The important requirement in troubleshooting the regulators is speed. Since production stops when the regulators are out of order, the company loses money. The faster they are put back to work the smaller the loss.

Bad bearings on cue-tach generators also will feed false signals to the regulator and cause motor speed to change or swing, resulting in a break in production. Poor commutation on the master dc motor will cause the entire machine to swing. Improper adjustment of draw controls by operators will cause production losses. Any variation in motor speed, whatever the cause, must be checked by the electronic technician to determine whether the variation was caused by faulty regulator action or by abnormal operating conditions. Generally speaking, however, close cooperation between production and maintenance personnel results in a minimum of lost production due to regulator failure.

There are two electronic speed-regulated paper machine drives at this plant, and one additional machine which employs a very effective magnetic amplifier circuit.

Problems, when initially encountered in these installations, generally were typical of those expected of any new design. From the electronic technician's viewpoint, they served to point out, once again, the value of careful circuit analysis in troubleshooting. END

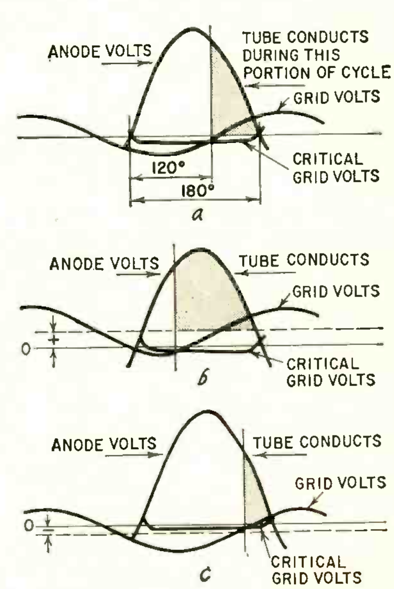
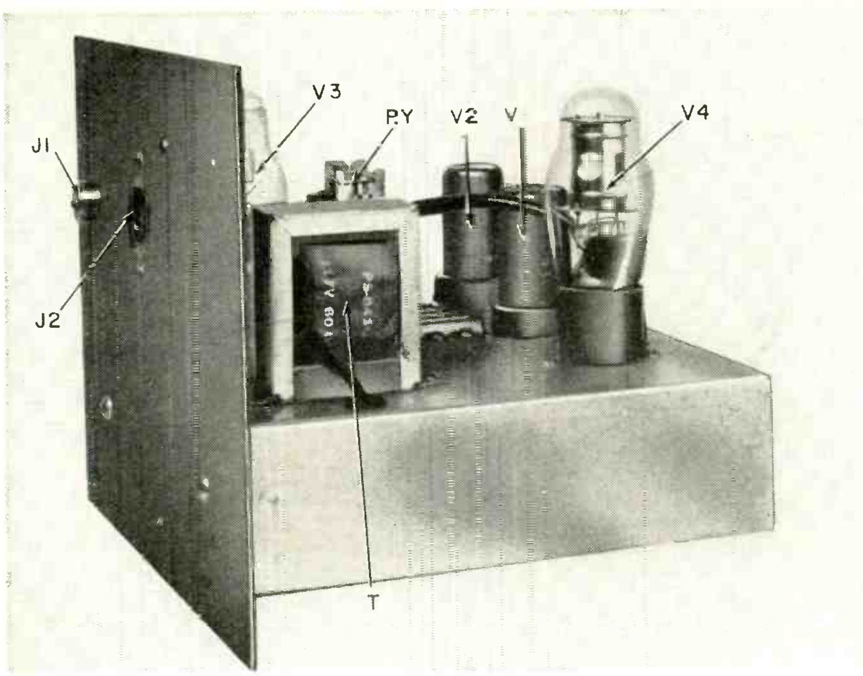


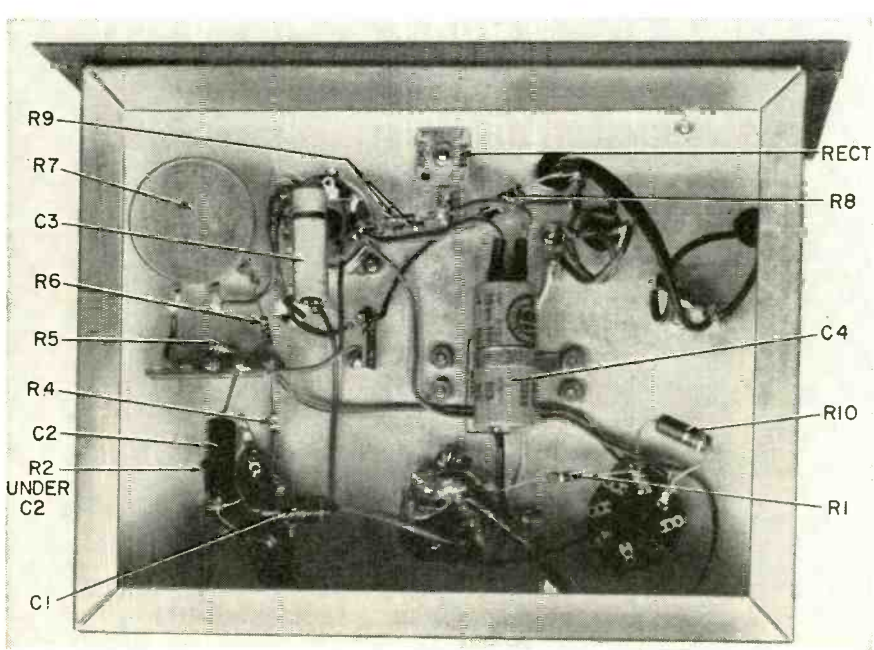
Fig. 5 — Thyratron operation: a—with no signal from amplifier; b—with positive signal; c—with negative signal.

Dust, dirt, and smog have no effect on this compact unit as it performs its job of counting metal objects passing its sensing coil

Electronic Counter has many uses....



The completed counter. Jacks on the front panel are for the sensing coil and connections to the relay switch terminals.



As a look under the chassis shows, a much more compact arrangement is possible.

By JOHN POTTER SHIELDS

THE electronic metal indicator and counter described in this article was designed to count accurately metallic objects passing by on a conveyor belt. It was intended to count metal can bodies in can manufacturing plants. It is also useful for counting filled metal cans prior to packaging in food processing plants, breweries, etc. Besides its use as a can counter, it has other functions which will be explained later.

One of the main advantages of this type of electronic counter is that it will work in locations where a photoelectric counter would be totally unsatisfactory. For example, it will work well where atmospheric conditions would quickly cloud the optical system of a photocell setup.

Another advantage is that buildup of dirt or other foreign materials on the pickup or sensing coil does not interfere with its operation. This is particularly important in installations where considerable dirt and grime are present and maintenance personnel may not always take the time to clean the sensing coil continually. The reason why the sensing coil can tolerate an accumulation of grime, even metal filings, is that the *relative motion* of the metal to be counted actuates the device.

How it works

V1 and V2 form a two-stage high-gain amplifier. The sensing coil is connected to the cathode circuit of the first stage. There are two reasons for this. First, due to the rather low impedance of the sensing coil, a better match can be obtained by placing it in the cathode rather than the grid circuit of this stage. Second, since the sensing coil is connected to the cathode circuit, the dc plate and screen currents of the tube will flow through it, causing its core to become slightly magnetized, a necessity for proper operation. The output from the second amplifier stage, V2, is coupled to the control grid of thyratron V3. Note that the signal is not rectified before it appears on the grid of V3.

Sensitivity is controlled by potentiometer R7 in V3's cathode circuit. In operation, the potentiometer is adjusted so that V3's cathode is slightly more positive than its control grid. This, of course, is the same as making the grid negative with respect to the cathode. In this condition, the tube is cut off and the relay remains open. When a metallic object passes within about 1 inch of the sensing coil, a minute voltage pulse is generated in the coil. This pulse is caused by the passing metallic object disturbing the magnetic field produced by the sensing coil. This pulse is fed to the two-stage amplifier and applied to the control grid of V3. When the amplified pulse reaches the grid of V3 the tube conducts, closing the plate circuit relay.

A standard half-wave power supply operates the device. An R-C pi-section filter provides adequate filtering, and an 0A3 gas regulator tube provides a regulated voltage for the screen of V2 and a reference static bias voltage for V3.

An electrolytic capacitor (C3) across the relay coil prevents relay chatter. If the device is used as an electronic counter, the value of this capacitor should be such that it will discharge through the relay coil rapidly enough so that the relay can respond to the next counting pulse. In this application, the smallest value of capacitance that will keep the relay from chattering should be used.

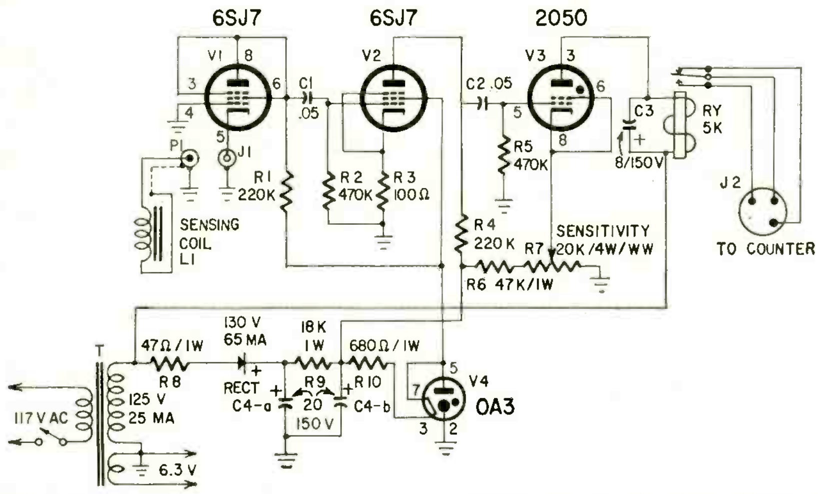
While a 6SJ7 pentode, triode-connected, was used for V1, a triode (6J5) is just as good.

Parts layout of the unit is not critical and the builder can use his judgment in layout. We used a shock-mounted tube socket for V1 to minimize microphonics. This is not necessary if the unit is located where there is little vibration.

If it is used to count metallic objects, a suitable electromagnetic counter can be obtained from a number of manufacturers. These counters are made with a variety of operating coil voltages including 6.3 and 117, making it possible to operate one from either the line voltage or the power transformer heater winding. I found it necessary to put a 0.1-μf capacitor across the relay contacts to insure reliable counter operation at high speeds.

The sensing or pickup coil consists of a choke coil with the I laminations removed. This coil is connected to the unit by a length of shielded cable. Since the impedance of the input circuit is low, the cable can be quite long without signal loss. The unit is very stable, operating for extended periods of time with no trace of instability or drift.

Other than the uses already mentioned, the electronic metal indicator and counter has a place in the experimenter's lab. For example, it can be used to check the speed of a phono turntable. Simply tape a small piece of iron or steel to the turntable so that, as the turntable revolves, the piece of metal comes to within an inch or less of the sensing coil. (The metal used must be a magnetic material such as iron or steel.) With an electromagnetic counter attached to the relay contacts, let the turntable run for exactly 1 minute. At the end of the minute, the counter will tell you the exact number of revolutions the turntable made. In brief, the uses for this device are limited only by your imagination. END



R1, 4—220,000 ohms
R2, 5—470,000 ohms
R3—100 ohms
R6—47,000 ohms, 1 watt
R7—pot, 20,000 ohms, linear taper, 4 watts wire-wound (Mallory M20PK or equivalent)
R8—47 ohms, 1 watt
R9—18,000 ohms, 1 watt
R10—680 ohms, 1 watt
All resistors ½-watt 10% unless noted
C1, 2—.05 μf, 600 volts
C3—8 μf, 150 volts, electrolytic
C4—20-20 μf, 150 volts, electrolytic
J1—Coaxial connector; female, chassis type
J2—3 prongs, panel connector
L1—sensing coil, 10.5 h, 110 ma (Stancor choke C-1001 or equivalent)
P1—coaxial connector 3 male, cable type
RECT—selenium, 130 volts, 65 ma
RY—5,000-ohm coil, (Advance GHE/2C/5000D or equivalent) (comes with dpdt contacts)
T—power transformer: primary, 117 volts; secondary, 125 volts, 25 ma.; 6.3 volts, 1 amp (Stancor PS-8416 or equivalent)
V1, 2—6SJ7
V3—2050
V4—OA3
Chassis
Panel
Miscellaneous hardware

Circuit of the four-tube unit.

Transistors by Alloy Diffusion

ALLOY DIFFUSION, a new process for making transistors, puts vhf germanium transistors in the low-price field. The Amperex OC170 made by this process has a cutoff frequency of 70 mc and an average beta gain of 80. It can be used as a mixer-oscillator in mobile radio equipment, car radios and short-wave receivers, and as rf and if amplifiers for FM receivers.

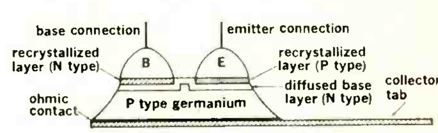
In the Amperex process, alloying and diffusion take place simultaneously. The transistor is built up on a piece of p-type germanium. Two small metal pellets are placed on it. Pellet B, for the base, contains only an n-type impurity. The other pellet (E), for the emitter, contains both p-type and n-type impurity.

When the assembly is heated, the germanium dissolves into the metal pellets until saturation and the pellet impurities diffuse into the solid germanium. However, the p-type impurity in the emitter pellet has such a low diffusion constant, that for practical purposes it does not penetrate into the germanium. The n-type impurity in the emitter and base pellets has a much greater diffusion factor and readily penetrates into the solid germanium to form a diffused n-type layer underneath the pellets.

When the assembly is cooled, a layer of germanium recrystallizes from the pellets. The layer that recrystallizes from the emitter pellet contains many atoms of the p-type impurity and is therefore a p-type germanium layer. The germanium layer that recrystallizes from the base pellet is n-type as there are no other impurites in this pellet.

Connections are made to the germanium and the metal pellets and a p-n-p transistor is obtained. The original p-type germanium is the collector, the pellet B is the base and pellet E the emitter.

The OC171 and OC169 are additional p-n-p types made by the alloy-diffusion process. The OC171 is designed as a

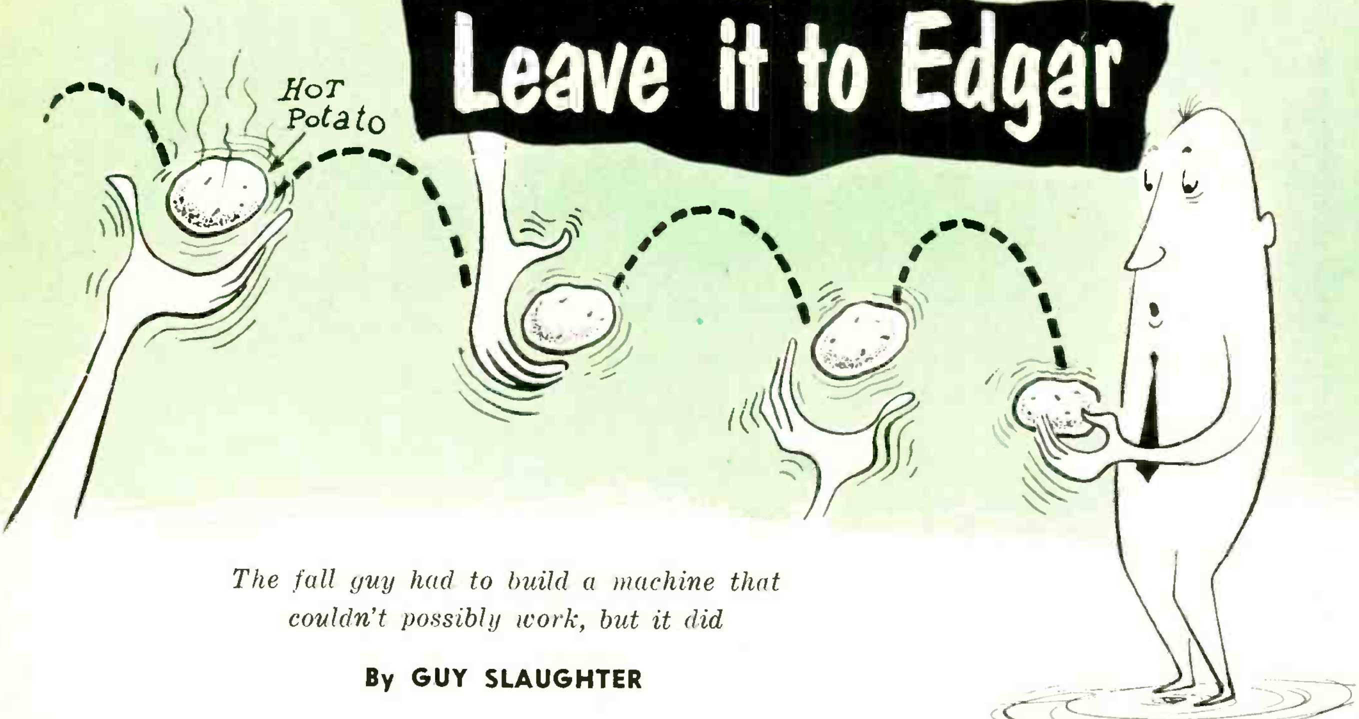


local oscillator and preamplifier in FM sets. The OC169 is used at lower frequencies and has slightly lower gain.

The alloy-diffusion process makes it possible to mass produce transistors with a base layer of only a few microns for very short transist time and high cutoff frequencies. The rejection rate is also very low which makes the low price (less than $2) possible. END

INDUSTRIAL ELECTRONICS

Leave it to Edgar



The fall guy had to build a machine that couldn't possibly work, but it did

By GUY SLAUGHTER

BILL HADLEY, chief development engineer for the Tin Plate Division of Mullaney Steel Corp., slammed his palm against the super's desk with an air of finality.

"No, sir," he said irritably, "I won't touch the blame thing!"

"Look, Bill," Morgan the super pleaded, "be reasonable. I know it looks like a bum idea. But I can't help it. Goddard still runs this department. And he wants this thing worked out."

"Stall him off," Hadley growled. "He's retiring next month. Stall the project until he starts drawing his pension and then we'll throw it out."

"I can't," Morgan wailed. "I thought of that. But Goddard insists we build up this sheet-assorting machine of his right now. He wants his name on one more set of patents before he walks out. He's already scheduled a demonstration of the blame thing for 3 weeks from Friday. If we don't have it ready, we're in the soup."

Hadley shrugged his shoulders. "That's your problem. Look at it from my point of view. The idea isn't sound. Goddard must be slipping because his gadget won't work. Not in 3 weeks or 3 years. If I assign a couple of my boys to the project, they'll have to admit failure when the time is up. Then Goddard'll get teed off and fire them. I can't afford that. Engineers are too hard to find."

Morgan threw up his hands. "All right, wise guy. So what do we do?"

"I don't know," Hadley said. "I told you it was your problem."

"Wait a minute," Morgan said after a short silence, "I've got an idea—What we need is a fall guy."

Hadley said, "I don't get it."

"Listen. Your boys are all too busy to put on this job. Right? They're working night and day on something else and we can't take them off it. Right?"

"If you say so," Hadley said. "Only I don't see . . ."

"You will," Morgan interrupted. "So we give the project to this other character, and it's his baby."

"Yeah," Hadley said, "I see. When the time's up, he hasn't done a job so my boys inherit the assignment, and meanwhile Goddard retires. Then we forget the whole thing."

"Check. And our fall guy gets the ax instead of you or me or any of your boys."

"Brother," Hadley said admiringly, "what a dirty trick!"

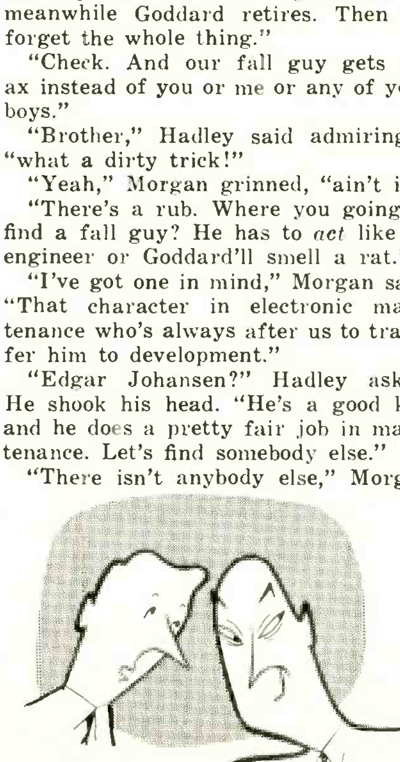
"Yeah," Morgan grinned, "ain't it?"

"There's a rub. Where you going to find a fall guy? He has to *act* like an engineer or Goddard'll smell a rat."

"I've got one in mind," Morgan said. "That character in electronic maintenance who's always after us to transfer him to development."

"Edgar Johansen?" Hadley asked. He shook his head. "He's a good kid, and he does a pretty fair job in maintenance. Let's find somebody else."

"There isn't anybody else," Morgan said. "Him we can palm off as an engineer. He can anyway get Goddard's gadget thrown together, even if it doesn't work. After that nature takes its course."



Bill Hadley bit his lip. He'd been around this place for a good many years and seen some nasty tricks pulled in his day. But up to now he'd never been actually involved in a deal like this. Still, Edgar was young and it wouldn't be too hard for him to find another job somewhere. Maybe the experience of trying to develop Goddard's gadget would even be good for him. And of course he'd never know the assignment was a fakeroo, an impossibility that the best engineer in the place couldn't handle. Still, it was a dirty trick.

"I don't like it, Morgan," he said. "The poor kid hasn't got a chance."

"You rather I give it to one of your boys?" Morgan asked sweetly. "You like that better?"

Bill Hadley made up his mind. He shrugged resignedly.

"Okay," he said. "Edgar it is."

"Check," Morgan said with a satisfied smile. "We leave it to Edgar."

"Yeah," Hadley said. He felt like a louse. "We leave it to Edgar. You going to tell him or do I have to?"

"Both of us. I'll give him the assignment and you brief him on the technical end. Okay?"

The fall guy arrives

Back in the lab, Bill Hadley heard the footsteps approaching his desk and looked up apprehensively. It was Edgar Johansen. The kid was grinning from ear to ear, and he carried the manila folder rolled into a tube as though it were a wand of royalty.

"Morning, Mr. Hadley, sir," Edgar said. He brushed a wad of tousled hair out of his eyes.

"Morning, Edgar," Hadley said. "I see you've got the prospectus on your new assignment." He jerked a thumb at the manila folder.

"Yes, sir, Mr. Hadley, sir," Edgar said. "I want to thank you for speaking to Mr. Morgan about me. He told me you recommended me for the project."

Hadley ground his teeth. What a sense of humor the super had. "Forget it, Edgar," he said. "How about if we go over the prospectus together?"

"Swell," Edgar said gratefully. "It's awfully nice of you to give me some of your time. I know you're real busy."

"Yeah," Hadley said gruffly. He cleared his throat, embarrassed. "Pull up a chair and we'll look over the prints."

Edgar slid a chair over to the desk self-consciously and sat down. Hadley unrolled the manila folder and spread it out in front of them. There were half a dozen sketches and a pencil-drawn schematic diagram. Hadley stared at the schematic representation of Goddard's idea unseeingly for a moment, feeling like a Judas. Then he forced his eyes into focus.

"Okay," he said. "Now the whole idea of the device is to sort tin plate for holes after it's been cut into sheets. We want to pick out those sheets with holes in them, dump them into a reject piler, and convey the prime plate into another piler. Savvy? Just like we do on the lines before the strip is cut into sheets."

"Yes, sir," Edgar said, his brow puckered. "But Mr. Hadley, sir, if we're going to assort sheets, how do we prevent the hole detector from detecting the spaces between sheets? I mean the spaces will look just like big holes to the detector."

"That's the idea of this gadget," Hadley said. "Let's trace out the circuits now. Visualize a conveyor belt carrying 3-foot-square sheets of tin plate toward a tray containing a bank of photocells wired in parallel, with a common load resistor. Just before the leading edge of the first sheet reaches the hole-detector tray, it slides across a single photo cell and cuts off the light from the source mounted above it. The signal developed by the single cell going dark feeds an amplifier, here, which triggers this relay tube into action. Through a time-delay circuit, the relay tube applies plate voltage to this amplifier fed by the paralleled bank of cells in the tray."

"I see," Edgar said excitedly. "The tray amplifier goes dead between sheets."

"Yeah," Hadley said. "Let's go on." He continued tracing out the circuit, wondering whether Edgar would find the flaws in the idea. "By the time the tray amplifier gets its plate voltage, the leading edge of the sheet has arrived at the detector tray, and slid across it to cut off the light arriving from the bank of light sources above it. Now the photocells in the tray are ready to detect any hole that might be in the sheet. When a hole flits past, one of the cells receives light for an instant and the signal developed across the load resistor feeds the amplifier which excites another time-delay circuit that, moments later, triggers this pair of thyratrons in a phase-shift circuit, energizing the solenoid in their plate circuit just as the bad sheet comes along. There is a deflection gate mechanically coupled to the solenoid core, so that the gate trips at the proper instant to deflect the sheet containing the detected hole into a rejected-sheet bin. Other sheets, those without holes in them, will slide over the top of the gate and be conveyed into another piler to be sold as prime plate."

"Yes, sir," Edgar said musingly, looking up from the schematic with a troubled frown. "But . . ."

"Now back to the detector tray," Hadley said hurriedly. "As the trailing edge of a sheet approaches the tray, it uncovers the single cell again, admitting light from the source above it. The current flow through the single cell now disables the relay tube, cutting off the plate voltage to the tray amplifier. During the time the tray is uncovered, one sheet having passed over it and the next one not having yet arrived, the tray amplifier is deprived of plate voltage and so the signal developed across the photocells' common load resistor is not passed on to the thyratrons to trip the deflection gate. When the next sheet arrives, the device is cocked again, so to speak, and the cycle repeats itself, tripping the gate when a hole is detected in a sheet or passing the sheet on if it's okay."

But it won't work

"Boy," Edgar said admiringly, shaking his head, "Mr. Goddard must have spent some time on that problem. It's clever even if it won't work."

"Won't work?" Bill Hadley echoed, startled. Maybe this kid was sharper than they'd thought. "Why not?"

"Well, gosh, Mr. Hadley, sir," Edgar said self-consciously, "first, every time the conveyor speed changes a little, the time-delay circuit will have to be altered in the disabling device. Second, whenever the disabling circuit cuts on or off, a nice big transient voltage goes whooping through the tray amplifier to trip the deflection gate. Third, whenever a hole passes that single cell, the disabling circuit will cycle and fail to reject a piece of defective plate. Fourth . . ."

"Hold it," Hadley interrupted. "I said I'd go through the circuit with you, not solve the problems encountered. That's *your* job." He pushed the folder toward Edgar, irritated. The kid's seeing the flaws made it awkward.

"Well, sure, Mr. Hadley, sir," Edgar said, picking up the folder. His face was turning red. "I didn't mean for you to work out the bugs. I was just . . ."

"Yeah, yeah," Bill Hadley said, "I know. You've got 3 weeks to get this thing built up and working. You better start."

"Right away, Mr. Hadley, sir," Edgar said, standing up and moving his chair back to where he had found it. His face had become an impassive mask. His feelings were obviously hurt.

"I'll get the mechanical shop to build up the conveyor and feeder," Hadley said kindly. He wished there were some other way to handle the situation, realized there wasn't. It was too bad the kid had to be the one. But there was no cure for it. "You'd better go to work on the electronic end."

"Yes, sir," Edgar said. He headed for the door to the lab.

"Oh, and, Edgar, Goddard is a funny guy," Hadley called after him. "You'd better not make too many changes in his gadget. He'll recognize them if you do and he'll raise hell around here."

"Yes, sir," Edgar said. "No changes." He left the room. Bill Hadley sighed deeply, hating himself.

The final test

"Today's the day," Morgan said, rubbing his chin apprehensively. "Edgar ready for the demonstration?"

"It's all set up," Bill Hadley said, "if that's what you mean. I've been staying away from there myself. I don't want to know too much about it."

"Check," the super said. "We'll catch hell, of course. But Goddard can't do any more than chew us out. After all, we assigned the project and it's been built up. When the demonstration fails, we'll appear distressed but not too apologetic. If the engineer couldn't handle the job, it's his fault, not ours."

"Trouble is," Hadley said, shaking his head, "I've got a conscience. The kid's been in to see me a dozen times and I've had to be too busy to see him. I feel like a heel."

"You'll get over it. Goddard won't hang him."

"Yeah, but the kid's sensitive. Goddard'll have plenty to say before he fires him, and it'll break the kid's heart."

"Better him than you or me," Morgan said. "Agree?"

"I don't know. I suppose so. But I keep thinking that, if I'd taken the project myself, maybe I could have found another way of doing the same thing Goddard's gadget is supposed to do but won't."

"That's no good," Morgan snapped. "You know Goddard. Change his designs a little and he raises hell."

"Yeah, yeah," Hadley said testily. "I'm just thinking out loud, is all. What time is it?"

The super looked at his watch, got up and walked around his desk. "Time to go. Goddard's meeting us in the assorting room. Remember now, distressed but not too apologetic."

It was noisy as always out on the floor, with the incessant grind and roar of heavy machinery providing a constant background. There was already a little knot of people gathered around the new assorting machine. Hadley recognized Goddard's broad back and balding head. The man was bent over the machine, peering into the steel cabinet attached to one of the rails forming the framework for the conveyors and feeding mechanism. Edgar stood beside him, shouting something into his ear.

Goddard straightened up as they approached, shook hands jovially first with Morgan, then with Hadley.

"Plane was early," Goddard yelled. "See you got her built up OK."

"Sure enough," Morgan shouted back. "We've been too busy to follow through on it the last couple weeks, Hadley and I. But we went through the prospectus before we assigned it to the engineer. Pretty ingenious idea."

"Thanks," Goddard shouted, beaming.

"Yeah," Bill Hadley heard himself yelling half-heartedly. "Clever approach." He stole a look at Edgar. The kid was still peering into the steel cabinet. Hadley went over to him. "How we doing?" he asked, embarrassed.

"Pretty good, Mr. Hadley, sir," Edgar said. "I haven't had much chance to run tests though."

"Understandable. Three weeks isn't all the time in the world." Hadley peered down into the cabinet. Tube filaments shone cherry red in the dark interior. The blue glow of a pair of thyratrons shed their eerie light. "Goddard been looking it over?"

"Yes, sir," Edgar said. "First thing he did was check around to see if I'd made any changes in his design."

"Did you?"

"It's all here," Edgar said, not meeting his eyes. "Just the way he drew it." He jerked a thumb at the cabinet, lowered its cover. "I guess I'm ready whenever Mr. Goddard is."

Hadley felt an empty sensation in the pit of his stomach. He considered leaving the scene for the solitude of his lab. He didn't much want to be around in the next few minutes when Edgar's failure became evident. But he couldn't very well leave either. He had a job of his own to protect, and he'd better stick around to testify that he'd had nothing to do with the machine other than to assign the project. Mentally, he rehearsed his speech. "It seemed such a clear-cut idea," he'd say, "that it never occurred to me there'd be any trouble with it. I've been awfully busy but if I'd known the lad was going to have trouble I'd have worked nights with him. I'd . . ." he derailed his train of thought abruptly, forced himself to walk back to Edgar's side.

"I'm sorry, Edgar," he said, yelling to be heard above the roar of machinery. "It was a dirty trick. I'll accept the full responsibility. I'll tell Goddard the whole deal, and . . ."

"Forget it, Mr. Hadley, sir," Edgar shouted. He grinned at him. "Don't worry about a thing."

"Are we ready?" Goddard was shouting. "Come on, let's get going here. I've got a speech to write." He chuckled, rubbed his balding head. "They're giving me a gold watch day after tomorrow. I'll have to say a few words."

After that it all seemed like a dream to Bill Hadley. He withdrew from the little crowd a few steps and watched the proceedings in a semi-daze. He saw the machine operator start the feeder and conveyor motors at Goddard's signal, saw the sheets of tin plate slide off the top of the pile one by one to drop onto the conveyor belts and start their short journey to the detector head. He saw half a dozen sheets pass the deflection gate and continue on their way to the prime piler. Then there was a buzz and a snap audible above the background noise as the deflection gate flopped up and a single sheet slid under it to be deposited in the reject piler. Edgar picked the sheet out of the piler and held it up for inspection, grinning broadly. There was a tiny hole visible near one end of the sheet. The demonstration continued, but Bill Hadley left. He wandered back to his lab and sat down at his desk, his mind whirling . . .

How did you do it?

"Okay, Edgar," Hadley said, trying to keep the puzzlement out of his voice, "you made it. The gadget works, Goddard is happy, Morgan and I are happy, and you've got a permanent job with me. You've also got my apologies for . . . but never mind that. What I want to know is, what's the gimmick?"

"The gimmick, Mr. Hadley, sir," Edgar echoed innocently. "I don't understand."

"You understand all right. You and I both know Goddard's idea wasn't sound. Now how did you make it work?"

"Oh," Edgar said. His voice was very small. "That." He dropped his eyes to the floor. "I . . . I cheated."

"Sure you cheated. But how?"

"It's a little idea of my own," Edgar said. "Nothing to it, really. I wired the bank of photocells in the detector tray in two halves, and used two separate load resistors, one for each half. Then each load resistor feeds one grid of a 6SN7. There's a center-tapped transformer feeding the plates. Push-pull, you might say."

Bill Hadley began to see the light. "Yeah, yeah," he said. "Go on."

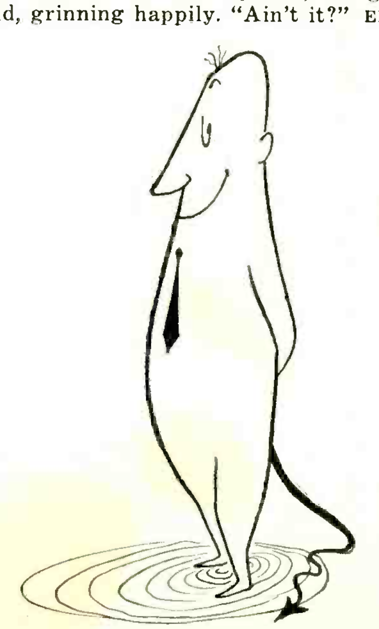
"The transformer secondary feeds a conventional voltage amplifier that feeds the deflection-gate thyratrons. That's all. When there's no sheet cutting off the light to the tray, each half of the photocell bank passes the same current, there's the same voltage drop across each load resistor and hence the same voltage at each grid of the 6SN7. Therefore, each triode pulls the same plate current through the transformer winding and the net output across the secondary is zero. When a sheet comes along and covers the cells, the two triodes still pull identical plate currents, output still zero. But when a hole comes along, only one cell passes current, one of the triodes gets more grid voltage than the other, and the current flow through the transformer is unbalanced. That produces a signal to be fed to the amplifier. A time-delay circuit fires the thyratrons, and the gate trips in time to catch the sheet with the hole in it. That's all."

"That's all," Bill Hadley breathed. "Yeah. Edgar, you're OK. I didn't think . . ." he broke off as an idea hit him. "Hey, wait a minute. How come Goddard didn't see you weren't using his circuit?"

"He couldn't tell," Edgar said, grinning. "I had his exact circuit wired up in that cabinet for him to look at. But it was a dummy. It isn't tied to anything. And my circuit is in another cabinet on the back of the machine where it doesn't show."

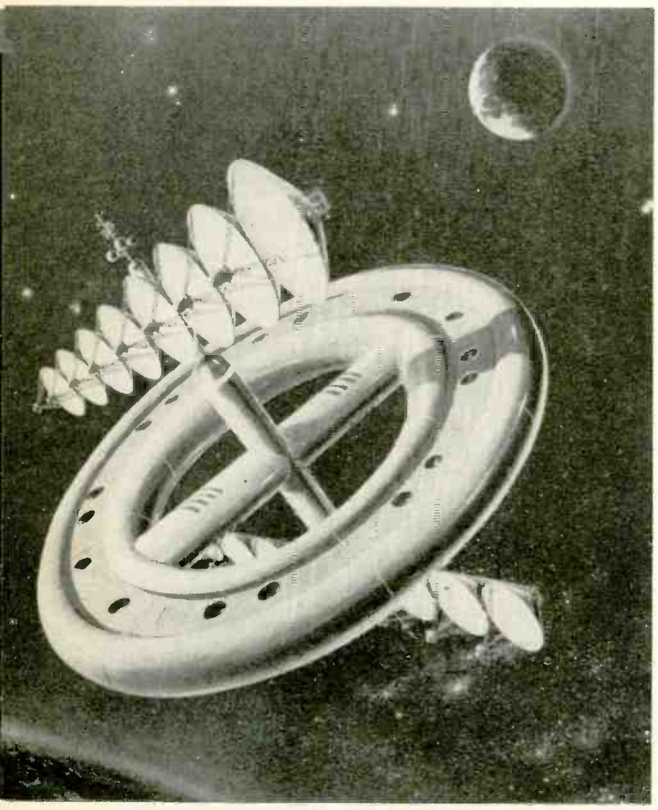
"Edgar," Bill Hadley said admiringly, "what a dirty trick!"

"Yes, sir, Mr. Hadley, sir," Edgar said, grinning happily. "Ain't it?" END

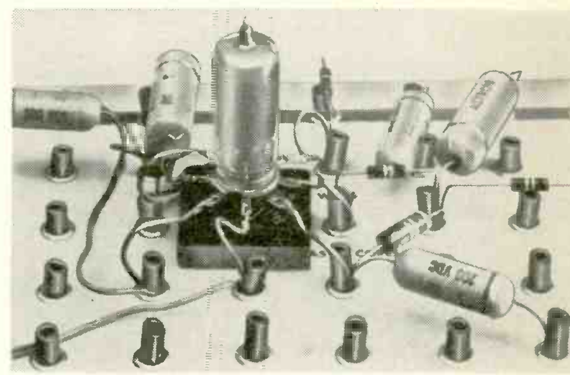


what's new?

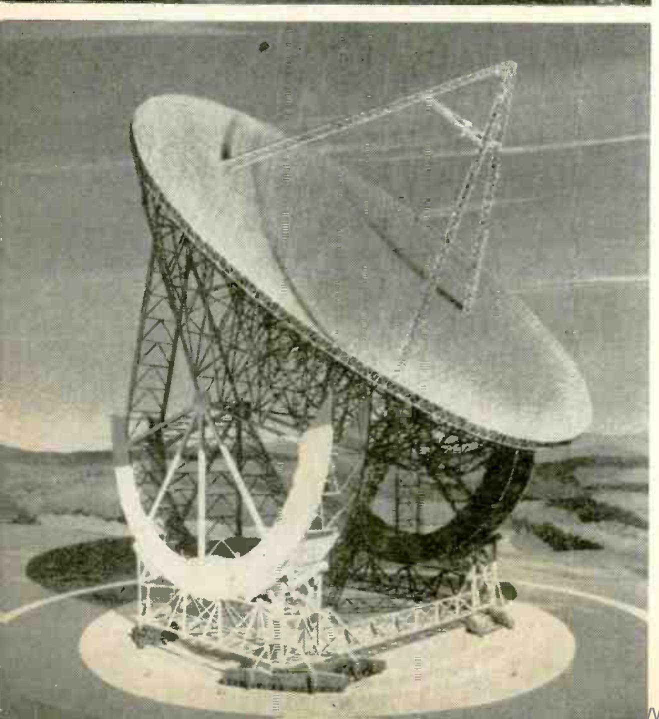
AUTOMOBILE PHONO CHANGER takes standard 45-rpm records, plays stack of 14 discs with ceramic pickup through the car's regular radio. The 12-volt motor is governor-controlled. Engineered and manufactured by RCA for 1960 Plymouths and DeSotos.



COMMUNICATIONS SATELLITES like this one may orbit the earth as relay stations linking all major cities for TV and microwave networks. Slow rotation of the doughnut would maintain stability and create artificial gravity for personnel. RCA conception is similar to that suggested by Hugo Gernsback in Radio-Electronics, March, 1958 (pages 33 and 125).



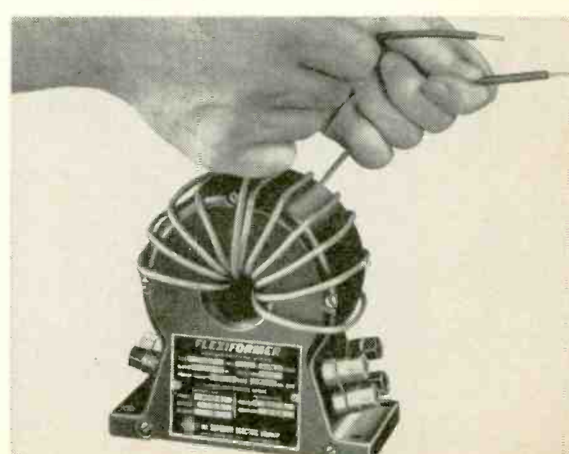
SOLDERLESS BREADBOARD has over 100 gold-plated eyelets with elastic rubber cores permitting instant connection or removal of two to six wires or component leads. Circuit Board is made by Plastic Associates, Laguna Beach, Calif.



600-FOOT RADIO TELESCOPE to be completed in 1962 will probe space up to 38,000,000,000 light years away for Naval Research Labs at Sugar Grove, W. Va. The more than 7-acre surface (600 feet in diameter) of this world's largest movable dish will dwarf the 250-footer at Jodrell Bank, England, presently the biggest known.

The huge reflector will also aid communications with space vehicles and may be used in detecting ballistic missile launchings across the ocean. It is being designed by Grad, Urban & Steelye, New York architects-engineers.

DO-IT-YOURSELF TRANSFORMER for laboratory bench has primary, core and binding posts arranged for rapid winding of secondary. This readily-adjustable source of ac voltage, made by the Superior Electric Co., Bristol, Conn., supplies up to 150 volt-amperes and can also be used as a current transformer.



Citi-fone, Vocaline ED-27 and Globe CB-100

2 WAY RADIOS FOR CITIZENS BAND

Vocaline Commaire model ED-27.

Citi-fone, transceiver for Citizens band.

By ROBERT F. SCOTT
TECHNICAL EDITOR

IN the September issue, we described RCA's Radio-Phone and International Crystal's Citizen Bander class-D transceivers. Now, we will cover the Multi-Elmac Citi-fone and the salient features of several other makes and models. The Citi-fone is a nine-tube transmitter-receiver combination operating on any five preselected channels. It is available in two models. The CD-5/6 operates from 117 volts ac and 6 volts dc. The CD-5/12 operates from ac and a 12-volt dc source. Two line cords are supplied. One plugs into an automobile's cigarette-lighter socket and the other into a standard 117-volt ac wall receptacle. There are three controls on the front panel—the on-off switch and volume control on the lower left, the channel selector in the center and the squelch control on the right.

The circuit

The Citi-fone's diagram is in Fig. 1. The receiver circuit is a single-conversion superhet with a broad-band 6BJ6 rf amplifier, 6BE6 mixer, half of a 12AU7 as a Pierce crystal oscillator, a pair of 6BJ6's in a two-stage 455-kc if amplifier, 6AL5 detector, avc and noise limiter, 6AN8 af amplifier and squelch control tube, and a 6AQ5 af power amplifier.

The transmitter is an oscillator-power amplifier combination using half of a 12AU7 as the crystal oscillator and a 6AQ5 rf power amplifier. The modulator consists of the pentode half of the 6AN8 and the 6AQ5 audio power amplifier. High-level Heising modulation is used, with the output transformer primary serving as the modulation choke.

The power supply uses a full-wave bridge type rectifier. The power transformer has dual primaries, one for 117 volts ac and the other a tapped low-voltage winding driven by a vibrator when operating from a dc source.

V5-b is a self-adjusting series noise limiter whose threshold is determined by the strength of the incoming signal. Resistors R1 and R2 form the detector load and C1 is the rf bypass. The detected audio signal and a negative voltage proportional to carrier strength are developed across the detector load. V5-b's plate is connected to a point on the detector load while its cathode is tied to the most negative point through R3 and R4.

The cathode is held at a level proportional to average carrier strength by the time constant of R3–C2, which is long compared to changes in the modulation envelope. Thus, with its cathode more negative than its plate, V5-b conducts and passes the signal to the audio amplifier. Noise peaks that exceed the maximum carrier modulation level instantaneously drive the plate negative with respect to the cathode and cut off the tube for the duration of the pulse.

The squelch circuit silences the receiver and eliminates annoying atmospheric and other noises when no signal is being received. V6-a's cathode is held at a comparatively constant positive voltage by returning cathode resistor R6 to a tap on a B-plus voltage divider consisting of R8, R9 and R10. Conduction in V6-a is controlled by the voltage difference between grid and cathode. Grid resistor R5 is returned to the plate of squelch control tube V6-b and the grid-to-cathode voltage is determined by the voltage drop across R7. Thus, conduction in the af amplifier is controlled by V6-b's plate voltage. When V6-b is conducting, V6-a's grid is sufficiently negative with respect to the cathode to cut off the tube, so there is no output. When cut off, V6-b restores normal operating bias, and the amplifier conducts.

V6-b gets its plate voltage through load resistor R7 connected to V6-a's cathode biasing network. The grid of V6-a is connected to the avc line, which is negative when a signal comes in. One end of the SQUELCH control (R14) goes to B-plus at the junction of R8 and R9; the other to a minus voltage at the junction of R11 and R12. Its setting determines bias of V6-b's cathode.

The SQUELCH control is adjusted just to the point at which

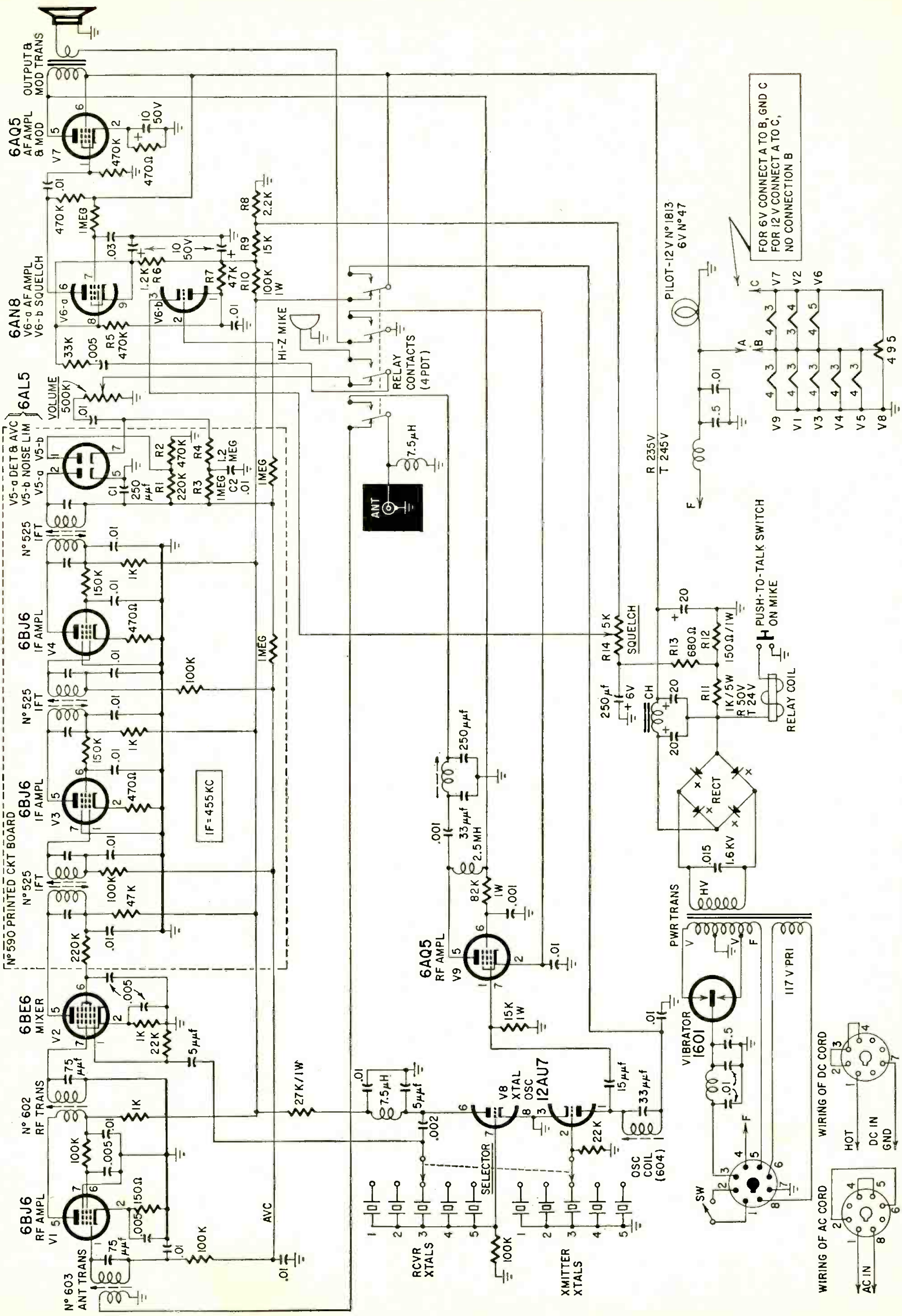


Fig. 1—Circuit of the Multi-Elmac Citi-fone.

V6-b conducts. Thus the amplifier is cut off when no signal is coming in. When a signal is received, the negative avc voltage cuts off V6-b so there is no current flow through R7. V6-a is then biased solely by the voltage drop across R6. When the station leaves the air, the avc voltage disappears. V6-b conducts and the voltage drop across R7 makes V6-a's grid more negative than the junction of R6 and R7. V6-a cuts off and again silences the receiver.

Vocaline ED-27

Called the Commaire, this transceiver is a 10-tube unit with several interesting design features that are uncommon in this type of equipment. Its receiver is a crystal-controlled double-conversion superhet. It is unusual in that it is not necessary to change receiver crystals when switching from one channel to another. In other words, it performs like a single-conversion superhet preceded by a crystal-controlled broad-band converter or a double superhet with a variable second if. The circuit of the rf amplifier and first and second conversion stages is shown in Fig. 2.

V1 is a broad-band rf amplifier with tuned grid and plate circuits. V2 is a crystal-controlled triode oscillator and pentode mixer. The 31-mc oscillator frequency is injected into the mixer grid circuit through inductive coupling between the oscillator and rf amplifier plate coils.

The oscillator signal beats with the incoming carrier to produce a first if ranging from 4.035 mc on channel 1 (26.965 mc) to 3.775 mc on channel 22 (27.225 mc). This if signal is developed across the first if transformer and fed to the signal grid of the 6BE6 second mixer. The second oscillator is inductive-tuned by L4. The FINE TUNING control—on the chassis—covers a range of from 3.580 to 3.320 mc to provide a 455-kc second if at the desired channel frequency. Thus, for channel 1, the first if is 4.035 mc (31.000–26.965 mc) and the second oscillator is tuned to the difference between the first and second if's, or 3.580 mc. Similarly, channel 11 (27.085 mc) develops a 3.915-mc first if and the second oscillator must be tuned to 3.460 mc. The 6BE6 output is amplified by a 455-kc if amplifier.

Pentode rf power amplifiers are used in all the transceivers that we've seen. The screen grid reduces the grid–plate capacitance to such a small value that pentodes are generally considered sufficiently stable in rf amplifiers to make neutralization unnecessary, and few transceiver manufacturers use it. However, the power sensitivity of the modern pentode is so great that the slightest amount of feedback may cause oscillation. We've seen cases where one brand of tube had to be neutralized in a given circuit while others didn't. Thus an unneutralized final amplifier might possibly lead to trouble—particularly in cases where the amplifier tube has to be replaced. Stability under all possible operating conditions is particularly important in Citizens Radio Service where the average operator is not trained to detect and correct spurious oscillations. Vocaline guards against this in the Commaire by connecting a neutralizing capacitor between the cold end of the oscillator plate coil and the final plate as in Fig. 3.

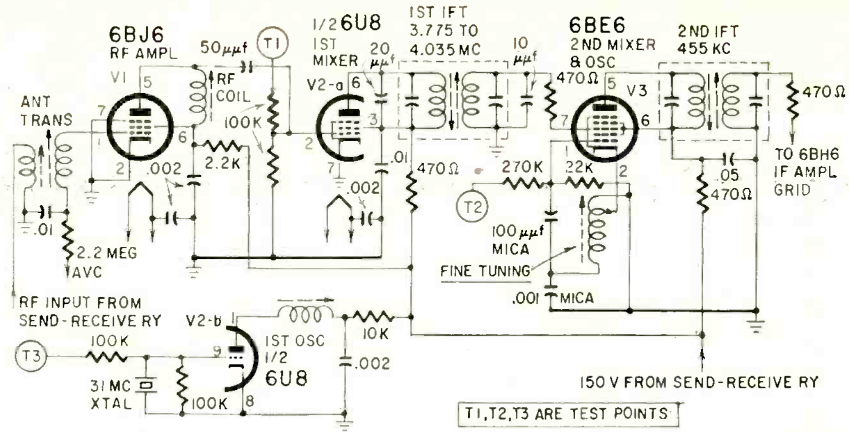


Fig 2—Rf amplifier, first and second conversion stages in Vocaline ED-27.

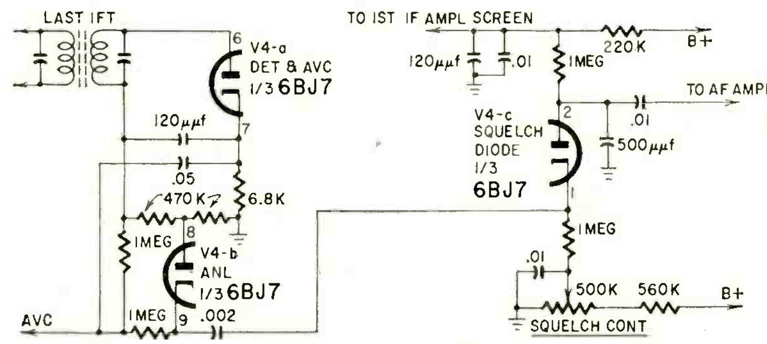


Fig. 3—Neutralization in the Vocaline's power amplifier.

Pi-type plate tank circuits are widely used in transceiver rf output stages to facilitate matching and loading the various types of antennas that may be used. Shunt-fed plate circuits are more common in most applications but Vocaline has selected a series-fed arrangement as in Fig. 3. In this case, plate supply voltage flows through the coil, and dc appears across the capacitors. The circuit is tuned to resonance with the capacitor nearest the plate and the antenna loading is adjusted with the capacitor on the output side.

The incandescent lamp in series with the antenna indicates relative antenna current. The lamp consumes some power that would normally appear in the antenna so it should be shunted by the switch when not being used.

Globe squelch circuit

The Globe CB-100 is a nine-tube three-channel transceiver operating from 117 volts ac or 12 volts dc. Its squelch circuit (Fig. 4) uses a diode instead of the triode or pentode as in the circuits described previously. Its detector circuit is conventional and its automatic noise limiter is similar to the one in the Citi-fone in Fig. 1.

The cathode of squelch diode V4-c is biased positive by a variable voltage picked up from the arm of the SQUELCH control and its plate receives a positive voltage from the screen grid of the first if amplifier.

With the SQUELCH control set correctly and no signal is coming in, the if amplifier operates at full gain and its screen voltage is low. This makes V4-c's plate less positive than the cathode so the tube cuts off and appears as an open circuit in the audio circuit between the output of the noise limiter and the input to the af amplifier. An incoming signal develops avc voltage that reduces the if amplifier gain and causes its screen voltage to rise. V4-c's plate is now more positive than the cathode so the tube conducts and passes the audio signal.

Other features of the Vocaline and Globe transceivers will be covered in a later issue. END

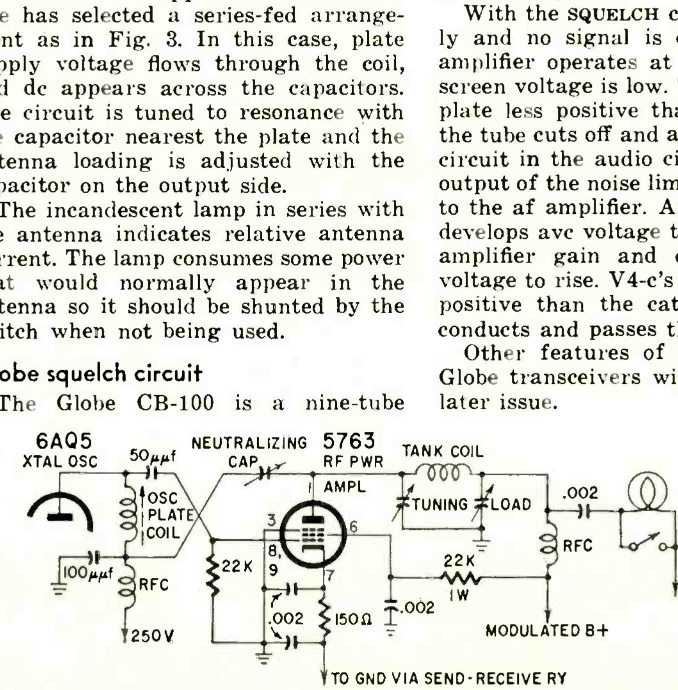


Fig. 4 — Globe CB-100's squelch circuit.

HINTS on installing MOBILE RADIO EQUIPMENT

A good installation is a useful installation, and a useful installation takes proper planning and work

By ROBERT J. HENDRICK

THE same basic procedures and precautions must be observed in any mobile installation, whether a 10-ton line truck or a standard automobile. Many installations fall flat on their faces and are a source of customer complaint right from the start, mostly because of minor mistakes in the original installation.

Since most vehicle operators have little or no technical knowledge of the radio equipment, take every precaution to prevent any degradation in its performance.

The old adage "an ounce of prevention is worth a pound of cure" is well applied to two-way radio installations. Start the customer off happy and he'll be easier to keep happy. Now, let's get down to business and see what has to be done.

Commercial two-way radio equipment is housed in rugged metal cabinets that can be secured to the vehicle with bolts or self-tapping metal screws. Later models of commercial mobile radio equipment are housed in a single rather compact cabinet, but some of the older units still in service may be in two or, in rare cases, three separate packages. These units are more bulky and present greater mounting difficulties than recent models. Happily, they are rapidly becoming obsolete and are disappearing from commercial use because of the new FCC regulations requiring narrow–band operation and better frequency stability.

In standard automobile installations where rear-mount type units are used, fasten the set to the raised portion of the trunk floor. Cables should face the rear since some models have metering receptacles and jacks that are on this end of the unit. Mounting in this position also leaves the customer more trunk space.

For permanent installations, bolt the cabinet down rather than use self-tapping screws. Sometimes, short metal brackets may be needed to support the two rear corners of the housing—they may overhang the raised portion of the trunk floor by 3 or 4 inches. These brackets can be formed out of strap iron or aluminum (Fig. 1). If self-tapping metal screws are used and the unit is placed on the lower portion of the trunk floor above the gas tank, which in most late model cars is mounted very, very close to the floor, be careful not to puncture the gas tank.

Truck installations of necessity have greater variations in mounting because there are so many sizes and models of vehicles. Generally two types of mountings are used. Where space permits, the unit can be placed under or behind the seat in the cab. Otherwise it must be mounted externally on the vehicle, in the most out-of-the-way location that is reasonably accessible for servicing. Whenever the unit is mounted externally, some type of weatherproof housing must be provided. Most manufacturers can supply weatherproof cabinets for their equipment, or the housing can be fabricated locally to meet the user's needs. Some operators like a housing made of marine plywood that provides room for tool storage as well as the radio equipment. Others prefer a weatherproof housing as compact as possible and fabricate it out of heavy-gauge sheet metal (Fig. 2).

When installing front-mount units, each installation has to be taken on a case-by-case basis since there is not much choice of location. Most late-model automobiles have very little space under the dash or against the firewall. Trucks are somewhat more adaptable to front-mount units since space is not so scarce. About all that can be done if the customer insists on front-mount units is to secure the cabinets with straps or brackets in the most out-of-the-way yet accessible location possible.

Whether installing the unit on automobile or truck, rear-mount, front-mount or externally, always place the unit in the most out-of-the-way location and at the same time make it as accessible for servicing as possible.

Cables and wiring

Cable placement, routing and connections are important phases of any mobile installation. The cable run should al-

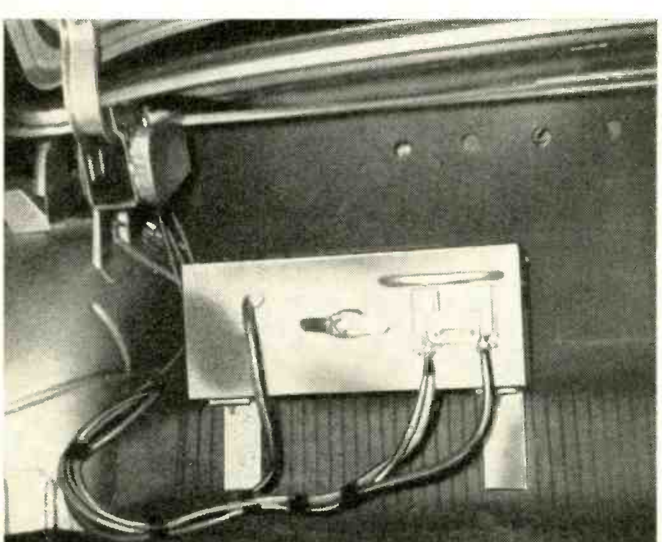


Fig. 1—Two simple brackets support radio overhang in trunk installation. Note that all cables point to the rear.

Fig. 2—Weatherproof housing is made of sheet metal. Lock keeps the public out.

ways begin at the radio and run toward the front of the vehicle. The initial placement of cables is temporary and approximate, since final placement under mats and seats and also length adjustment are determined after the power cable has been run through the firewall and connected to the power source and the control cable's length has been adjusted. The power cable and relay control wiring should be routed through the firewall by using existing holes and heavy rubber grommets. Try the holes where the automobile cabling is routed if space permits; otherwise a spare knockout can be used or a new hole drilled through the firewall. Always use a hole large enough to permit inserting a heavy rubber grommet or adequate taping of cables to prevent nicking and subsequent shorting to the metal of the firewall.

Since connecting up the power cable, fuse block and relay is much the same for all types of vehicles, we shall consider this phase of the installation as a whole. Properly connecting the power cable to the power source can make the difference between very satisfactory or poor performance. By observing a few basic rules the power-cable installation will cause no difficulty. First securely fasten the hot lead of the power cable to the hot side of the vehicle battery to get a very-low-resistance connection—preferably at the hot side of the starter solenoid rather than direct to the battery terminal. This avoids corrosion which often develops at the battery terminal, causing a high-resistance termination and excessive voltage drop. If a connection at the battery terminal is necessary, coat the terminals with an anti-corrosion compound.

The power supply's ground cable should be fastened securely to the vehicle frame, engine block or, if convenient, directly to the battery ground terminal. As with the hot side of the power cable, a good low-resistance connection is important. Clean and scrape the point where the connection will be made until a bright, smooth surface is obtained. After securing this connection, made to frame or engine block, spray with a clear plastic coating of some type to minimize oxidation and the possibility of a high-resistance joint in the future.

The remainder of the power-supply installation is a matter of placement, routing and securing. The fuse block and relay should be mounted with self-tapping metal screws to the firewall, if possible. The next best spot is on the inside skirt of one of the front fenders, in each instance getting the fuse block and relay as high as possible to minimize splashings from the road and engine oil and grime from collecting on them. Most relays should be mounted with their terminals pointing downward (Fig. 3) to keep water from collecting in the cover and causing defective operation or failure.

Connections to the relay and fuse block terminals should always be secure electrically and mechanically. If I seem a little overzealous in stressing the importance of the power-cable installation, it is from bitter experience. Many and varied symptoms and deceptive troubles have been traced to faulty power-supply installations. If we keep our power supply to the radio equipment working at top efficiency, we have made a sizable contribution toward an efficient trouble-free installation.

Running cables in automobile installations from firewall to the radio unit in the trunk is much the same for all cars, although there may be some slight variations. Leave enough of the control cable to reach the control head under the dash conveniently and adjust the length of the power cable so no excessive amount of loose cable remains on the engine side of the firewall. Then route the power and control cables under the front floor mat, both cables running side by side. Install a cable clamp at the firewall to prevent slipping. The cable run continues under the floor mats to the rear.

The routing of the cables at this point is a matter of choice. They may be run down the middle or on the right or left side, depending to a great extent upon the make and model of automobile and choice of the installer. Always route the cables under the floor mats and seats in a manner that will avoid binding or unnecessary strain, and by all means try to place them so the rear seat does not rest directly upon them, since a constant rubbing over a long period of time at this point will bare the cables and cause trouble. This type of trouble often develops as an intermittent condition and may be difficult to locate from the operator's description of it.

At this point, all excess cable is pulled to the trunk, adjusted for proper length to plug into the radio unit, coiled and neatly taped to prevent tangling and an unsightly appearance. Fig. 4 shows a typical wiring layout for an automobile installation.

Truck installations where the radio unit is installed under or behind the seat in the cab are much the same as for automobiles. The cables are placed under the floor mat, coiled neatly under the seat and taped so that no undue amount of binding or strain is placed upon them.

For truck installations in which the radio unit is mounted externally, a great deal more planning is necessary. The cables must be routed out of the weatherproof housing of the radio unit and into the vehicle cab. Usually a hole is cut in the rear of the cab or the cables may come into the cab through a hole in the floorboard. However, the hole in the cab is preferred, since this keeps the cables away from the considerable amount of mud and water they would receive if run under the floorboard. Always protect the portion of the cables between the weatherproof housing and the cab by running them through a piece of 1¼-inch flexible tubing or water hose. Secure and waterproof by doping the ends of this tubing where it enters the weatherproof housing and the vehicle cab.

Installing accessories

Mounting the control head, microphone hook or support plate, and speaker is similar for all types of vehicles. They

(*Continued on page* 68)

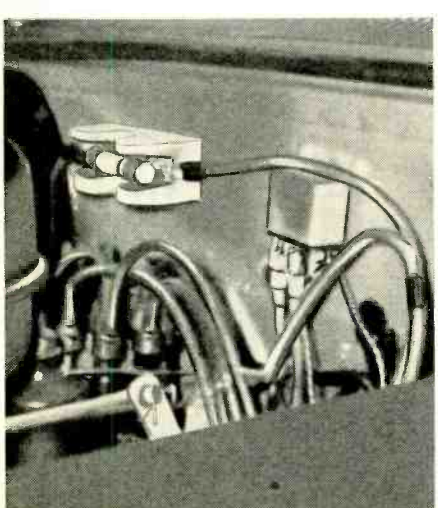


Fig. 3—Fuse block is mounted high up on the engine side of the firewall. Relay terminals point downwards.

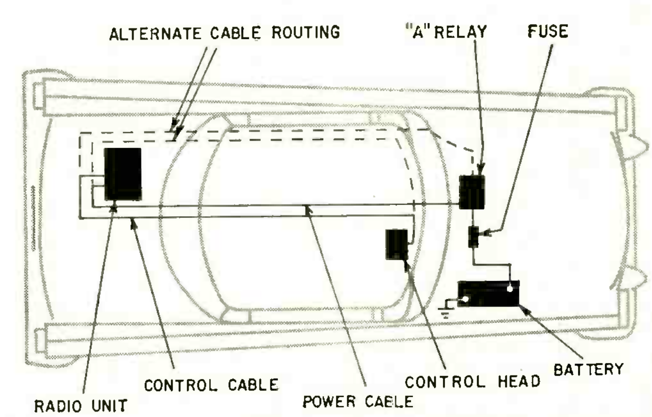


Fig. 4—Typical wiring layout for a rear-mount automobile installation.

New Transistor Intercom Kit

TALK WITH ANY OR ALL FIVE STATIONS WITH YOUR OWN INTERCOM SYSTEM

- Battery Power Permits Placement Anywhere
- Versatile Unit has Many Important Uses
- Complete Privacy of Conversations Assured

TRANSISTOR INTERCOM KIT (XI-1 and XIR-1)

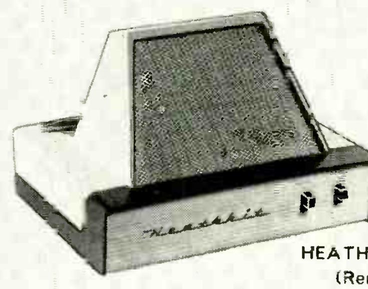
A flexible, versatile transistor intercom, has been developed by Heath engineers to enable you to set up your own communications system at an unbelievably low price.

Consisting of a master unit (XI-1) and up to five remote stations (XIR-1), the system is designed for any remote unit to call the master, for any remote station to call any other remote station, or for the master unit to call any single remote unit or any combination of remote units. Complete privacy is assured, since a call to a remote station cannot be interrupted or listened to while the remote unit is in operation unless switched in by the master unit. Used with clock-radio, opposite page, it can serve as a music or "selective alarm" system.

Transistor circuitry means long life, instant operation and minimum battery drain. Eight ordinary, inexpensive "C" flashlight batteries will run a unit for up to 300 hours of normal "on" time. Circuitry is especially designed for crisp, clear intelligible communication and the instant operation feature allows tuning of the units off between calls, extending battery life. Use of battery power does away with power cords, allowing each unit to be placed where most convenient. Only two wires are required between the master unit and each remote station. Beautifully styled, the Heathkit Intercom presents a new approach in design. Both master and remote stations have two-piece cases in ivory and turquoise for a rich, quality appearance. Batteries not included. Shpg. Wt. 6 lbs.

HEATHKIT XI-1 (Master)

$27.95



HEATHKIT XIR-1 (Remote)

$6.95

Shpg. Wt. 4 lbs.

AC POWER SUPPLY (XP-1)

A permanent power supply for 24-hour operation of the XI-1 Intercom on household current. Converts 110 V. AC to well filtered 12-volt DC output, eliminating the need for batteries. Power supply is small, compact and fits in space normally occupied by batteries.

HEATHKIT XP-1 .... $9.95

NEW IMPROVED DESIGN

New

HEATHKIT SP-2A (stereo) Shpg. Wt. 15 lbs.

$56.95

$5.70 down. $6.00 mo.

STEREO-MONO PREAMP KIT (SP-2A, SP-1A)

Get the SP-2A Stereo Preamp kit now, or the SP-1A monophonic version which you can easily convert to stereo whenever you choose by assembling the second channel (C-SP-1A) and plugging it into your SP-1A.

The SP-2A permits stereo, two channel mixing, or either channel monophonic use, and includes a remote balance control.

Six inputs (12 in the stereo version) accommodate tape, magnetic phono and microphone, plus three separate high level inputs. Level controls provided on "mag. phono" and high level inputs. Switch selects NARTB equalization for tape head input, and RIAA, LP or 78 RPM compensation for mag. phono input

HEATHKIT SP-1A (monophonic) Shpg. Wt. 13 lbs. $37.95

HEATHKIT C-SP-1A (not shown) (converts SP-1A to SP-2A) Shpg. Wt. 4 lbs. ... $21.95

THE WORLD'S BIGGEST BARGAIN IN A HI-FI AMPLIFIER

New

55 WATT HI-FI AMPLIFIER KIT (W-7A)

Utilizing advanced design in components and tubes to achieve unprecedented performance with fewer parts, Heathkit has produced the world's first and only "dollar-a-watt" genuine high fidelity amplifier. Meeting full 55-watt hi-fi rating and 50-watt professional standards, the new improved W-7A provides a comfortable margin of distortion-free power for any high fidelity application.

The sleek, modern styling of this unit allows unobtrusive installation anywhere in the home. The clean, open layout of chassis and precut, cabled wiring harness makes the W-7A extremely easy to assemble. Shpg. Wt. 28 lbs.

HEATHKIT W-7A

$54.95

SPECIFICATIONS—Power output: Hi-Fi rating, 55 watts; Professional rating, 50 watts. **Power response:** ±1 db from 20 cps to 20 kc at 55 watts output. **Total harmonic distortion:** Less than 2% from 30 cps to 15 kc at 55 watts output. **Intermodulation distortion:** Less than 1% at 62 watts output using 60 cps and 6 kc signal mixed 4:1. **Hum and noise:** 80 db below 55 watts, unweighted. **Damping factor:** Switch on front panel for selecting either maximum (20:1) or unity (1:1). **Output impedances:** 4, 8 and 16 ohms and 70-volt line. **Power requirements:** 117 volts, 50/60 cycles, 90-160 watts. **Dimensions:** 8½" D. x 6⅛" H. x 15" W.

New HEATHKIT

Stereo Amplifiers

YOUR BEST DOLLAR VALUE IN STEREO . . .

14/14 WATT STEREO AMPLIFIER KIT (SA-2)

Complete control is at your fingertips with this versatile Stereo Amplifier-Preamplifier. Providing 14 watts per stereo channel, or 28 watts total monophonic, the SA-2 offers every modern feature in a master stereo control center at a price to please the budget minded. The unit offers selection of dual channel stereo operation, monophonic operation using both channels simultaneously, or using either channel for monophonic program material independent of the other channel. A 4-position input selector switch provides choice of mag. phono, crystal phono, tuner, and high level auxiliary input for tape recorder, TV, etc. Other features include RIAA equalization on mag. phono, channel reversing function, clutched volume control, ganged dual tone controls, speaker phase reversal switch and two AC outlets. Handsomely styled black and gold vinyl-clad steel cabinet. Shpg. Wt. 23 lbs.

SPECIFICATIONS—Power output: 14 watts per channel, "hi-fi"; 12 watts per channel, "professional"; 16 watts per channel, "utility". **Power response:** ±1 db from 20 cps to 20 kc at 14 watts output. **Total harmonic distortion:** less than 2%, 30 cps to 15 kc at 14 watts output. **Intermodulation distortion:** less than 1% at 16 watts output using 60 cps and 6 kc signal mixed 4:1. **Hum and noise:** mag. phono input, 47 db below 14 watts; tuner and crystal phono, 63 db below 14 watts. **Controls:** dual clutched volume; ganged bass, ganged treble; 4-position selector; speaker phasing switch. **AC receptacle:** 1 switched, 1 normal. **Inputs:** 4 stereo or 8 monophonic. **Outputs:** 4, 8 and 16 ohms. **Dimensions:** 4½" H. x 15" W. x 8" D. **Power requirements:** 117 volts, 50/60 cycle, AC, 150 watts (fused).

HEATHKIT SA-2

$52.95

New

HEATHKIT SA-3

$29.95

ECONOMY STEREO AMPLIFIER KIT (SA-3)

This amazing performer delivers more than enough power for pure, undistorted room-filling stereophonic sound at the lowest possible cost. Featuring 3 watts per stereo channel and 6 watts as a monophonic amplifier, the SA-3 has been proven by exhaustive tests to be more than adequate in volume for every listening taste.

You will find its ease of assembly another plus feature. Heathkit construction manuals, world famous for their clarity and thoroughness, lead you a simple step at a time to successful completion of the kit. Larger than life-size diagrams show you exactly what each part looks like, where it goes, and how it is installed.

The amplifier is tastefully styled in black with gold trimmed control knobs and gold screened front and rear panel. A tremendous buy at this low Heathkit price! Shpg. Wt. 13 lbs.

SPECIFICATIONS—Power output: 3 watts per channel. **Power response:** ±1 db from 50 cps, 20 kc at 3 watts out. **Total harmonic distortion:** less than 3%; 60 cps, 20 kc. **Intermodulation distortion:** less than 2% @ 3 watts output using 60 cycle & 6 kc signal mixed 4:1. **Hum and noise:** 65 db below full output. **Controls:** dual clutched volume; ganged treble, ganged bass; 7-position selector; speaker phasing switch; on-off switch. **Inputs (each channel):** tuner, crystal or ceramic phono. **Outputs (each channel):** 4, 8, 16 ohms. **Finish:** black with gold trim. **Dimensions:** 12½" W. x 6¾" D. x 3¼" H.

New

HEATHKIT XR-2P

(6 lbs.)

$29.95

HEATHKIT XR-2L

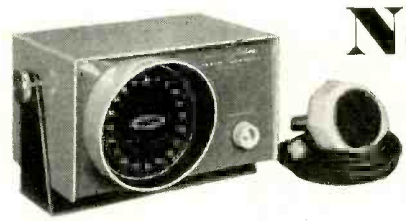
(7 lbs.)

$34.95

6-TRANSISTOR PORTABLE RADIOS (XR-2P and XR-2L)

New, improved styling, new vernier tuning, up to 1,000 hours on flashlight batteries . . . are just a few of the plus features you get with these new transistor portables. Carry them with you wherever you go; to the beach, on trips, boating, etc. These new, improved models bring you the outstanding performance of the preceding models plus brand new styling and the additional convenience of vernier tuning for smooth, effortless station selection. The XR-2P features a mocha and beige high-impact plastic case. The XR-2L has a sun-tan color leather case with an identical beige plastic front. Six Texas Instrument transistors are used for high sensitivity and selectivity. A large 4" x 6" PM speaker with heavy magnet provides excellent tone quality. The roomy chassis makes it unnecessary to crowd components, adding greatly to ease of construction. The six standard size "D" flashlight batteries used for power provide extremely long battery life and can be purchased anywhere. Fun to build, and fun to use . . . order one today!

New



HEATHKIT DS-1

$69.95

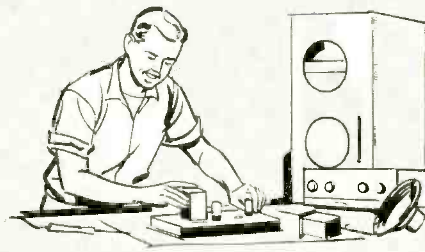
$7.00 DN., $7.00 MO.

- Indicates Depth and Type of Bottom From 0 to 100 Feet
- Detects Submerged Objects (fish, logs, etc.) and Their Depth
- Completely Transistorized . . . Operates From Flashlight Batteries

TRANSISTOR DEPTH SOUNDER (DS-1)

Weekend boatsman or professional . . . fisherman or skindiver . . . here's the depth sounder for you. Depth is indicated by a flashing neon lamp rotating behind a transparent circle in the molded black plastic dial face. A large hood around the dial enables the viewer to easily read the indicator in bright light or sunshine. The transducer uses a barium titanate element mounted in a faired, molded epoxy resin housing with solid brass through-hull fitting and mounting hardware. While designed for permanent mounting on the bottom of the boat, temporary outboard mounting of the transducer is also possible. The completely transistorized circuit operates from 6 flashlight cells and one long-life battery. Comes complete with splash-proof cabinet, hardware and gimbal-type mounting bracket. Shpg. Wt. 10 lbs.

New HEATHKIT Amplifiers & Tuners



A NEW AMPLIFIER AND PREAMP UNIT PRICED WELL WITHIN ANY BUDGET

14-WATT HI-FI AMPLIFIER KIT (EA-3)

This thrilling successor to the famous Heathkit EA-2 is one of the finest investments anyone can make in top quality high fidelity equipment. It delivers a full 14 watts of hi-fi rated power and easily meets professional standards as a 12-watt amplifier.

Rich, full range sound reproduction and low noise and distortion are achieved through careful design using the latest developments in the audio science. Miniature tubes are used throughout, including EL-84 output tubes in a push-pull output circuit with a special-design output transformer. The built-in preamplifier has three separate switch-selected inputs for magnetic phono, crystal phono or tape, and AM-FM tuner. RIAA equalization is featured on the magnetic phono input. Shpg. Wt. 15 lbs.

NOTE THESE OUTSTANDING SPECIFICATIONS—Power output: 14 watts, Hi-Fi; 12 watts, Professional; 16 watts Utility. **Power response:** ±1 db from 20 cps to 20 kc at 14 watts output. **Total harmonic distortion:** less than 2%, 30 cps to 15 kc at 14 watts output. **Intermodulation distortion:** less than 1% at 16 watts output using 60 cps and 6 kc signal mixed 4:1. **Hum and noise:** mag. phono input, 47 db below 14 watts; tuner and crystal phono, 63 db below 14 watts. **Output impedances:** 4, 8 and 16 ohms.

HEATHKIT EA-3

$29.95

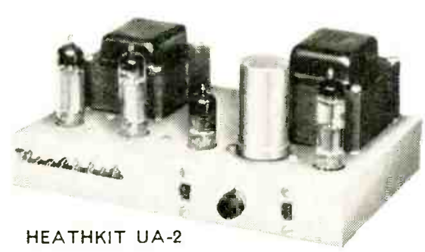
NEVER BEFORE HAS ANY HI-FI AMPLIFIER OFFERED SO MUCH AT SO LOW A PRICE

New

"UNIVERSAL" 14-WATT HI-FI AMPLIFIER KIT (UA-2)

Meeting 14-watt "hi-fi" and 12-watt "professional" standards, the UA-2 lives up to its title "universal" performing with equal brilliance in the most demanding monophonic or stereophonic high fidelity systems. Its high quality, remarkable economy and ease of assembly make it one of the finest values in high fidelity equipment. Buy two for stereo. Shpg. Wt. 13 lbs.

SPECIFICATIONS—Power output: Hi-Fi rating, 14 watts; Professional rating, 12 watts. **Power response:** ±1 db from 20 cps to 20 kc at 17 watts output. **Total harmonic distortion:** Less than 2% from 20 cps to 20 kc at 14 watts output. **Intermodulation distortion:** Less than 1% at 14 watts output using 60 cps and 6 kc signal mixed 4:1. **Hum and noise:** 73 db below 14 watts. **Output impedances:** 4, 8 and 16 ohms. **Damping factor:** Switched for unity or maximum; maximum damping factor 15:1. **Input voltage for 14 watt output:** .7 volts. **Power requirements:** 117 volts 50/60 cycles, 55 watts. **Dimensions:** 10" W. x 6½" D. x 4¾" H.



HEATHKIT UA-2

$22.95

MORE STATIONS AND TRUE FM QUALITY ARE YOURS WITH THIS FINE TUNER KIT

New

HIGH FIDELITY FM TUNER KIT (FM-4)

This handsomely styled FM tuner features better than 2.5 microvolt sensitivity, automatic frequency control (AFC) with on-off switch, flywheel tuning and prewired, prealigned and pretested tuning unit. Clean chassis layout, prealigned intermediate stage transformers and assembled tuning unit makes construction simple—guarantees top performance. Flywheel tuning and new soft, evenly-lighted dial scale provide smooth, effortless operation. Vinyl-covered case has black, simulated-leather texture with gold design and trim. Multiplex adapter output also provided. Shpg. Wt. 8 lbs.

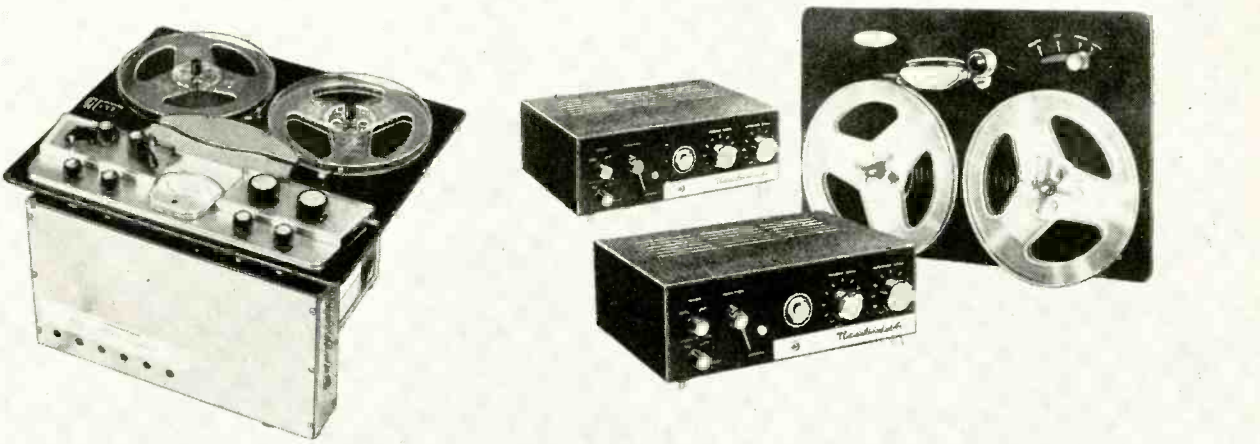
SPECIFICATIONS—Tuning range: 88 to 108 mc. **Quieting sensitivity:** 2.5 uv for 20 db of quieting. **IF frequency:** 10.7 mc. **Image ratio:** 45 db. **AFC correction factor:** 75 kc per volt. **AM suppression:** 25 db. **Frequency response:** ±2 db 20 to 20,000 cps. **Harmonic distortion:** Less than 1.5%, 1100 uv, 400 cycles 100% modulation. **Intermodulation distortion:** Less than 1%, 60 cycles and 6 kc mixed 4:1 1100 uv, 30% modulation. **Antenna:** 300 ohms unbalanced. **Output impedance:** 600 ohms (cathode follower). **Output voltage:** nominal .5 volt (with 30% modulation, 20 uv signal). **Power requirements:** 105-125 volts 50/60 cycle AC at 25 watts. **Overall dimensions:** 4½" H. x 13¼" W. x 5½" D.

HEATHKIT FM-4

$34.95

HEATH COMPANY/Benton Harbor, Mich. — a subsidiary of Daystrom, Inc.

New HEATHKIT® Tape Recorders



- Choice of 3 Outstanding Models
- Compare With $350-$400 Machines
- Preassembled Tape Mechanism
- Choice of Monophonic or Stereo models
- Complete versatility
- Easy to assemble, easy to use

PROFESSIONAL QUALITY TAPE RECORDER KITS (TR-1 Series)

Enjoy the incomparable performance of these professional quality tape recorders at less than half the usual cost. These outstanding kits offer a combination of features found only in much higher priced professional equipment, generally selling for $350 to $400. Not the least of these special features is the handsome styling which characterizes the kits . . . a semi-gloss black panel is set off by a plastic escutcheon in soft gold, which is matched by black control knobs with gold inserts. The mechanical assembly, with fast forward and rewind functions, comes to you completely assembled and adjusted; you build only the tape amplifier. And, you'll find this very easy to accomplish, since the two circuit boards eliminate much of the wiring. Separate record and playback heads and amplifiers allow monitoring from tape while recording and a "pause" control permits instant starting and stopping of tape for accurate cueing and tape editing. A digit counter is provided for convenient selection of any particular recording. Push-pull knob provides instant selection of 3¾ or 7½ IPS tape speed. Safety interlock on record switch reduces possibility of accidental erasure of recorded tapes. Shpg. Wt. 30 lbs.

SPECIFICATIONS—Tape speed: 7.5" and 3.75" per second. **Maximum reel size:** 7". **Frequency response (record-playback):** ±2.5 db, 30 to 12,000 cps at 7.5 IPS; ±2.5 db, 30 to 6,500 cps at 3.75 IPS. **Harmonic distortion:** 1% or less at normal recording level; 3% or less at peak recording level. **Signal-to-noise ratio:** 50 db or better, referred to normal recording level. **Flutter and wow:** 0.3% RMS at 7.5 IPS; 0.35% RMS at 3.75 IPS. **Heads (3):** erase, record, and in-line stereo playback (TR-1C, monophonic playback). **Playback equalization:** NARTB curve, within ±2 db. **Inputs (2):** microphone and line. **Input impedance:** 1 megohm. **Model TR-1D & TR-1E outputs (2):** A and B stereo channels. **Model TR-1C output (1):** monophonic. **Output levels:** approximately 2 volts maximum. **Output impedance:** approximately 600 ohm (cathode followers). **Recording level indicator:** professional type db meter. **Bias erase frequency:** 60 kc. **Timing accuracy:** ±2%. **Power requirements:** 105-125 volts AC, 60 cycles, 35 watts. **Dimensions:** 15½" W. x 13½" D. Total height 10¾". **Mounting:** requires minimum of 8½" below and 1½" above mounting surface. May be operated in either horizontal or vertical position.

MODEL TR-1C Monophonic Tape Deck: Monophonic Record and Playback. **$159.95** $16.00 DWN. $14.00 MO.

MODEL TR-1D Two Track Stereo Tape Deck: Monophonic Record and Playback, plus Playback of 2-track Pre-recorded Stereo Tapes (stacked). **$169.95** $17.00 DWN. $15.00 MO.

MODEL TR-1E Four Track Stereo Tape Deck: Monophonic Record and Playback, plus Playback of 4-track Pre-recorded Stereo Tapes (stacked). **$169.95** $17.00 DWN. $15.00 MO.

MODEL C-TR-1C Conversion Kit: Converts TR-1C to TR-1D (see TR-1D description above). Shpg. Wt. 2 lbs. **$19.95**

MODEL C-TR-1D Conversion Kit: Converts TR-1D to TR-1E (see TR-1E description above). Shpg. Wt. 2 lbs. **$14.95**

MODEL C-TR-1CQ Conversion Kit: Converts TR-1C to TR-1E (see TR-1E description above). Shpg. Wt. 2 lbs. **$19.95**

NOTE: To convert TR-1C to TR-1E, purchase both C-TR-1C and C-TR-1D conversion kits.

STEREO-MONO TAPE RECORDER KITS (TR-1A Series)

Here are the tape recorders the avid hi-fi fan will find most appealing! Their complete flexibility in installation and many functions make them our most versatile tape recorder kits. This outstanding tape recorder now can be purchased in any one of three versions. You can buy the new two-track (TR-1AH) or four-track (TR-1AQ) versions which record and play back both stereo and monophonic programming, or the two-track monophonic record-playback version (TR-1A) and later convert to either two-track or four-track stereo record-playback models by purchasing the MK-4 or MK-5 conversion kits. The tape deck mechanism is extremely simple to assemble. Long, faithful service is assured by precision bearings and close machining tolerances that hold flutter and wow to less than 0.35%. Power is provided by a four-pole, fan-cooled induction motor. One lever controls all tape handling functions of forward, fast-forward or rewind modes of operation. The deck handles up to 7" tape reels at 7.5 or 3.75 IPS as determined by belt position. The TR-1A series decks may be mounted in either a vertical or horizontal position (mounting brackets included). The TE-1 Tape Electronics kits supplied feature NARTB equalization, separate record and playback gain controls and a safety interlock. Provision is made for mike or line inputs and recording level is indicated on a 6E5 "magic eye" tube. Two circuit boards simplify assembly.

MODEL TR-1A: Monophonic two-track record/playback with fast forward and rewind functions. Includes one TE-4 Tape Electronics kit. Shpg. Wt. 24 lbs. **$99.95** $10.00 DWN. $9.00 MO.

TR 1A SPECIFICATIONS—Frequency response: 7.5 IPS ±3 db 50 to 12,000 cps; 3.75 IPS ±3 db 50 to 7,000 cps. **Signal-to-noise ratio:** better than 45 db below full output of 1.25 volts/channel. **Harmonic distortion:** less than 2% at full output. **Bias erase frequency:** 60 kc (push-pull oscillator).

MODEL TR-1AH: Two-track monophonic and stereo record/playback with fast forward and rewind functions. Two TE-4 Tape Electronics kits. Shpg. Wt. 36 lbs. **$149.95** $15.00 DWN. $13.00 MO.

TR-1AH SPECIFICATIONS—Frequency response: 7.5 IPS ±3 db 40 to 15,000 cps; 3.75 IPS ± db 40 to 10,000 cps. **Signal-to-noise ratio:** 45 db below full output of 1 volt/channel. **Harmonic distortion:** less than 2% at full output. **Bias erase frequency:** 60 kc (push-pull oscillator).

MODEL TR-1AQ: Four-track monophonic and stereo record/playback with fast forward and rewind functions. Two TE-4 Tape Electronics kits. Shpg. Wt. 36 lbs. **$149.95** $15.00 DWN. $13.00 MO.

TR-1AQ SPECIFICATIONS—Frequency response: 7.5 IPS ±3 db 40 to 15,000 cps; 3.75 IPS ±3 db 40 to 10,000 cps. **Signal-to-noise ratio:** 40 db below full output of .75 volts/channel. **Harmonic distortion:** less than 2% at full output. **Bias erase:** 60 kc (push-pull oscillator).

HEATH COMPANY/Benton Harbor, Mich.

a subsidiary of Daystrom, Inc.

New "Acoustic Suspension" Hi-Fi Speaker System Kit

HEATHKIT AS-2U (unfinished)

$69⁹⁵

HEATHKIT AS-2M (mahogany) **$79.95**
HEATHKIT AS-2B (birch) **EACH**

NOW—FOR THE FIRST TIME —EXCLUSIVELY FROM HEATH

ACOUSTIC SUSPENSION HI-FI SPEAKER SYSTEM KIT (AS-2)

A revolutionary principle in speaker design, the Acoustic Research speaker has been universally accepted as one of the most praiseworthy speaker systems in the world of high fidelity sound reproduction. Heathkit is proud to be the sole kit licensee of this Acoustic Suspension principle from AR, Inc., and now offers for the first time this remarkable speaker system in money-saving, easy-to-build kit form.

The 10″ Acoustic Suspension woofer delivers clean, clear extended-range bass response and outstanding high frequency distribution is provided by the specially designed "cross-fired" two-speaker tweeter assembly.

Another first in the Heathkit line is the availability of preassembled and prefinished cabinets. Cabinets are available in prefinished birch (blond) or mahogany, or in unfinished birch suitable for the finish of your choice. Kit assembly consists merely of mounting the speakers, wiring the simple cross-over network and filling the cabinet with the fiberglass included. Shpg. Wt. 32 lbs.

SPECIFICATIONS—Frequency response (at 10 watts input): ±5 db, 42 to 14,000 cps; 10 db down at 30 and 16,000 cps. **Harmonic distortion:** below 2% down to 50 cps, below 3% down to 40 cps at 10 watts input in corner room location. **Impedance:** 8 ohms. **Suggested amplifier power:** 20 watts minimum. **Suggested damping factor:** high (5:1 or greater). **Efficiency:** about 2%. **Distribution angle:** 90° in horizontal plane. **Dimensions:** 24″ W. x 13½″ H. x 11⅜″ D.

New Test Equipment

HEATHKIT FMO-1 — Price to be announced

AN INSTRUMENT LONG-AWAITED BY SERVICE TECHNICIANS EVERYWHERE!

HEATHKIT FM TEST OSCILLATOR KIT (FMO-1)

Here in one compact, easy-to-use instrument are provided all the test signals and sweep frequencies required for fast, easy alignment and troubleshooting of RF, IF and detector sections of FM tuners and receivers. An instrument unique in the test equipment field . . . being the only one of its type designed especially for FM service work.

SPECIFICATIONS—Output frequencies: for RF alignment, 90 mc (FM band low end), 100 mc (FM band middle range), 107 mc (FM band high end). **Modulation:** 400-cycle incidental FM. **IF and detector alignment:** 10.7 mc sweep. **Sweep width markers:** 200 kc to over 1 mc, variable, 10.7 mc (crystal), 100 kc sub-markers. **Modulation:** 400-cycle AM. **For other applications:** 10.0 mc (crystal) and harmonics, 100 kc, 400-cycle audio. **Controls:** main frequency selector, modulation switch/concentric level control, marker oscillator switch/concentric level control, sweep width—power switch, output control, AF-RF (source impedance) switch. **Power supply:** transformer, selenium rectifier. **Power requirements:** 105-125 V, 50/60 cycles, 12 watts. **Cabinet size:** 7⅜″ H. x 4¾″ W. x 4⅜″ D.

HEATHKIT RF-1

$27⁹⁵

PREASSEMBLED AND ALIGNED BANDSWITCH/COIL ASSEMBLY

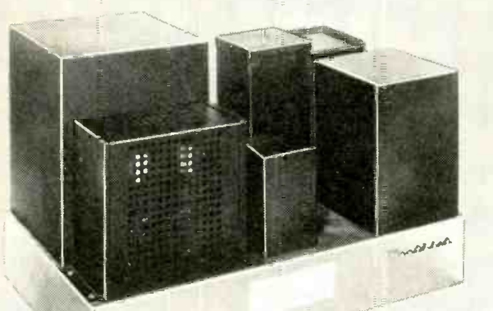
RF SIGNAL GENERATOR KIT (RF-1)

Moderately priced, and capable of precision performance the RF-1 provides highly accurate and stable RF signals for trouble-shooting and aligning RF and IF circuits of all kinds. Modulated or unmodulated RF output of at least 100,000 microvolts is available, controlled by both fixed-step and continuously variable controls. A built-in 400 cycle audio generator with 10-volt output provides internal modulation of RF signal and is available separately for audio tests. A preassembled bandswitch and coil assembly, aligned to factory precision standards, eliminates the need for special alignment equipment. Shpg. Wt. 7 lbs.

SPECIFICATIONS—Frequency range: Band A, 100 kc to 320 kc; Band B, 310 kc to 1.1 mc; Band C, 1 mc to 3.2 mc; Band D, 3.1 mc to 11 mc; Band E, 10 mc to 32 mc; Band F, 32 mc to 110 mc. **Calibrated harmonics:** 110 mc to 220 mc. **Accuracy:** 2%. **Output:** impedance, 50 ohms; voltage, in excess of 100,000 uv on all bands. **Modulation:** internal, 400 cycles approx. 30% depth; external, approx. 3 V across 50 k ohm for 30%. **400 cycles audio output:** approx. 10 V open circuit. **Tube complement:** VI 12AT7 RF oscillator, V2 6AN8 modulator and output. **Power requirements:** 105-125 V 50/60 cycles AC, 15 watts. **Aluminum cabinet dimensions:** 6½″ W. x 9½″ H. x 5″ D.

New HEATHKIT®

Ham Radio Gear



HEATHKIT KS-1

$169⁹⁵

TOP POWER WITH ECONOMY AND SAFETY

KILOWATT POWER SUPPLY KIT (KS-1)

The KS-1 is designed as a companion to the "Chippewa" Linear Amplifier and is also suitable for supplying plate power to most other RF amplifiers in the medium to high power class. The KS-1 features an oil-filled, hermetically sealed plate transformer to minimize corona, a swinging choke in the filter circuit for good regulation, and a 60-second time delay relay to permit adequate heating of the mercury vapor rectifiers before application of plate voltage. All components are conservatively rated and well insulated for long life and dependable service. Shpg. Wt. 105 lbs.

SPECIFICATIONS—Maximum DC power output: 1500 watts. **Nominal DC voltage output:** 3000 or 1500 volts. **Maximum DC current output:** Average 500 ma, peak 1000 ma. **Regulation:** 180 to 600 ma (typical linear amplifier), 8%; 0 to 300 ma (typical class C amplifier), 10%; 0 to 500 ma, 15%. **Ripple:** Less than 1%. **Tube complement:** (2) 866A mercury vapor rectifiers. **Recommended ambient temperature:** 50 to 100 degrees F. **Circuit:** Two half-wave mercury vapor rectifiers in a full wave, single-phase configuration with swinging choke input filtering. **Line power requirements:** 115 V, 50/60 cycles, 20 amperes; 230 V, 50/60 cycles, 10 amperes. **Chassis size:** 17¾" W. x 12" H. x 13" D.

HEATHKIT KL-1

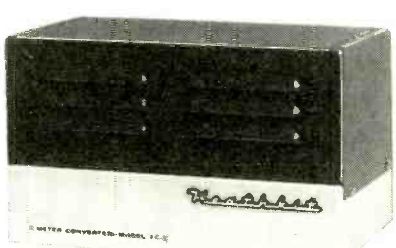
$415⁰⁰

MOVE TO THE TOP IN TRANSMITTING POWER

"CHIPPEWA" KILOWATT LINEAR AMPLIFIER KIT (KL-1)

The KL-1 operates at maximum legal amateur power inputs in SSB, CW or AM service using any of the popular CW, SSB and AM exciters as a driver. Premium tubes (4—400's) push the "Chippewa" to top performance levels while a centrifugal blower provides more than adequate cooling. Shpg. Wt. 70 lbs.

SPECIFICATIONS—RF section: Driving power required (10 meters); Class AB1 (tuned grid) 10 watts peak; Class C (tuned grid) 40 watts; Class AB1 (swamped grid) 60 watts peak. **Power input:** Class AB1 (SSB-voice modulation) 2000 watts PEP; Class AB1 (SSB-two tone test) 1300 watts; Class AB1 (AM linear) 1000 watts; Class C (CW) 1000 watts. **Power output (20 meters):** Class AB1 (SSB-voice modulation) 900 watts PEP; Class AB1 (SSB-two tone test) 550 watts; Class AB1 (AM linear) 300 watts; Class C (CW) 750 watts. **Output impedance:** 50 to 72 ohms (unbalanced). **Input impedance:** 50 to 72 ohms (unbalanced). **Band coverage:** 80, 40, 20, 15 and 10 meters. **Panel metering:** 0 to 50 ma. grid current; 0 to 100 ma screen current; 0 to 5000 volt plate voltage; 0 to 1000 ma plate current. **Tube complement:** Final tubes, (2) 4-400A; clamp tube, (1) 6DQ6; voltage regulators, (4) OD3, (2) OC3. **Power requirements:** AC (power supply primary circuit), 250 watts, 115 volt, 50/60 cycles; DC, 3000 to 4000 volts, 450 ma. **Cabinet size:** 19½" W. x 11⅝" H. x 16" D.



HEATHKIT XC-2

$36⁹⁵

2-METER CONVERTER KIT (XC-2)

Extends coverage of the Heathkit "Mohawk" Receiver to the 2-meter band. May also be used with receivers tuning a 4 mc segment between the frequencies of 22 and 35 mc when appropriate crystal is used. Shpg. Wt. 7 lbs.

SPECIFICATIONS—Noise figure: 4.5 db; 1 uv signal provides 20 db thermal noise quieting. **Sensitivity:** approx. .1 uv input will provide a signal better than 6 db over noise level. **Gain:** approx. 40 db. **Pass band:** essentially flat 144 to 148 mc; approx. 35 db down at 143 and 149 mc. **Image rejection:** better than 100 db (tunable). **Output impedance:** 50 to 75 ohms. **Input impedance:** 50 to 75 ohms; 300 ohms with balun. **Frequency:** input, 144 to 148 mc; output, 22 to 26 mc with crystal supplied. **Tubes:** 6AM4, 6BS8, 6EA8, 12AT7. **Crystal:** .005% 3rd overtone. **Power requirements:** 150 volts DC at 50 ma (dropping resistor supplied for 210 VDC RX-1 operation) 6.3 volts AC/DC at 1.375 amps. **Size:** 9" W. x 5½" H. x 4¾" D.

HEATHKIT UT-1

$28⁹⁵

"BEST BUY" UTILITY POWER SUPPLY KIT (UT-1)

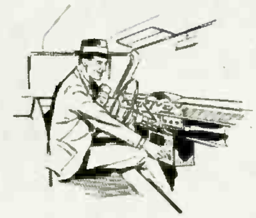
This power supply is ideal for converting the Heathkit "Cheyenne" and "Comanche" mobile transmitter and receiver to fixed station operation; or may be used to provide necessary filament and plate voltage for a wide variety of amateur equipment. Features silicon diode rectifiers, high capacity filters for superior dynamic regulation, and line filtering to minimize TVI and reduce receiver line noise. On ICAS basis, provides 150 watts DC plus filament power for 6.3 volt or 12.6 volt filament applications (6.3 VAC., 8 amps. or 12.6 VAC., 4 amps.; 600 VCD., 250 ma or 600 VDC., 200 ma and 300 VDC., 100 ma). Less than 1% ripple; excellent regulation. Housed in attractive green and gray-green cabinet measuring 9" long, 4¾" wide, 6" high. Shpg. Wt. 15 lbs.

New Citizen's Band Transceiver

WIRED OR KIT FORM

HEATHKIT CB-1
42^{95}
(kit model)

HEATHKIT W-CB-1
60^{95}
(wired model)
$6.10 dwn., $6.00 mo.



Both models include transceiver, crystal, microphone and two special power cords.

- No Tests to Take—No Operator's License Required
- Any Citizen 18 or Older Can Have Own Station
- Hundreds of Business and Personal Uses

CITIZEN'S BAND TRANSCEIVER KIT (CB-1)

The Heathkit CB-1 Citizen's Band Transceiver is a compact radio transmitter and receiver combination designed to operate on the new 11-meter "Citizen's Band". No tests to take, no special knowledge or operator's license required . . . you need only fill out forms we supply, and mail them to FCC to apply for station license. Operates just like any short wave radio used by police and other communication services. Front panel switch selects both "transmit" and "receive". Two or more Heathkit Transceivers provide you with your own 2-way radiotelephone system for making necessary business and personal contacts with family, friends or associates. A Heathkit accessory power supply makes the CB-1 completely portable for use in cars, trucks, boats, etc., using 6 or 12 volt batteries. With appropriate accessory antenna, the CB-1 can be used for communicating between truck and office, home and automobile, boat and shore, farm-house and field . . . literally hundreds of useful applications. Comes complete with microphone, 2 power cords for mobile or fixed operation, station ID card, call letters, and crystal for one channel and FCC application form. Order power supply and antenna separately. Attractively styled in two-tone "mocha" and "beige". Shpg. Wt. 10 lbs.

SPECIFICATIONS—Receiver type: Superregenerative detector w/rf stage. **Power input:** 5 watts maximum to plate of final RF amplifier (FCC requirement). **Transmitter frequency control:** Third overtone type quartz crystal operating within 0.005% of marked channel frequency between —20° and +130° F. **Modulation:** AM plate and screen modulation automatically limited to less than 100% (FCC requirements). **Power supply:** Internal 117 V. 50/60 cycles. AC (35 watts). For 6 V battery power, use Model VP-1-6 Vibrator Power Supply (6.5 amps); for 12 V battery power, use VP-1-12 (4 amps). **Total B+ requirements:** 260 volts at 60 ma; total heater requirements, 6.3 volts at 1.8 amps. or 12.6 volts at 0.9 amps. **Power rectifier:** 2 silicon diodes in full wave voltage doubler circuit. **Microphone:** Combination hand-held and desk type, ceramic element, plastic case, with cord and connector. **RF output impedance:** 50 ohms. **Speaker size:** 3½" (round). **Undistorted audio power output:** Approximately 1 watt. **Line cords:** Two supplied, one for AC operation, one for battery operation. Power circuits automatically switched when appropriate line cord is plugged in. **Cabinet dimensions:** 8" H. x 6" D. x 9¾" W.

SPECIFY FREQUENCY CHOICE
(1st and 2nd choice)

CLASS D CITIZEN'S BAND FREQUENCIES

26.965 mc	27.035 mc	27.115 mc	27.185 mc
26.975 mc	27.055 mc	27.125 mc	27.205 mc
26.985 mc	27.065 mc	27.135 mc	27.215 mc
27.005 mc	27.075 mc	27.155 mc	27.225 mc
27.015 mc	27.085 mc	27.165 mc	*27.255 mc
27.025 mc	27.105 mc	27.175 mc	

*This channel shared with Class C Radio Control.

ANTENNAS

CBU-1 "UTILITY" ANTENNA $9.95
Good coverage, portable antenna for temporary mobile or fixed installations. 45½" base-loaded antenna, 12' connecting cable, mounting bracket and clip. 3 lbs.

CBM-1 "MOBILE" ANTENNA $19.95
Best coverage mobile installation. Easy to install spring base, ¼ wave, 9' whip; 15' connecting cable and necessary hardware. 7 lbs.

CBF-1 "FIXED LOCATION" ANTENNA ... $19.95
Excellent coverage, ¼ wave "ground plane", 9' elements: 50' connecting cable and mounting bracket. 7 lbs.

WIRED AND KIT FORM POWER SUPPLIES FOR MOBILE USE

6 volt Vibrator Power Supply for use with 6 volt batteries.
KIT—Model VP-1-6. Shpg. Wt. 4 lbs **$7.95**
WIRED—Model WVP-1-6. Shpg. Wt. 4 lbs **$11.95**

12 volt Vibrator Power Supply for use with 12 volt batteries.
KIT—Model VP-1-12. Shpg. Wt. 4 lbs **$7.95**
WIRED—Model WVP-1-12. Shpg. Wt. 4 lbs **$11.95**

HEATHKIT

ORDER BLANK

NOTE: all prices and specifications subject to change without notice.

Enclosed find ( ) check ( ) money order. Please ship C.O.D. ( )

On Express orders do not include transportation charges—they will be collected by the express agency at time of delivery.

On Parcel Post Orders include postage for weight shown. All prices are NET F.O.B. Benton Harbor, Michigan, and apply to Continental U.S. and Possessions only. 20% Deposit required on all C.O.D. orders.

HEATH COMPANY BENTON HARBOR 20, MICH.

a subsidiary of Daystrom, Inc.

Name________________________

Address________________________

City & Zone________________ State________
(PLEASE PRINT)

SHIP VIA
☐ Parcel Post
☐ Express
☐ Freight
☐ Best Way

QUANTITY	ITEM	MODEL NO.	PRICE
	☐ SEND FREE HEATHKIT CATALOG	POSTAGE	
		TOTAL	

HEATHKITS are also available at your Dealer see listing on next page

Fig. 5—Control head and mike are mounted in center or slightly left-center on the dash.

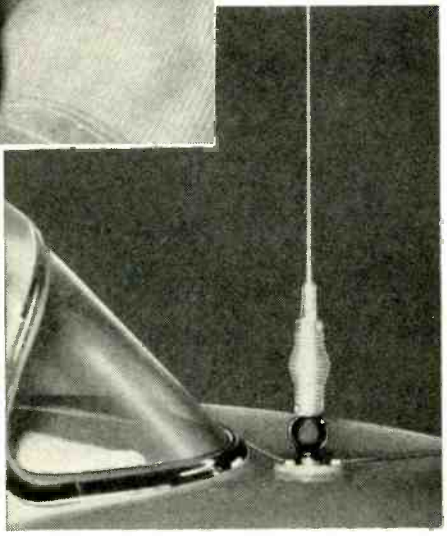


Fig. 6—Permanent whip-antenna installation uses a universal spring-base swivel-mounted antenna on one of the rear fenders.

(*Continued from page* 59)

must be mounted in as accessible and handy a location as possible with respect to the operator.

The control-head bracket is usually secured to the underside of the instrument panel near the center or slightly to the left of center (Fig. 5) since in most vehicles the driver also operates the radio equipment. This location gets the control head out of the way as much as possible, leaving knee and leg room on both sides.

The microphone hook or support plate can be mounted on the instrument panel in a spot convenient for the operator. Since the radio operator is usually driving the vehicle, a position near the center or slightly left of center on the instrument panel is preferred. On late-model automobiles in particular, this may not be possible as the panel is so crowded with other accessories. Many times a compromise between accessibility and space for mounting must be made. As long as the man who uses the equipment is satisfied, the problem is solved. A final suggestion on microphone mounting: a bracket can be made out of strap aluminum and secured to the underside of the instrument panel near the control head and the microphone mounted on this bracket. Sometimes you will come across a vehicle owner who under no circumstances will let you drill holes in the dress side of the instrument panel for mounting the microphone support. The bracket just mentioned will also solve this problem.

Mounting the speaker usually resolves into finding suitable space in the vehicle and at the same time satisfying the operator's requirements of receiving adequate intelligible communications. There are several places where a speaker can be mounted. Probably the most common location in all types of vehicles is on the firewall, as near the floorboard as possible without interfering with foot space. This location puts the speaker out of sight and at the same time provides adequate sound level in most instances. However, in some installations, particularly in trucks where the noise level is extremely high, the operator prefers the speaker in a location that improves the sound distribution. Three positions come to mind that will give improved sound level over the firewall type mounting.

The speaker bracket may be secured under the instrument panel alongside the control head. This is usually the alternate method of mounting in automobiles. On many truck installations the speaker is mounted on the top, flat portion of the instrument panel, or overhead by securing the speaker bracket to the metal section of the headliner, taking care not to pierce the roof with the self-tapping screws. This type of mounting is usually acceptable for trucks, since marring the vehicle's interior, and unsightly appearance, are less objectionable than poor sound level from the speaker.

Of course, mounting the speaker on the steering column with a special bracket is always a possibility. However, on most late model cars and trucks this has become impractical.

Antennas

Three general types of mobile antennas are in use: the low-band and high-band vhf antenna and the uhf type. Let us consider the low-band vhf antenna covering the 25–50-mc range. The most common kind in this service is the universal spring-base swivel-mounted antenna with a quarter-wave whip. Permanent automobile installations usually locate it on one of the rear fenders or preferably on the flat portion of the car body above the upper corner of the trunk lid (Fig. 6). Bumper mounting can be used but is not recommended due to the fact that a poor ground plane exists and reflected power is usually high. Consequently the antenna's efficiency is materially reduced. Disguise type antennas are also available for cowl or front fender mounting but again are not recommended except for special purposes such as plainclothes detective cars, etc., because the efficiency of such antennas is also poor.

Truck installations usually find the antenna placed on one of the rear corners of the cab in a position that keeps the whip from striking the cab when the vehicle is moving. Whether the antenna is mounted on an automobile or a truck, avoid marring the body finish when drilling the mounting holes and make sure that the mounting is completely watertight to prevent leaks in the trunk or cab. On some late-model automobiles, an inner re-inforcing panel is placed inside the trunk adjacent to the upper quarter-panel of the rear fenders, sometimes making it necessary to cut through this re-inforcing metal to mount the antenna and bring the antenna lead-in to the radio unit. In such installations, always seal the inner panel after the antenna has been mounted and the lead-in properly placed, since an opening at this point lets dust enter the trunk and is a cause for customer complaint.

Another type antenna is also used, less frequently, in the 25–50-mc band. It is designed for rooftop mounting on automobiles and trucks. Its built-in loading coil makes it possible to shorten the whip length considerably, making the rooftop mounting more practical.

Finally, regardless of the type antenna you use, make sure that the lead-in is well secured and clamped to prevent breaks at the antenna because of vibration and strain over a long period of time. Also see that the whip is adjusted properly in a vertical plane and in respect to the lines of the vehicle to give the best appearance possible.

Mobile antennas for the 150–174- and 450–470-mc bands are almost universally the rooftop type, although you may occasionally find a gutter mount or a coaxial-type antenna in service. These latter are usually found in temporary installations, since their performance is not generally as good as the standard rooftop type.

The gutter-mounted type antenna is essentially the same as the rooftop type with the addition of a bracket and clamp for securing to the vehicle rain gutter. The efficiency of the gutter-mounted antenna is considerably impaired since the ground plane supplied by the vehicle roof is absent on one side and a directional effect may be noticed. Consequently, this type antenna is not recommended except for temporary installations and in services where the equipment is always used over relatively short distances that can easily be covered with a less efficient antenna.

The coaxial type antenna is usually fender- or bumper-mounted and again is not recommended for standard installations. It is expensive and generally does not perform as well as the conventional rooftop variety.

Rooftop antennas for the 150–174- and 450–470-mc bands are mounted in essentially the same manner, and installation procedures for all practical purposes are identical. Mounting the antenna requires one hole in the roof near the center, exact placement depending upon the location of dome light and roof support bows. Since the hole is usually ⅝ to ¾ inch in diameter, a good drill bit or preferably a hole saw is necessary to get a clean, smoothly cut hole. Be careful not to puncture the headliner.

Automobile installations require that the antenna lead-in be fished through the hole in the roof, routed between the roof and headliner, and by way of the rear corner post to the radio in the trunk. The corner post on late-model automobiles has become progressively thinner and can cause some difficulty in getting the lead-in fished to the trunk. An electrician's fish tape or a length of No. 12 or 14 solid medium-soft drawn wire works well as a fish line. Usually a 5- or 6-inch length of the headliner above the rear glass on one side can be carefully unfastened so the lead-in can be fished to this point first and then to the corner post, thus facilitating the fishing process. Once the lead-in has been fished from the trunk through the hole in the roof, the antenna installation can be completed quickly. See that the lead-in is perfectly free at all points so no strain will be placed upon it. Then carefeully replace the unfastened portion of the headliner so it looks as well as it did originally, secure the antenna to the roof and align the rod if necessary.

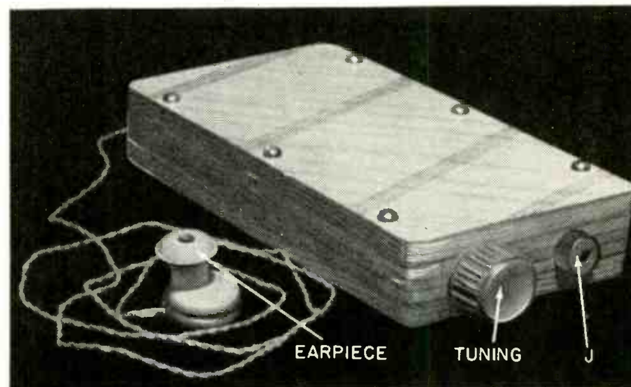
Finally, never forget that performance requirements are rigid for any commercial mobile installation. Determine the customer's requirements and expectations. Install the equipment to meet the most severe conditions anticipated and hope that the operator will give it somewhat better treatment. END

"You've got a bad needle."

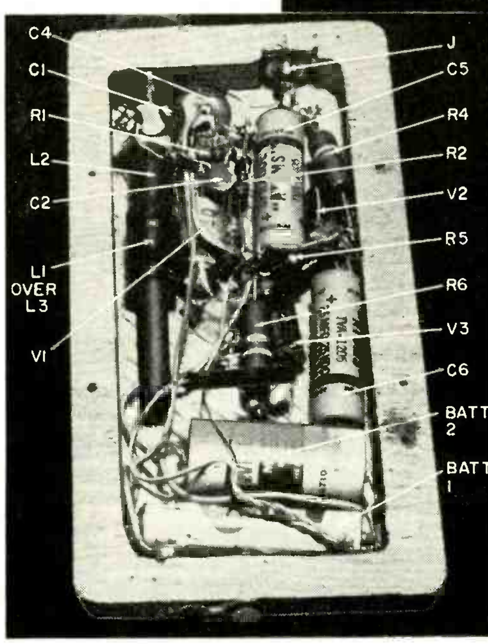
TRANSITUBE POCKET RADIO

By HOMER L. DAVIDSON

Pocket-size set in a unique wood case combines tube and transistor in its circuit



The finished unit looks like a solid block of wood.

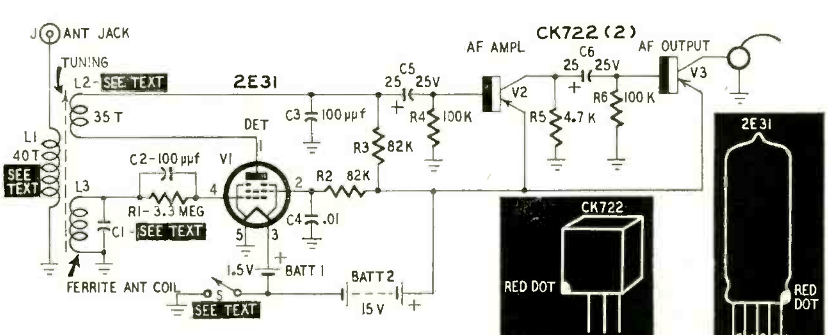


Some crowding is needed to fit standard components into the small case.

THIS radio is designed around a subminiature hearing-aid tube and two transistor amplifier stages. The subminiature tube is a 2E31 used as a regenerative detector. Of course, a 2E35, CK503AX or CK506AX could also be used. I happened to have a 2E31 on hand.

A ferrite antenna coil is used. This high-gain unit has a long core. Two windings are added to the coil. The first (L1) consists of 40 turns of No. 28 enameled wire closewound over the existing coil. Secure this winding with cellophane tape. The other winding (L2) is 35 turns of No. 28 wire closewound about ½ inch away from L2.

A 100-μμf capacitor is connected



Circuit of the transitube radio receiver.

across the coil's original winding (see diagram) to tune the receiver to the higher frequencies of the broadcast band. (Our local stations are at 1400, 1040 and 1000 kc.) The whole broadcast band may be covered by placing a 220-$\mu\mu$f capacitor (C1) across this winding.

A 25-μf electrolytic couples the signal from the detector to the first transistor amplifier. The transistor stages are conventional R-C-coupled amplifiers with base and collector resistors connected to ground. Their emitters are connected to the positive end of the B-supply. The last stage drives a hearing-aid earpiece.

A miniature 15-volt battery is used for the B-supply and a 1.5-volt penlight cell for the detector's filament. Filament leads must be connected as shown. The on-off switch is home-made. Two small brads are nailed through the bottom of the set's wooden case, and a soldering lug is bolted to the case. Turning this lug connects the brads, completing the battery circuit.

The case is made from two pieces of ¼-inch and one piece of ½-inch plywood. First, cut the three pieces to size, place a small brad through each corner and sand all sides evenly. Next the center of the ½-inch board is removed, leaving a ½-inch border. At the top of the case a ¼-inch hole is drilled for the antenna coil's core. Another ¼-inch hole is drilled for the antenna jack. The earpiece leads run through a hole in the opposite end of the case.

There is no special way of mounting the parts, although they must be kept as close together as possible. Be very careful to prevent parts from touching and leads from shorting. Generous use of spaghetti will help.

Operation is simple. Just turn on the power, plug an outdoor antenna into the antenna jack and you are ready to listen. The antenna coil's core is a combination tuning and volume control. Tuning is critical for distant stations, but for local stations some detuning may be necessary to reduce volume. Outdoors, I use a flexible antenna wire run up my coat sleeve to receive local stations.

If the set's gain and sensitivity seem poor, reverse the tickler winding (L1) connections. Varying the value of the detector's plate-load resistor (R3) may give sharper tuning. END

R1—3.3 megohms
R2, 3—82,000 ohms
R4, 6—100,000 ohms
R5—4,700 ohms
All resistors ½-watt 10%
C1—see text
C2, 3—100 $\mu\mu$f, ceramic
C4—.01 μf, ceramic
C5, 6—25 μf, 25 volts, electrolytic
BATT 1—1.5 volts, penlight cell
BATT 2—15 volts, hearing-aid battery
J—tip jack
L1—40 turns No. 28 enameled wire on L3, see text
L2—35 turns No. 28 enameled wire on L3, see text
L3—ferrite antenna coil (Superex Ferri-Loopstick or equivalent; Allied No. 51 C 036; Lafayette MS-11)
S—see text
V1—2E31
V2, 3—CK722
Plywood board, 6 x 3½ x ½ inches (for case)
Plywood board, 6 x 3½ x ½ inches (2) (for case)
Miscellaneous hardware

Dial-Cord Dilemma

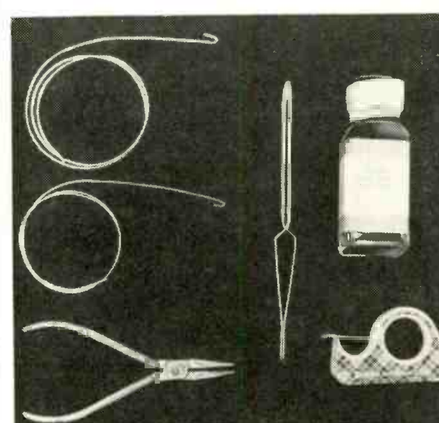
If you do the job right, you won't end up with your fingers tied to the chassis

By ROY E. PAFENBERG

THE prospect of replacing the dial cord in certain modern receivers is not to be taken lightly. Apparently the best engineering brains are assigned to design these monstrosities and they, out of frustration, attempt to outdo each other in the complexity of their creations. The simple mechanism capable of rotating a single shaft a maximum of 180° has grown until it seems that every component that can be shifted has been coupled to the fragile dial cord.

Be that as it may, a defective dial cord must be replaced after the owner of the set has tried and in the process bent the tuning capacitor plates, broken the dial glass, cracked the cabinet and lost the dial pointer or spring.

It is difficult to make a reasonable profit on a dial-cord job because the



Simple tools and bottle of dial-cord dressing aid restringing dial cords.

customer, even if he has attempted the repair himself, generally regards it as a simple mechanical operation, unworthy of a technician's time and pay.

The answer to this problem lies in salesmanship. By the simple arithmetic of time multiplied by an hourly rate, you can usually convince the customer that a service charge of $3 to $5 is not excessive. Also point out that while the set is being serviced, a general overhaul is in order. This selling of insurance by correcting minor defects, replacing weak tubes, leaky or underrated coupling capacitors, etc. can turn these nuisance jobs into real money makers.

Now let us see how we can do these

jobs as painlessly and profitably as possible.

▶ Do not consider published data beneath your skill. Manufacturers' service data and the specialized dial-stringing guides do much to speed up the job. On many sets, when the dial cord is restrung in what appears to be the obvious manner, not one degree of rotation will result. When the manufacturer's admittedly complex instructions are followed, they work like a charm, despite the finished job appearing to be such a maze of opposing forces that it couldn't be turned with a pipe wrench. Use all service data, and be grateful.

▶ Use the proper cord and springs for each job. An adequate stock of cord, springs and pointers pays off in time and money. Use only good-quality materials and stay away from fish-line expedients. On the really tough jobs, prestress the cord by hanging a heavy weight on it for several hours.

▶ Take advantage of the proper tools. Long-nose pliers and clamping tweezers have their uses. Fine piano-wire snakes are simple and effective tools. Bend eyelets and hooks in the ends of a variety of sizes and lengths and you will find them invaluable. A length of solder formed around the drive pulley will hold its shape without springing off and may be used to pull the cord through when space is at a premium. Scotch tape will often hold the cord in place until the spring can be secured.

▶ Remember that most dial-cord restringing problems arise from too much tension rather than not enough.

▶ When the job is completed, be sure that knots are secure and seal them with service cement.

▶ Don't let the set go if it is not absolutely perfect. A comeback on an apparently simple, purely mechanical repair can do you nothing but harm in the customer's eye. Use one of the available dial-cord dressings as insurance.

That's all there is to it. Let these pointers help build your business and increase your profits. END

1 FAMILY; 3 HAMS, 3 STATIONS

Father, son and grandson in the Gallo family of New Orleans, La., are all licensed amateurs, each with his own complete rig. Louis Jacob, W5AU, right

in the photograph, started things off. His son Liberato Louis, W5GHV, is in the middle. And to the left is *his* son KN5TNR, now 14 years old, now in high school. The older Gallos make loudspeaker housings at their plant, located at 2107 Montegut St., New Orleans.—*E. T. Jones*

LAB TYPE TRANSISTOR CHECKER

By checking dc gain the technician can learn a great deal about ac operation

By CARL DAVID TODD*

IF you are a service technician, you have been repairing transistor radios, intercoms and hi-fi preamps. (Or soon will be!) This means that you must have the equipment to test transistors properly.

There are some 65 transistor parameters which can be measured for a complete evaluation study. Fortunately, only a few need be measured to determine if a transistor's characteristics have changed markedly from those it should have.

One of these parameters is dc gain. Frequently current gain decreases as the transistor ages. This results in less amplification in the circuit in which it is used, and can create distortion and circuit mismatching due to changes in impedance.

The technician usually finds the transistor in an ac amplifier circuit. Equipment for measuring this small-signal ac gain has been described in various articles. A more meaningful parameter in many circuit applications is the dc gain in the common-emitter configuration, h_{FE}. What is h_{FE} and how does it compare? There is fairly good correlation of h_{fe} (alternating-current gain) and h_{FE} (dc gain) at low levels and some knowledge of h_{FE} is a must for power output work. Dc gain is also a very important parameter in switching, control or logic circuits. This factor also enters into bias circuit design for rf amplifiers.

By definition: **h_{FE} is the ratio of the collector current (dc) to the base current (dc) or,**

$$h_{FE} = \frac{I_C}{I_B}$$

A possible measuring circuit is shown in Fig. 1. A collector-to-emitter voltage is applied; a base current caused to flow and the value of h_{FE} is calculated by dividing collector current by base current.

This method has several disadvantages. First, it requires two good milliammeters. And if any reasonable accuracy is required, the meters must be better than those usually in the shop.

The calculation required is a nuisance and increases the possibility for error. It would be convenient in many respects if one or more meters and the calculation could be omitted.

The test set to be described needs only one milliammeter and does the calculating internally. The resulting h_{FE} value is displayed by a reading on a multiturn dial.

Circuit theory

As previously stated, h_{FE} is the ratio of the collector current, I_C, to the base current, I_B. We are interested only in this ratio. By inserting two resistors, as shown, in the simplified circuit of Fig. 2, two voltages V_1 and V_2 will be produced which are directly proportional to I_B and I_C, respectively.

Note that the polarities of voltages V_1 and V_2 are such that the voltage V_3 is the difference of the two. If a dc null detector is used to measure V_3 and either R_1 or R_2 adjusted until V_3 is zero, then the two voltages must be equal. This leads to a simpler expression,

$$h_{FE} = \frac{R_1}{R_2}$$

Now h_{FE} is expressed only as a function of two resistances. Since only the ratio of R1 to R2 is important, either may be varied to produce the null in V_3. If R2 were varied, the h_{FE} reading would be a nonlinear function as in Fig. 3.

*Semiconductor Div. Hughes Products. P.O. Box 278, Newport Beach, Calif.

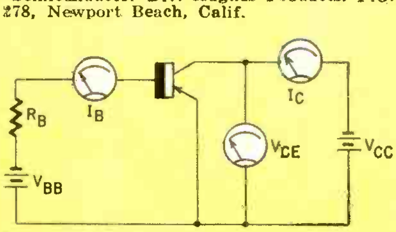


Fig. 1—Simple circuit for measuring h_{FE}

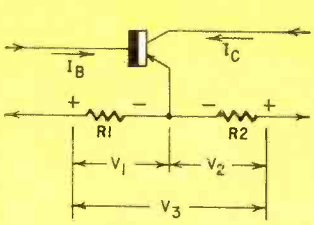


Fig. 2—Basic circuit for using resistors to measure h_{FE}.

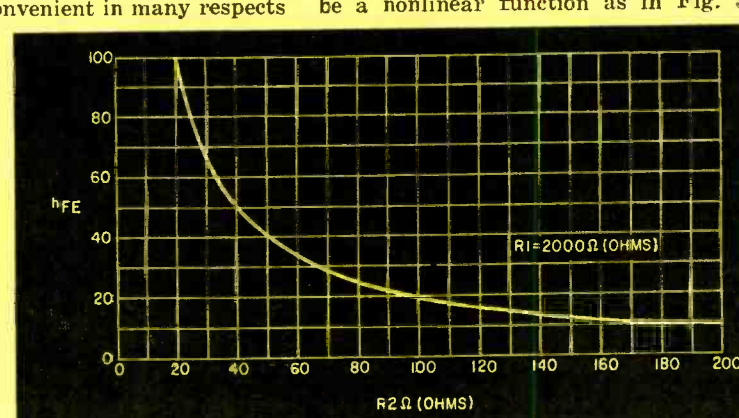
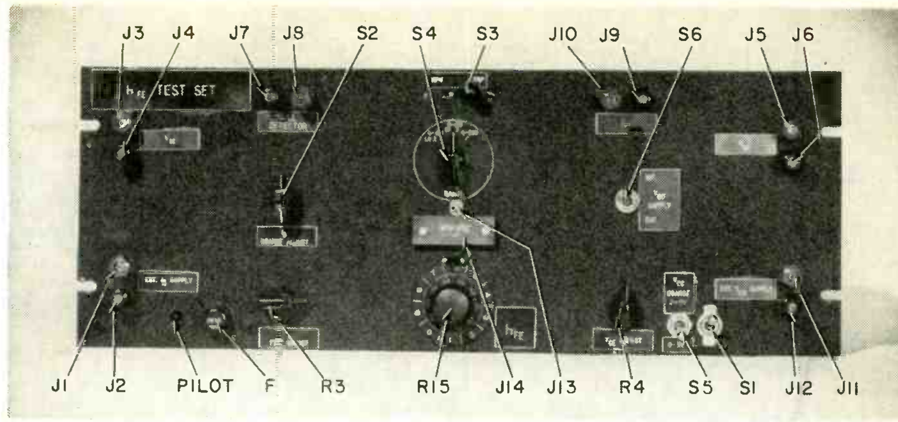


Fig. 3—Curve showing relation between R2 and h_{FE} when R1 is fixed.

However, if R1 were the variable and R2 were held constant, a linear relation as in Fig. 4 would be obtained between h_{FE} and R1.

It is impractical to vary R1 in the circuit since this requires a base-resistor current generator with a very high impedance with respect to R1. R1 must have a value in the order of several thousand ohms to obtain sufficient voltages for V_1 and V_2 when small currents are involved. This would require an unreasonable base-current generator, so the base current—and indirectly the collector current—could remain constant when the null is being obtained.

This problem may be avoided by using a circuit like that in Fig. 5. Here,



A clean front-panel layout gives the instrument a professional appearance.

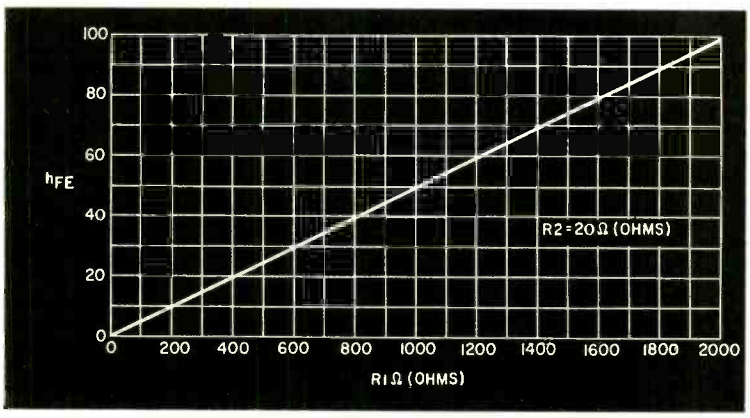


Fig. 4—Relation between R1 and h_{FE} when R2 is fixed

the equivalent R is, in effect, only a portion of R1″. A potentiometer could have been used in place of R1″, but it is hard to get an accurate potentiometer that has the required wattage rating.

The maximum value of h_{FE} that may be measured is determined by the ratio of the parallel equivalent of R1″ and R1′ to the value of R2.

Circuit description

Fig. 6 is a block diagram of a test set using the resistance-null technique. Fig. 7 is the unit's schematic.

The internal base-current supply consists of a voltage-doubler power supply and a network of resistances. T1 is a 25-volt filament transformer. Switch S2 is for coarse adjustment of I_B while potentiometer R3 is for fine adjustment.

Base current can be varied from zero to some maximum value determined by the setting of S2 for all ranges up to 10 ma. The highest current range is adjusted with an additional potentiometer section ganged with R3. This is necessary because of power dissipation requirements. Protective resistor R12 helps limit the maximum current that can be drawn when the h_{FE} RANGE switch is in the 0–100 high-current position.

Base current can come from an external supply if desired.

The collector supply uses a full-wave bridge rectifier and a transistor voltage control. Transistor V does two jobs. It adjusts the collector supply voltage and is a filter. The basic circuit is in Fig. 8. This is merely a dc emitter-follower stage and for reasonable values of R_L (the effective loading resistance of the transistor under test) the output voltage, V_{OUT}, will be very nearly equal to the base voltage. (That is, V_{BE} will be quite small.) V_{OUT} will actually be somewhat less than V_{BB} because of the forward emitter–base drop. Nevertheless, varying the base voltage varies the output. So, if the base is held constant, the output will be constant for practical purposes even though the collector supply voltage may vary.

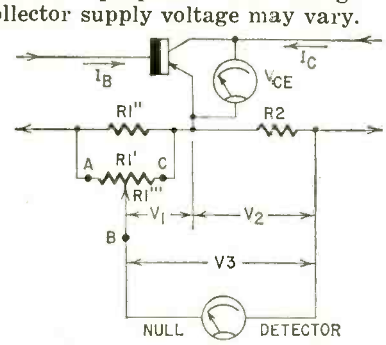


Fig. 5—Basic h_{FE} test circuit modified to allow high base current.

With the simple shunt-capacitor filter alone, ac ripple would be very high. Passive filtering is always a problem for high-current supplies. However, by using the transistor as an active filter, ripple content is greatly diminished.

The base voltage is held constant by the R-C filter network consisting of C4 and a portion of R4 as shown in Fig. 7. With the filter described, ripple is in the order of 1 mv rms or less. Should the 1 ampere or so available from the internal supply be insufficient, a set of terminals for external V_{CC} supply is provided.

The actual measuring portion of the test set shown in Fig. 6 has three ranges h_{FE}. One 0–100 range is for low-current operation and the other for high-current use. The 0–500 range is suitable for both high and low currents.

All h_{FE} range changing is done by switching in various base- and collector-current reading resistors with S4.

Two extra switch sections are used for S4. These are "potential" switches for the null detector circuitry used to eliminate errors caused by voltage drops across the switch contacts as high currents. As indicated in Fig. 9, this technique eliminates difficulty due to contact resistance and resistance in the leads.

Terminals are provided for monitoring V_{CE}, V_{BE} and I_C, and for connecting the null detector into the circuit.

Switch S3 reverses both base and collector supplies to accommodate either n-p-n or p-n-p transistors.

Construction

Rack-mount construction techniques

(*Continued on page* 78)

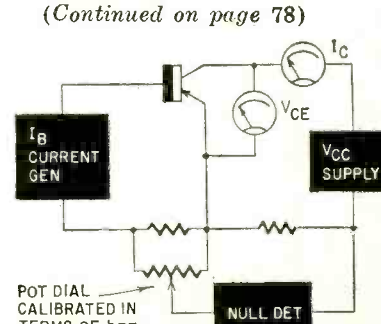


Fig. 6—Block diagram of an h_{FE} test set that uses the resistance-null technique.

"TUBE INVENTORY DOWN 30%,

...from using General Electric's PROFIT* Program. That's the dollar-saving, income-building record of Chicago partners Robert Knudsen and Harold Russell!

* Programmed Replenishment OF Inventory Turnover

"We're moving more tubes than ever, with a stock one-third less. Inventory turnover is that much higher, which shows in increased profits." The two busy partners of Tel-Rad TV Sales-with-Service, 5839 Belmont Ave., Chicago, name this as their principal benefit from General Electric's new PROFIT* Program.

Another big saving—space! The compactness of the General Electric Inventory Rack means that a service dealer can do away with 50 to 60 feet of shelving. Furthermore, the attractive, organized display of tubes gives the shop a modern and professional-looking appearance.

Knudsen and Russell add, "Now our tube stock's geared to our needs. And it stays that way—plenty of fast-selling types, a minimum of slow movers. The distributor's weekly re-order visit takes care of everything." No stock-taking or clerical work by the partners is involved. This saves them time for profitable repairwork.

You too can increase turnover and boost income with General Electric's new PROFIT* Program. Available with the purchase of tubes from your G-E tube distributor. See him today! *Distributor Sales, Electronic Components Division, General Electric Company, Owensboro, Kentucky.*

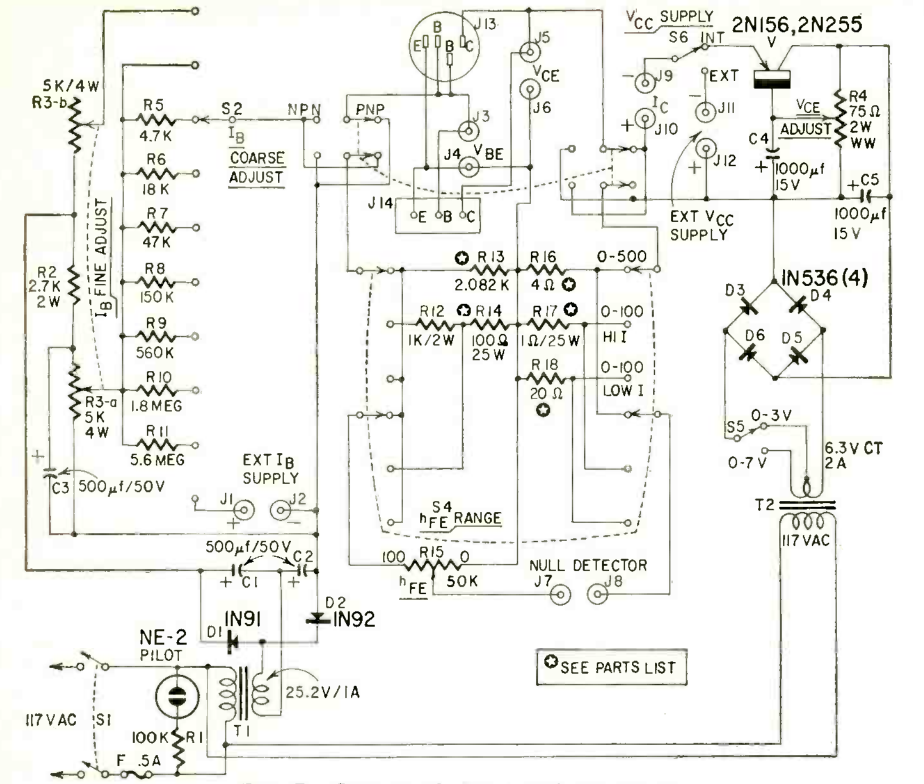
TEL-RAD'S SERVICE WORK doesn't stop while tube stocks are being checked. Here Richard Schlueter (facing rack in picture at left), salesman for Melvin Electronics, General Electric tube distributor, inspects the PROFIT* tube inventory for types to re-order. Schlueter does this job weekly, handling all routine and paperwork—thus saving valuable time for Knudsen and Russell.

OUR SALES ON THE INCREASE!"

Progress Is Our Most Important Product

GENERAL ELECTRIC

2-111-223



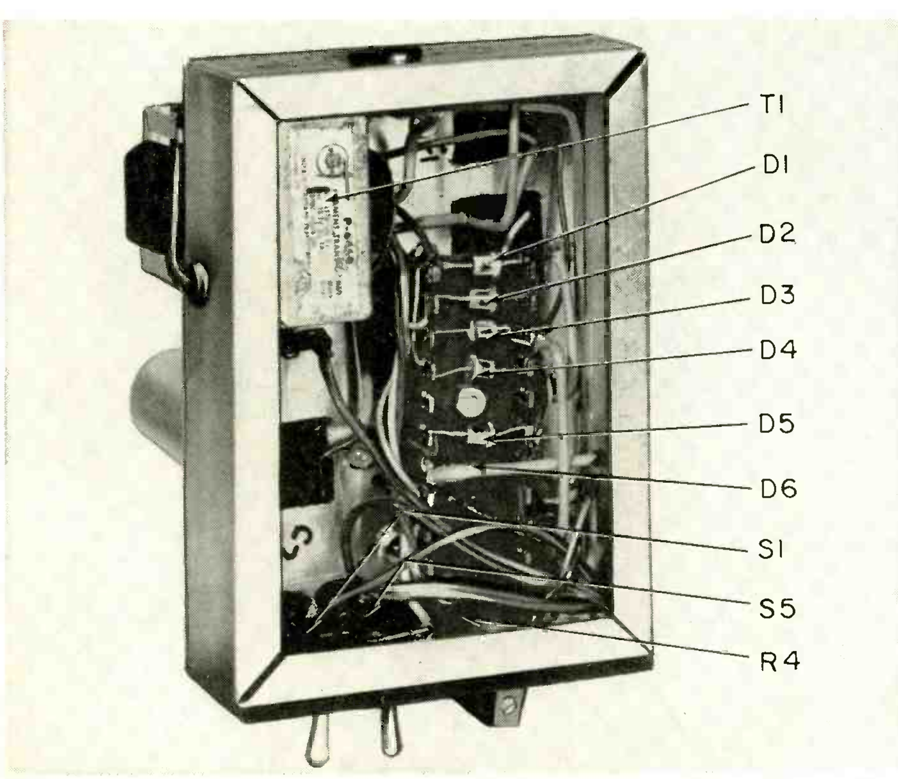
R1—100,000 ohms
R2—2,700 ohms, 2 watts
R3—Dual pot, 5,000 ohms per section, 4 Watts, wirewound
R4—pot, 75 ohms, 2 watts, wirewound
R5—4,700 ohms
R6—18,000 ohms
R7—47,000 ohms
R8—150,000 ohms
R9—560,000 ohms
R10—1.8 megohms
R11—5.6 megohms
R12—1,000 ohms, 2 watts
R13—2,082 ohms (four 500-ohm 1-watt, 1% and 82-ohm ½-watt, 5% in series)
R14—100 ohms, 25 watts (selected for close tolerance)
R15—10-turn pot 50,000 ohms
R16—4 ohms (four 1-ohm 1-watt, 5% in series)
R17—1 ohm, 25 watts (selected for close tolerance)
R18—20 ohms (four 5-ohm 1-watt, 1% in series)
All resistors ½-watt 10% unless noted
C1, 2, 3—500 µf, 50 volts, electrolytic
C4, 5—1000 µf, 15 volts, electrolytic
D1, 2—1N91
D3, 4, 5, 6—1N536
F—0.5 amp
J1-J12—banana jacks
J13—transistor socket (Lafayette MS-395 or equivalent)
J14—transistor socket, 3 pin
S1—dpst toggle
S2—1-pole 10-position rotary
S3—4-pole 2-position lever
S4—4-pole 3-position wafer
S5, 6—spdt toggle
T1—filament transformer: primary, 117 volts; secondary, 25.2 volts, 1 amp (Stancor P6469 or equivalent)
T2—filament transformer: primary, 117 volts; secondary, 6.3 volts ct, 2 amps (Stancor P6134 or equivalent)
V—2N156, 2N255
NE-2 neon pilot-lamp assembly
10-turn dial for R15
Chassis to suit
Miscellaneous hardware

Fig. 7—Circuit of the transistor tester.

(*Continued from page* 75)
were used in the author's original model of the h_{FE} test set since it was to be included with other test panels mounted in a standard relay rack. The general layout is straightforward, as shown in the photos, but is not critical since the primary concern is for dc conditions.

Wiring may be either from point to point or square-cornered as the builder wishes. The only critical points to watch when wiring the unit are switch S4 and the dress of the leads to and from potentiometer R15. When wiring S4, be sure that connections to the current reading resistors R13, R14, R16, R17, R18 are made as shown in Fig. 9. All wiring to and from R15 should be kept away from the 117-volt line to prevent ac pickup which may give a false null-detector reading.

To increase the power dissipation capabilities of regulator transistor V, it should be mounted on a heavy sheet of copper, brass or aluminum. A 5 x 6-inch sheet of ⅛-inch stock should be adequate.



Transformers, rectifiers and capacitors are on the chassis attached to the panel.

What can it do

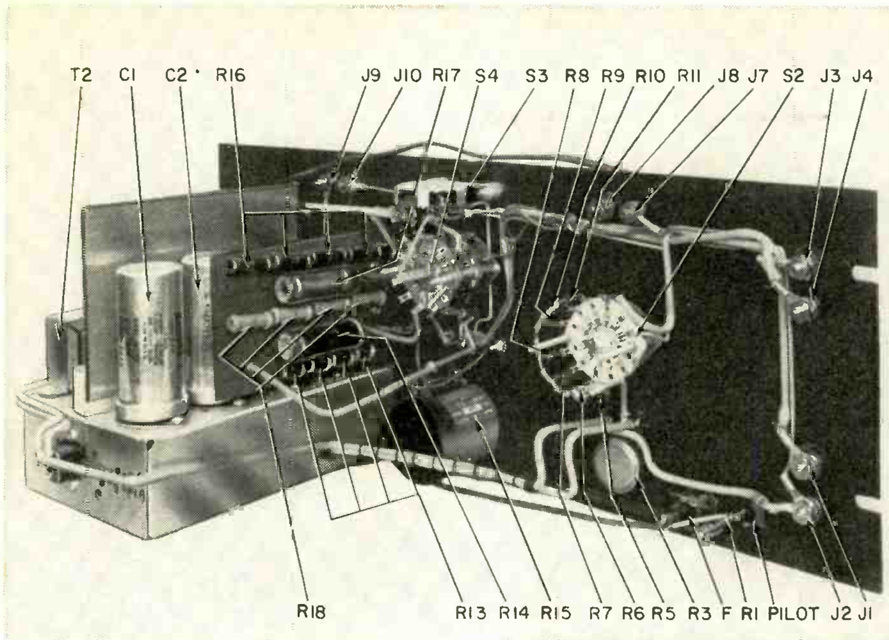
The test set shown in Fig. 7 measures h_{FE} up to 100 for a maximum collector current of 400 ma in the low-current range and up to 5 amps in the high-current range, provided the maximum base current does not exceed 40 or 500 ma, respectively. In the 0–500 range, I_C may be a maximum of 1 amp with the I_B maximum being 40 ma.

Collector voltage available depends upon the collector current. The primary limitations are the power dissipation capabilities of the voltage control transistor, and the voltage drop across the I_C reading resistor. The difference between the desired V_{CE} voltage and the total unfiltered supply voltage of approximately 7 volts appears partially across the collector-current reading resistor (R_C) and the remainder across transistor V. An equation which relates the variables involved is:

$$V_{CE} = V_{CC} - I_C R_C - V_{CE2}$$

(V_{CE2} is the collector-to-emitter voltage of transistor V.)

To determine the maximum value of collector current permissible, several factors must be studied. First of all, since a transistor's current gain is a function of the collector current and voltage, there is a maximum value of collector current and a minimum value



A look backstage. Layout is not critical and can be changed.

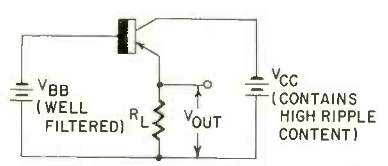


Fig. 8—Transistor voltage-control and filter circuit.

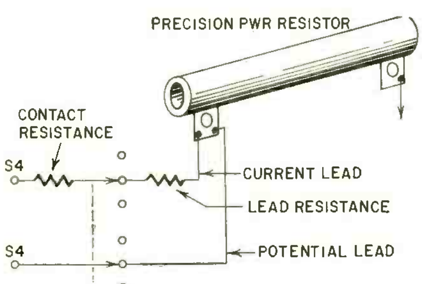


Fig. 9—How to connect potential lead to high current resistor without running into trouble with switch-contact or lead resistance.

of collector voltage at which the regulator transistor will have sufficient h_{FE} to be effective. For the transistor used, the maximum value of I_C is roughly 3 amps and the minimum voltage is roughly 0.5.

Thus the maximum value of V_{CE} available to be applied to the transistor under test will be:

$$V_{CE\,max} = V_{CC} - I_CR_C - 0.5$$

For the test set described, V_{CC} is approximately 7 or 3.5 volts, depending on the position of S5.

Oddly enough, for a given value of I_C there is also a minimum value of V_{CE} which may be applied to the transistor under test, because all voltage not dropped either across the current reading resistor, R_C, or across the transistor under test must appear across the regulator transistor. To avoid damaging V, the applied V_{CE} to the transistor under test must be greater than a value given by the following expression:

$$V_{CEmin} = V_{CC} - I_CR_C - \frac{PC_{max2}}{I_C}$$

where P_{Cmax2} is the maximum collector power rating of transistor V. Thus, for small values of I_C, the minimum value of V_{CE} is not important. At large currents, however, this factor must be considered. Switch S5 has been provided to give some aid to this problem.

Using the tester

To measure h_{FE}, a transistor is plugged into the socket, the V_{CE} ADJUST control is set to give a voltage on the meter connected to the V_{CE} terminals which is somewhat higher than for the operating point desired, and the base-current control adjusted to give the required value of I_C. Some readjustment of the V_{CE} control may be necessary. Once the operating point has been set, turn the h_{FE} dial until the meter connected to the NULL DETECTOR terminals reads zero.

The sensitivity required for the null detector depends on the operating I_C and the desired accuracy. The higher the value of I_C, the less sensitive the detector has to be. It may be shown that, for points near the null, the null-detector voltage is given by the expression:

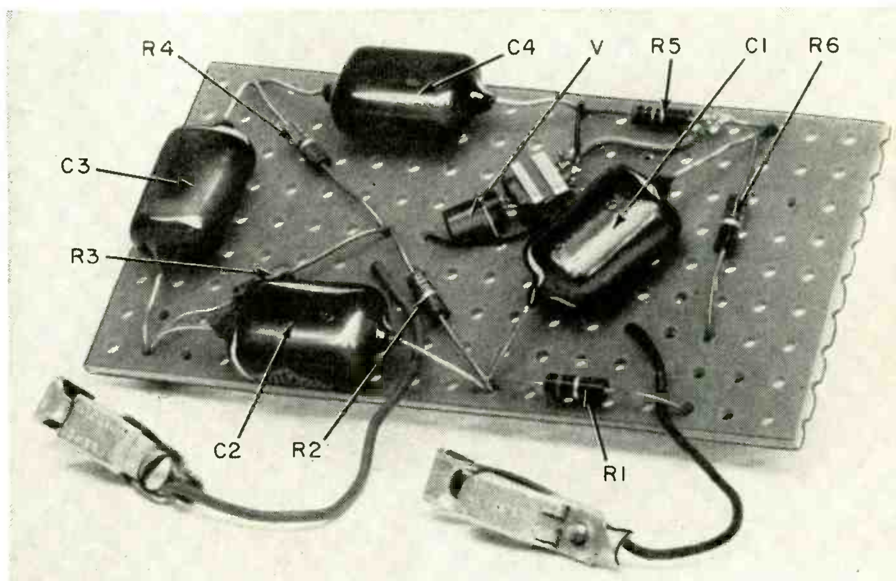
$$V_N = h_{FE}^* = I_CR_C$$

where h_{FE}^* is the *percent* change of h_{FE} from the null value. Thus, if measurements are being made at a collector current of 20 ma on the 0–100 range, a null detector capable of detecting 12 mv is required if an h_{FE}^* of 3% is desired. The h_{FE} dial reads directly from 0 to 100 on the 0–100 range. On the 0–500 range the dial reading is multiplied by 5. END

Sine Waves via Phase Shift

Simple 1-transistor phase-shift oscillator puts out stable sine waves

By F. T. MERKLER



The whole works makes a compact and neat layout when parts are mounted on a perforated phenolic board.

FOR some reason, transistor phase-shift oscillators have not received the attention they deserve. It is true that the transistor version seems more difficult to design than the vacuum-tube circuit, but this is not due to a defect in the transistor but to an attempt to apply vacuum-tube thinking to an entirely new type of device. Perhaps you can physically replace a vacuum tube with an audio transistor (properly biased) in a standard three-mesh network and have it operate, *if* you make the supply voltage high enough and pick a transistor with a high beta. This transistor circuit has definite advantages. When correctly designed, it produces a crisp sine wave, starts easily and continues oscillating until the battery drops down to about 4 volts. Not to be overlooked is the low cost of the few small parts needed.

The unit described here is the result of painstaking effort to produce a quality circuit that would be reliable, easily started, stable under temperature change, and would allow for unavoidable transistor variations. It oscillates at approximately 1,000 cycles with the components specified. Eleven 2N109 transistors were tested for dc beta to be sure of a proper spread in characteristics. Each variation in the circuit was tested with each of the 11 transistors at five supply voltages from 13 to 4 volts dc. The final circuit is a four-mesh network with voltage feedback from collector to base of the grounded emitter amplifier. The feedback circuit protects the transistor from thermal runaway.

One of the tests given the completed unit was a heat run, with a test setup that monitored transistor case temperature, collector current and frequency. At the start of the run, case temperature was 28°C, collector current was 4.4 ma and frequency was 1,171 cycles per second. Supply voltage was held at 10 volts dc throughout the run. At a case temperature of 63°C, collector current was 7.8 ma and frequency of oscillation was 2,202 cycles per second. At a case temperature higher than 63°C (149°F), the circuit no longer oscillated, but the transistor was not damaged as its collector current leveled out at about 8.1 ma. The case temperature

SAVE ½ THE TIME

Make Twice The Profit!

in TV Trouble-Shooting

THIS EASY
SIGNAL INJECTION
POINT-TO-POINT
DIRECT VIEWING
WAY

MODEL 1075

B&K TELEVISION ANALYST

Solve Rough Sweep Output Problems

NEW **Model A107**
DYNA-SWEEP
CIRCUIT ANALYZER

Saves many hours of service work. Provides vertical and horizontal sync and driving pulses that enable you more easily and quickly to check out every stage in the sync and sweep sections of a television receiver.

Tracks down troubles in the horizontal and vertical output circuit including defective output transformer and yoke; checks for shorted turns, leakage, opens, short circuits, and continuity. Includes unique high-voltage indication. Eliminates trial and error replacements.

Model A107 Dyna-Sweep. Companion unit for use only with B&K Model 1075 Television Analyst for driving source. **Net, $49.95**

Model 1070 Dyna-Sweep. Same as Model A107 but has its own horizontal and vertical driving pulse, and is used independently of the Model 1075. **Net, $69.95**

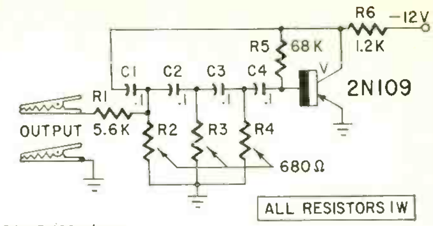
New Technique Makes TV Servicing Easier, Faster, More Profitable

Thousands of service technicians already save thousands of hours every day with the amazing B&K Television Analyst. Enables you to inject your own TV signal at any point and watch the resulting test pattern on the picture tube itself. Makes it quick and easy to isolate, pin-point, and correct TV trouble in any stage throughout the video, audio, r.f., i.f., sync, and sweep sections of black & white and color television sets—*including intermittents.* Makes external scope or wave-form interpretation unnecessary. Enables any serviceman to cut servicing time in half, service more TV sets in less time, really satisfy more customers, and make more money. Color generator provides both rainbow pattern and color bars.

MODEL 1075 TELEVISION ANALYST. Complete with standard test pattern, white dot, white line, and color-bar slide transparencies, and one clear acetate. Net, **$259.95**

See your B&K Distributor or Write for Bulletin ST24-E

B&K MANUFACTURING CO.
1801 W. BELLE PLAINE AVE • CHICAGO 13, ILL.
Canada: Atlas Radio Corp., 50 Wingold, Toronto 10, Ont.
Export: Empire Exporters, 277 Broadway, New York 7, U.S.A.



R1—5,600 ohms
R2, 3, 4—680 ohms
R5—68,000 ohms
R6—1,200 ohms
All resistors ½-watt 10%
C1, 2, 3, 4—0.1μf, 15 volts or higher
V—2N109
alligator clips (2)
Phenolic chassis board
Miscellaneous hardware

Circuit of the 1-transistor oscillator.

was taken up to 71°C, which is the manufacturer's specified maximum, and the external heat removed. As the circuit cooled, current drain slowly decreased and the unit resumed oscillating at about 63°C. The phase-shift oscillator was kept operating at normal room temperature for about 24 hours with a Berkeley counter set to record the frequencies on a graph. No failure occurred and the frequency settled down to 1,118 cycles per second, with a 3-cycle variation over the time period.

Practical uses for this circuit are numerous. A small probe-type unit can be made up, with a male phono plug on the output end ready to test audio amplifiers. Use the oscillator for musical instruments and toys; it has good stability and is economical to build. In these applications if you wish to vary the frequency, vary the capacitance in the network, not the resistance, to get new and different tones. For example: make each capacitor (C1, C2, etc.) equal to .068 μf and you will have a frequency of 2,100 cycles per second. In building this circuit, remember, good stability depends on high-grade components. Use impregnated-paper capacitors and 1-watt composition resistors. I know 15 or so of these oscillators that have been built into receivers, test oscillators and impedance bridges. At no time was any difficulty experienced with this circuit. Use it with utmost confidence.

(Our tests showed that a better waveform could be obtained by taking the output from the 5.6K resistor and the transistor's collector.—*Editor*) END

CORRECTIONS

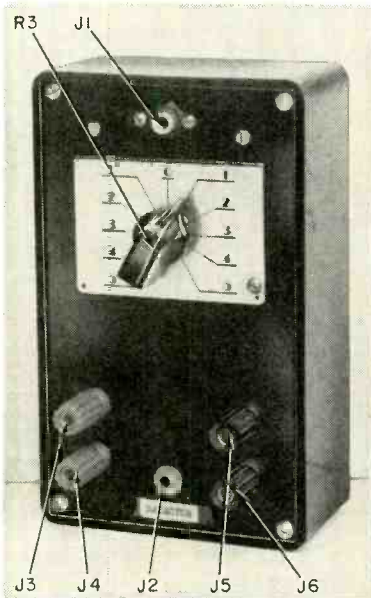
In "Tape Machines For Stereo", October 1959, an incorrect price was listed for the Newcomb SM310 recorder. The correct price is only $499.50. We regret any inconvenience this error may have caused.

In the article "Transistor TV Portable" in the August issue, we erroneously described the Foster-Seeley sound detector as a ratio detector. In the 7th line of the paragraph on the sound system (page 47) change the word ratio to diode.

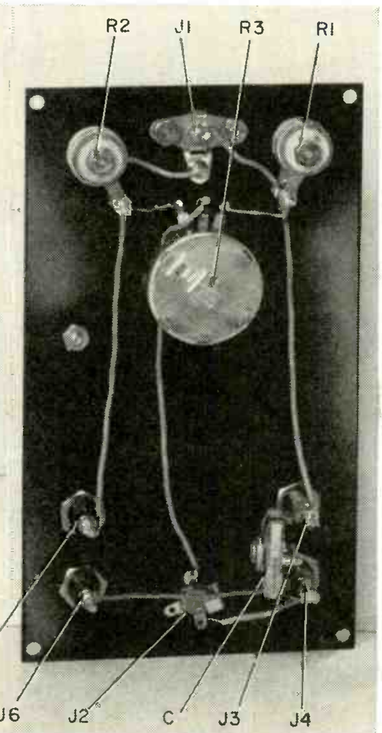
We thank Mr. Y. H. Lee of Sao Paulo, Brazil for calling this to our attention. (See also Correspondence Column.)

MATCH RESISTORS *fast*

By I. QUEEN
EDITORIAL ASSOCIATE



Front panel of finished unit which measures resistor mismatch up to 5%.



A look at the comparator's insides shows just how simple a unit it is.

BENCH TESTED

The percentage comparator, tested in our usual manner, works essentially as described. But using an audio detector a null could not be obtained better than about ± 3%. Using a scope for the detector gave accuracy better than 1%. Total accuracy (no pointer adjustment) is about ± 2% with components used and a scope as detector. When pointer is repositioned as described in article, high accuracy (0.5%) is possible.

PROBABLY few technicians feel that they have much use for a bridge to measure resistance. An ohmmeter is so much more convenient and less expensive, and is generally adequate. However, there is an important bridge application that one encounters from time to time. That is the *matching* of resistors, say to within 1% or better. An ohmmeter is not accurate enough for this purpose. This comparator bridge can match resistors to within a fraction of 1 per cent, reads up to a maximum of 5%, and can compare and match capacitors.

Matching is called for in phase splitters, balanced networks, push-pull amplifiers and similar circuits. Sometimes precision resistors are specified but actually *matched* pairs are required. It is generally true that the actual value of resistance is not very critical. With access to a percentage comparator you can check the accuracy of precision resistors before you connect them into a balanced circuit. Even better, you can measure the resistors you already have on hand, perhaps avoiding the purchase of expensive units. Even 10% resistors may be used in delicately balanced networks if they are matched.

To test a matched pair, you need only compare one with the other. Thus a complete bridge is not needed. This circuit uses only two bridge arms; the other two are the resistors being matched. An ac signal source lets us use an earpiece as a sensitive detector. I use a 600-ohm audio generator capable of about 5 volts output, but even a low-power transistor oscillator may be used. A signal frequency of about 850 cycles provides sufficient sensitivity.

R1 and R2 should be nearly equal, preferably to within 0.5% tolerance.

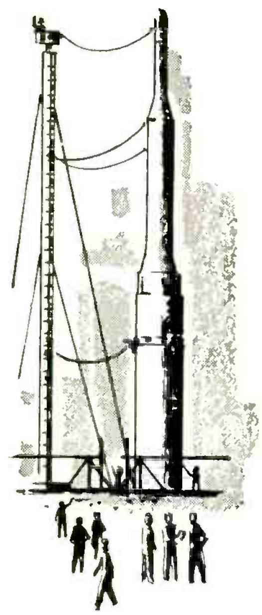
Connect the comparator to a signal generator. Connect the pair to be matched to terminals J3–J4 and J5–J6. Plug in an earpiece and balance the bridge. Note the percentage difference. Now transpose the matched pair and balance again. The first reading should be on one side of zero, the second on the other. Both readings should be nearly *equal*. If they differ by a con-

(*Continued on page* 88)

SOUND FAMILIAR?

It's a box CREI helps men out of.

Since 1927 we have directed the technical education of students—as individuals and in groups—in *advanced* electronics engineering technology. CREI students (more than 20,400 are currently enrolled) keep pace with the needs of the ever-advancing electronics industry and are eagerly sought by employers who offer solid opportunities for rapid promotion.

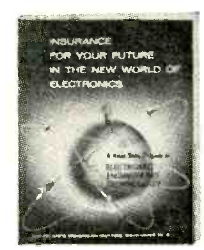


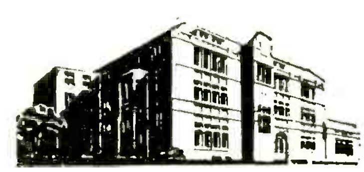
As David F. Grunewald, 602 South St., Oconomowoc, Wisc., puts it: "I've been fortunate to get another very good promotion ... assigned to work along with an engineer in development work on different electronics projects assigned to him. It's a salaried position with A. C. Spark Plug, Milwaukee. Financially just in the past year the cost of the course has been paid for three times over."

Among the many CREI home study advantages: You need not quit your present position. You can meet your family responsibilities while gaining a college-level knowledge of electronic engineering technology so essential for career advancement. Your education is accomplished on your own time, during hours chosen by you. No time is wasted in travel. You have plenty of time to do your best. Your work is under the supervision of a regular staff instructor who guides your progress step by step. Courses are prepared by experts, presented in easy-to-understand form, kept up to date by constant revision. Experience in more than three decades of home-study teaching, during which time we have corrected and commented on many hundreds of thousands of examinations, enables us to avoid difficult-to-understand text matter in our lessons.

Design, construction, and maintenance of complex electronics equipment—missiles, radar, servomechanisms, astronautical devices, satellites — demand men with *advanced* theoretical *and* practical knowledge. CREI home study courses can make you eligible to meet such demands. Your CREI diploma is a door-opener to better positions, added responsibilities, and salary increases.

QUALIFICATIONS for CREI. If you have had basic electronic education, practical experience in electronics, and a high school education, you can probably qualify. To find out, use card on left to get free 54-page book, "Insurance for Your Future in the New World of Electronics." Tuition is reasonable; it may be paid monthly. One $10-a-week raise will repay your investment and leave you a bonus the first year. Available to veterans under the G. I. Bill.





RESIDENCE SCHOOL for those who can attend classes in Washington, D. C. Day and evening classes start at regular intervals. Qualified graduates earn AAS degree in 27 months. Electronics experience not required for admission.

CAPITOL RADIO ENGINEERING INSTITUTE

ECPD Accredited Technical Institute Curricula
Founded 1927

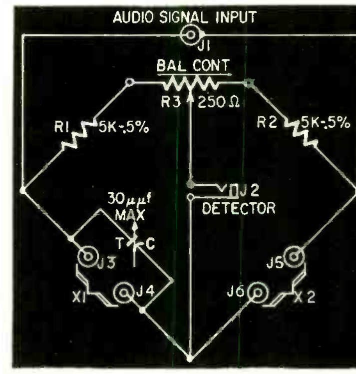
Dept. 1412-F1 **X_1**
3224 - 16th Street, N.W.
Washington 10, D. C.

TEST INSTRUMENTS

(*Continued from page 83*)

siderable amount, your standards R1 and R2 are probably not sufficiently matched. If the readings differ by a small amount (not greater than 1%), reposition your pointer knob.

For example, suppose the readings are 1% and 1.5%, respectively. Evidently the correct reading is 1.25%, the median value. Loosen the pointer knob, relocate to read 1.25% both times.



J1—phono jack
J2—miniature phone jack
J3, 4, 5, 6—binding posts
Calibrated scale, see text
Pointer knob
R1, 2—5,000 ohms, 0.5%
R3—pot, 250 ohms, wire-wound
C—30 μμf, mica trimmer

The comparator's complete circuit.

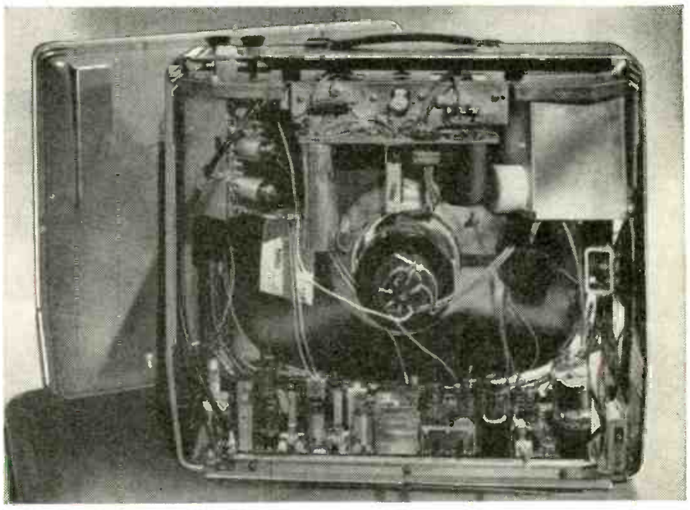
The next step is to adjust C. This is done with a matched pair connected to the X terminals and the bridge balanced for minimum tone. Vary C slowly until the sound is nearly gone. It should be possible to bring the output very close to actual null. If the sound cannot be brought down to minimum with C across terminals J3–J4, disconnect it and try across J5 and J6. It balances out the capacitance of the wiring.

When the resistance at X2 is larger than at X1, potentiometer R3 will balance to the *left* of zero and vice versa. This can be definitely determined by an actual measurement. Balance the comparator with a matched pair. Then add a small resistor (in series with one of the pair being tested) and note which side of balance the pointer must move. Thereafter you will always know which resistor is the *larger* of the pair, by noting whether balance occurs to the right or left of zero.

Without circuitry changes, this comparator may be used for capacitance. Keep leads to capacitors very short to maintain high accuracy. With a variable capacitor across one set of terminals, this instrument becomes a capacitance meter. Connect an unknown fixed capacitor across the other terminals, then adjust the variable for balance (with the pointer knob left at zero). Known fixed capacitors may be used to calibrate the variable in terms of μμf.

The calibrated scale is Croname No. 422 marked 5–0–5 units. Originally the word "gain" was also on it, but this was removed. The dial is calibrated over 300° so it requires a potentiometer that is also variable over the same angle. I use an industrial type, but the Mallory R250L will do just as well. This can be varied over 297°. It must, of course, be a linear type. END

1960 TV DESIGN TRENDS



Remove back of this Motorola receiver and every component is available.

Part I—Modern look in TV should mean fewer servicing problems and less technician exasperation

By **WAYNE LEMONS**

EVERY year the TV set designers rearrange, refine and change tube types in a never-ending search for perfection and advertising blurbs —1960 is no exception. A great deal of emphasis is placed on ease of service, and accessibility is better than ever before on most models. This is not true of all manufacturers, unfortunately, but is more or less true of the industry as a whole. Several manufacturers claim that from 90% to 98% of servicing may be performed by simply removing the back cover.

Even allowing for some overenthusiasm on the part of the builders, there is no doubt that the technician has been considered by most designers. In fact, we find this year that almost every manufacturer has turned his big selling guns toward the technician, hoping, of course, for a favorable recommendation to the potential customer. So let's take a look at some of the new circuits and mechanical features we'll be seeing in the coming year.

Picture tubes

The most dramatic change this year is the recently introduced "squarer" 23-inch picture tube whose faceplate is part of the tube itself. Advantages claimed for this tube are more brightness and contrast, less reflected light and of course more area. The only cleaning necessary is the exposed faceplate. No grime can collect on the picture tube proper.

Other developments include a tube built by Motorola claimed to have 10 times more cathode area and thus should have 10 times more cathode life. An internal focus "shield" developed by Philco and said to give better focus over the entire screen and be less affected by outside influences is also new.

Not all manufacturers are using 110° tubes. Some have reverted to 90° types to be able to use more high voltage. The 110° types have a greater tendency to develop internal arcing. One manufacturer uses an external spark gap to provide for this contingency. The spark gap discharges harmlessly the excessive voltages which might otherwise be detrimental to the internal elements of the tube.

Of course, the 2EP4 electrostatically focused and electromagnetically deflected picture tube used in the Philco transistor portable is a new arrival on the service scene.

(Recommended cleaning material for picture tubes and faceplates is still water only or a very mild soap if absolutely necessary. As always, use of strong glass cleansers may damage the faceplate.)

Single-rod antennas

As we look over the '60 line, we find that more manufacturers are going to the single rod, called "Unipole," "Power Tower" etc., as a built-in antenna for local reception. Aside from its obvious mechanical advantage over the "rabbit ear" types, it can often produce as good or better pictures. The disadvantage is that the single rod represents an unbalanced load to a tuner that by design is a balanced-input device. Most manufacturers use balun coils and work the rod antenna against some large metal surface such as the chassis or picture-tube mount. A schematic of such an arrangement as used in an Admiral 15D1B 17-inch portable is shown in Fig. 1.

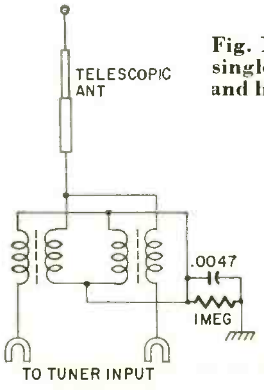
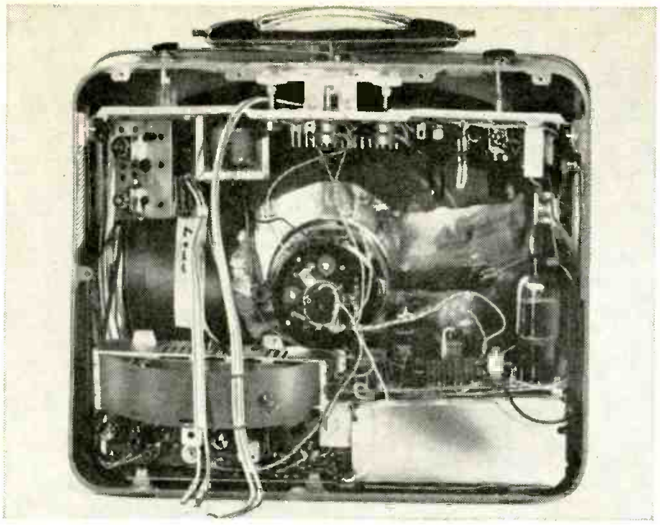


Fig. 1—Power-Tower single-rod antenna and balun coil-matching circuit.

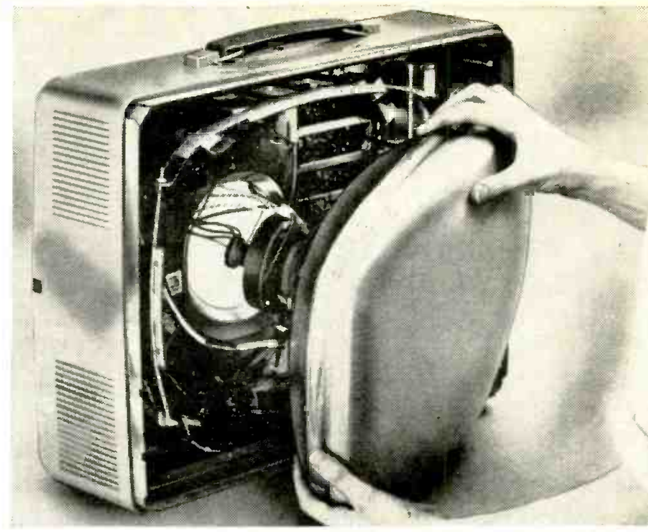
Printed boards

Although we service technicians have —in some quarters—been accused of apathy concerning the industry, we have certainly been far from indifferent to printed boards! The reaction has run from reluctant tolerance to downright disgust. When the National Alliance of Television Electronic Service Associations (NATESA) conducted a survey last year, a whopping 74% of the 2,500 technicians sent questionnaires responded. This compares with a response of roughly 10% to 25% on other matters.

Accessibility and difficulty of circuit tracing were considered the major problems by those polled. They also wanted more and better service information and single-sided (circuit on one side only) boards. This information and other recommendations of those polled were presented to the Institute of Printed Circuits by NATESA. That service people and their gripes were considered by the manufacturer is evidenced by the 1960 printed-board designs. (See the article on this subject on page 98 of this issue.)



With the back off, this Philco portable is easy to get at.



In the new RCA portable, picture tube can be easily removed from front of set.

Road Maps

"Road map" is the term being used by most manufacturers who use printed boards, to describe the 1960 concept of printed circuitry. An exact replica of wiring on the back side is printed on the exposed side of the board to facilitate circuit tracing. This lets the technician follow the circuit from component to component without the aid of a strong lamp behind the board. Most boards are laid out with coordinates indicated so that a particular part can be localized to a certain section of the board. "Towns" or key test points are spotted, sometimes with voltage readings stamped on. One manufacturer uses color coding to distinguish the different circuits.

Board Breakage

Board breakage or conductor separation was a major drawback of the early printed board. This problem seems to be just about a thing of the past. Admiral, to prove they believe in the durability of the printed board, guarantees it for 5 years. Sylvania has a dramatic demonstrator that continuously flexes the printed board while the set operates normally. This proves beyond doubt that the new boards are more rugged.

Conductor Lifting

This problem has also been licked, according to the manufacturers. New processes seal the wiring to the board. This means though that we'll have to use needle-sharp probes to pierce through the "seal" to the conductor when testing.

Hand-wired sets

They are still around and could be for some time to come. Neither Zenith nor Hoffman have printed boards, and there may be others. Zenith, according to all sales figures, had an outstanding year with "hand-crafted" sets. This, possibly, is due in part to recommendations by service people, and may account for the big "sell" this year of printed boards to technicians through association and other meetings. It's hard to dispute the fact that service technicians' recommendations have great influence on the set buyer. This is especially true of negative recommendations, such as, "*Don't* buy a set with a 360° tube," etc.

Hoffman's circuit might be a trend in itself. In addition to being completely hand-wired, it uses conventional circuitry throughout and has no semiconductor diodes or rectifiers. This an extremely unusual departure from what we've been used to seeing recently. It certainly has the advantage of time-honored circuits that are generally reliable and easy to troubleshoot.

Modules

In addition to printed boards, Motorola is using modules in some of its models. A module consists of a number of components formed into decks much like the printed-circuit Couplates that have been used for several years. The decks are then stacked to form an even more compact circuit unit. Riser wires act as supports and terminals for the units. The Motorola modules are unusual in that every component in the module may be tested individually because, even though many internal connections are made, an external connection is provided for each end of every component. This does not mean that we will always be able to substitute a given part, because we can't remove the defective one from the circuit. The schematics of the horizontal and vertical sweep modules as used in the Motorola TS-556 (Fig. 2) will illustrate this more fully.

Sound

Last year emphasis was placed on more and better sound, and the trend continues. Many sets have phono input plugs so the TV may be used as a part of a stereo setup. Multiple speakers are almost a rule rather than a rarity. The rarity is a push-pull amplifier. Most sets, even those having four or five speakers, are using single-ended amplifiers and some sort of series-parallel connection to the speakers. The Admiral 20H6 TV and 3S1 amplifier has an extra single-ended stage for stereo, using EL84/6BQ5 as output tubes in an inverse feedback circuit.

Although a few companies including G-E are still using ratio detectors, most companies have replaced this type with some form of gated-beam detector, a more economical circuit. Zenith, who began the trend to gated-beam detection some years ago, is still using the 'BN6 type tube. Most other companies are now using the 'DT6, which is said to give somewhat better detection under low-signal conditions. Philco is using a tube heretofore unused commercially to our knowledge in gated-beam detection,

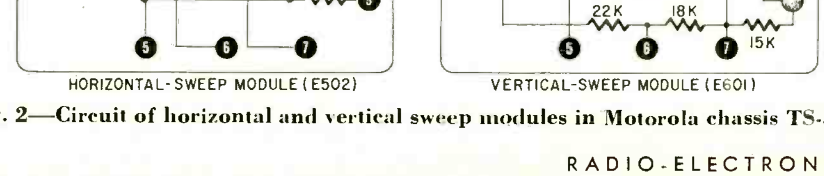
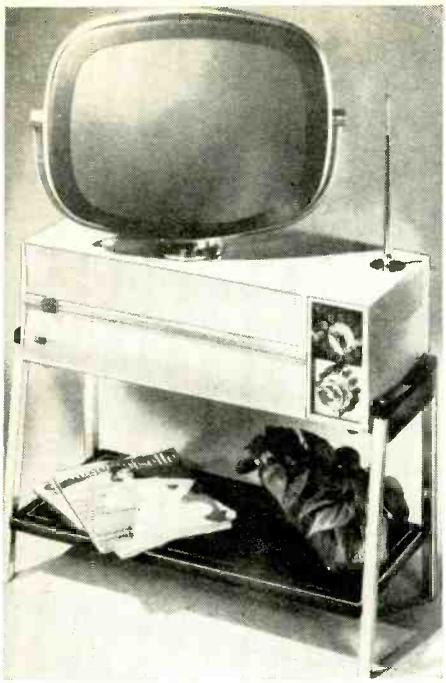


Fig. 2—Circuit of horizontal and vertical sweep modules in Motorola chassis TS-556.



Single-pole rod antenna comes with 1960 Philco Predicta model 3412GL.

the 6CS6 pentagrid. The circuit as used by Philco in the 10L60 chassis is shown in Fig. 3. The 6CS6 is similar to the 6BE6, but was especially designed for service as a pentagrid sync separator and noise canceller.

Surge protectors, thermistors

Many companies are using some form of surge protection to prevent damaging tubes during the warmup period. This is true even on power-transformer type sets.

Admiral is using a manual-reset type of thermal cutout on their nontransformer sets. A button must be pushed in before the set will operate after an overload.

Most companies who do not provide surge protection on transformer sets are using a fused power supply that will prevent damage to the expensive power transformer should a B-plus short occur. A good practice when a major service job is performed on a transformer set not having such protection is to insert a 3.5- to 5-amp fuse in series with the transformer primary. This may save the customer a burned-out power transformer in the future. Slow-blow fuses are best for this application as they tolerate short overloads.

We find thermistors in just about every 110° chassis this year, especially in the vertical deflection circuit. The thermistor is needed because the resistance of 110° yokes tends to increase with heat, causing a reduction in height after the set has been on for some time. In most circuits, the thermistor is a 3.8-ohm (cold) unit in series with the vertical yoke coils. As the yoke heats, the thermistor also heats. The thermistor's resistance decreases with heat, so the yoke heating effect is cancelled. Zenith 16D25 and 16D25Q chassis place a larger-value thermistor in series with the plate load of the vertical oscillator tube. It increases the drive as the yoke heats up to prevent the decrease in height.

Color

In addition to RCA and Magnavox, Admiral also is promoting a color set this year. This is not as great a trend as might appear, since both Magnavox and Admiral sets are built for them by RCA. There is little circuit change from the 1959 models. Service and convergence adjustments remain almost identical.

This gradual branching out to different companies may be the approach that will finally get color off the ground. It is evident that as large as RCA is and as much money as they have spent promoting color, sales have just not materialized. The positive negative attitude that many service technicians have taken against color has also been a strong sales deterrent.

Fine tuning

We find more of the "preset" type of fine tuning this year. This allows the customer or technician to set the fine tuning once for stations used. Manufacturers rely on the newer low-drift tuners to stay on frequency over long periods of time. Manual overall fine tuning is not used in as many models for 1960. Usually some simple method of presetting the fine tuning is provided in the form of an external knob or button. However, some must be set with a nonmetallic screwdriver after removing the channel-selector knob.

G-E has an oscillator centering adjustment on top of its vhf tuner to compensate for capacitance changes when changing the oscillator tube. It also aids in oscillator adjustment when power tuning is used, since this mechanism blocks access to the individual channel slugs.

So far we have gotten an overall impression of the 1960 sets. Next month we will go into a little more detail and discuss some interesting circuits, look at remote-control units and survey this year's new tubes. TO BE CONTINUED

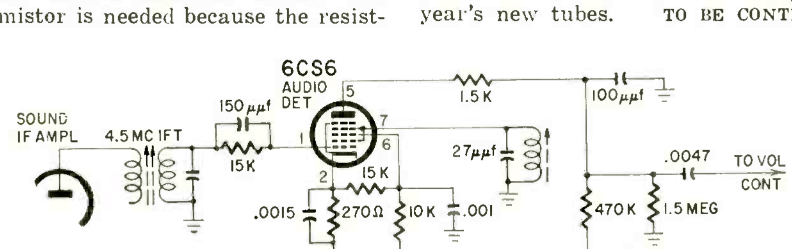


Fig. 3—FM sound detector circuit in the Philco 10L60 chassis.

SUPERIOR'S NEW MODEL 77

VACUUM TUBE VOLTMETER

WITH NEW 6" FULL-VIEW METER

Compare it to any peak-to-peak V. T. V. M. made by any other manufacturer at any price!

- Model 77 completely wired and calibrated with accessories (including probe, test leads and portable carrying case) sells for only $42.50.
- Model 77 employs a sensitive six inch meter. Extra large meter scale enables us to print all calibrations in large easy-to-read type.
- Model 77 uses new improved SICO printed circuitry.
- Model 77 employs a 12AU7 as D.C. amplifier and two 9006's as peak-to-peak voltage rectifiers to assure maximum stability.
- Model 77 uses a selenium-rectified power supply resulting in less heat and thus reducing possibility of damage or value changes of delicate components.
- Model 77 meter is virtually burn-out proof. The sensitive 400 microampere meter is isolated from the measuring circuit by a balanced push-pull ampl.fier.
- Model 77 uses selected 1% zero temperature coefficient resistors as multipliers. This assures unchanging accurate readings on all ranges.

AS A DC VOLTMETER: The Model 77 is indispensable in Hi-Fi Amplifier servicing and a must for Black and White and color TV Receiver servicing where circuit loading cannot be tolerated.

AS AN AC VOLTMETER: Measures RMS values if sine wave, and peak-to-peak value if complex wave. Pedestal voltages that determine the "black" level in TV receivers are easily read.

AS AN ELECTRONIC OHMMETER: Because of its wide range of measurement leaky capacitors show up glaringly. Because of its sensitivity and low loading, intermittents are easily found, isolated and repaired.

SPECIFICATIONS

• **DC VOLTS**—0 to 3/15/75/150/300/750/1,500 volts at 11 megohms input resistance. • **AC VOLTS (RMS)** —0 to 3/15/75/150/300/750/1,500 volts. • **AC VOLTS** (Peak to Peak) —0 to 8/40/200/400/800/2,000 volts. • **ELECTRONIC OHMMETER** —0 to 1,000 ohms/10,000 ohms/100,000 ohms/1 megohm/10 megohms/100 megohms/1,000 megohms. • **DECIBELS** —10 db to + 18 db, + 10 db to + 38 db, + 30 db to + 58 db. All based on 0 db = .006 watts (6 mw) into a 500 ohm line (1.73v). • **ZERO CENTER METER**—For discriminator alignment with full scale range of 0 to 1.5/7.5/37.5/75/150/375/750 volts at 11 megohms input resistance.

Model 77—VACUUM TUBE VOLTMETER . . . Total Price $42.50—Terms: $12.50 after 10 day trial, then $6.00 monthly for 5 months if satisfactory. Otherwise return, no explanation necessary!

Model 77 comes complete with operating instructions, probe and test leads. Use it on the bench—use it on calls. A streamlined carrying case, included at no extra charge, accommodates the tester, instruction book, probe and leads. Operates on 110-120 volt 60 cycle. Only..................

$42.50 NET

SUPERIOR'S NEW MODEL 80

20,000 OHMS PER VOLT ALLMETER

THE ONLY 20,000 OHMS PER VOLT V.O.M. SELLING FOR LESS THAN $50 WHICH PROVIDES ALL THE FOLLOWING FEATURES:

- **6 INCH FULL-VIEW METER** provides large easy-to-read calibrations. No squinting or guessing when you use Model 80.
- **MIRRORED SCALE** permits fine accurate measurements where fractional readings are important.
- **CAPACITY RANGES** permit you to accurately measure *all* condensers from .00025 MFD to 30 MFD in addition to the standard volt, current, resistance and decibel ranges.
- **HANDSOME SADDLE-STITCHED CARRYING CASE** included with Model 80 Allmeter at no extra charge enables you to use this fine instrument on outside calls as well as on the bench in your shop.

Model 80 — ALLMETER . . . Total Price $42.50—Terms: $12.50 after 10 day trial, then $6.00 monthly for 5 months if satisfactory. Otherwise return, no explanation necessary!

SPECIFICATIONS:

7 D.C. VOLTAGE RANGES:
(At a sensitivity of 20,000 Ohms per Volt)
0 to 15/75/150/300/750/1500/7500 Volts.

6 A.C. VOLTAGE RANGES:
(At a sensitivity of 5,000 Ohms per Volt)
0 to 15/75/150/300/750/1500 Volts.

3 RESISTANCE RANGES:
0 to 2,000/200,000 Ohms. 0-20 Megohms.

2 CAPACITY RANGES:
.00025 Mfd. to .3 Mfd., .05 Mfd. to 30 Mfd.

5 D.C. CURRENT RANGES:
0-75 Microamperes, 0 to 7.5/75/750 Milliamperes, 0 to 15 Amperes.

3 DECIBEL RANGES:
− 6 db to + 18 db   + 14 db to + 38 db   + 34 db to + 58 db

FEATURES:

• A built-in Isolation Transformer automatically isolates the Model 80 from the power line when capacity service is in use.

• Selected, 1% zero temperature coefficient metalized resistors are used as multipliers to assure *unchanging* accurate readings on all ranges.

Model 80 Allmeter comes complete with operating instructions, test leads and portable carrying case. Only...............

$42.50 NET

NOTE: The line cord is used only for capacity measurements. Resistance ranges operate on self-contained batteries.

SHIPPED ON APPROVAL
NO MONEY WITH ORDER—NO C.O.D.

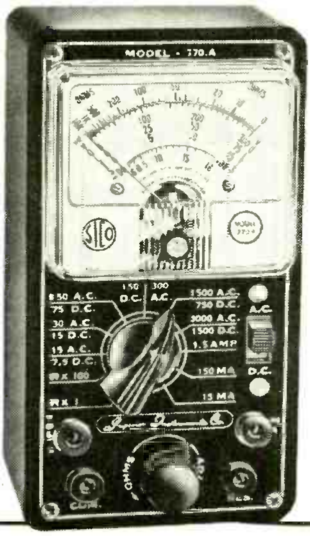
Try for 10 days before you buy! If completely satisfied, send down payment after trial and pay balance at indicated monthly rate — NO INTEREST OR FINANCE CHARGES ADDED. If not completely satisfied, return to us, no explanation necessary.

SEE PAGE 95 FOR COMPLETE DETAILS

MOSS ELECTRONIC, INC.   3849 TENTH AVE., NEW YORK 34, N. Y.

SUPERIOR'S NEW MODEL 770-A **The FIRST Pocket-Sized**

VOLT-OHM MILLIAMMETER



USING THE NEW "FULL-VIEW" METER

71% MORE SCALE AREA!!

Yes, although our new FULL-VIEW D'Arsonval type meter occupies exactly the same space used by the older standard 2½" Meters, it provides 71% more scale area. As a result, all calibrations are printed in large easy-to-read type and for the first time it is now possible to obtain *measurements instead of approximations* on a popular priced pocket-sized V.O.M.

FEATURES:

- ★ Compact—measures 3⅛" x 5⅞" x 2¼"
- ★ Uses "Full View" 2% accurate 850 Microampere D'Arsonval type meter
- ★ Housed in round-cornered, molded case
- ★ Beautiful black etched panel. Depressed letters filled with permanent white, insures long-life even with constant use.

SPECIFICATIONS:

6 A.C. VOLTAGE RANGES: 0-15/30/150/300/1500/3000 Volts. **6 D.C. VOLTAGE RANGES:** 0-7.5/15/75/150/750/1500 Volts. **2 RESISTANCE RANGES:** 0-10,000 Ohms, 0-1 Megohm. **3 D.C. CURRENT RANGES:** 0-15/150 Ma., 0-1.5 Amps. **3 DECIBEL RANGES:** — 6 db to + 18 db, +14 db to +38 db, +34 db to +58 db.

Model 770-A VOLT OHM MILLIAMMETER . . . **Total Price $15.85—Terms:** $3.85 after 10 day trial, then $4.00 per month for 3 months if satisfactory. Otherwise return, no explanation necessary!

The Model 770-A comes complete with self-contained batteries, test leads and all operating instructions.

$15.85 NET

SUPERIOR'S NEW MODEL 79 **SUPER-METER** — **WITH NEW 6" FULL-VIEW METER**

A Combination VOLT-OHM MILLIAMMETER.

Plus CAPACITY, REACTANCE, INDUCTANCE AND DECIBEL MEASUREMENTS.

Also Tests SELENIUM AND SILICON RECTIFIERS, SILICON AND GERMANIUM DIODES.

The Model 79 represents 20 years of continuous experience in the design and production of SUPER-METERS, an exclusive SICO development.

In 1938 Superior Instruments Co. designed its first SUPER-METER, Model 1150. In 1940 it followed with Model 1250 and in succeeding years with others including Models 670 and 670-A. All were basically V.O.M.'s with extra services provided to meet changing requirements.

Now, Model 79, the latest SUPER-METER includes not only every circuit improvement perfected in 20 years of specialization, but in addition includes those services which are "musts" for properly servicing the ever increasing number of new components used in all phases of today's electronic production. For example with the Model 79 SUPER-METER you can measure the quality of selenium and silicon rectifiers and all types of diodes—components which have come into common use only within the past five years, and because this latest SUPER-METER necessarily required extra meter scale, SICO used its new full-view 6-inch meter.

Specifications

D.C. VOLTS: 0 to 7.5/15/75/150/750/1,500.
A.C. VOLTS: 0 to 15/30/150/300/1,500/3,000.
D.C. CURRENT: 0 to 1.5/15/150 Ma. 0 to 1.5/15 Amperes.
RESISTANCE: 0 to 1,000/100,000 Ohms. 0 to 10 Megohms.
CAPACITY: .001 to 1 Mfd. 1 to 50 Mfd.
REACTANCE: 50 to 2,500 Ohms, 2,500 Ohms to 2.5 Megohms.
INDUCTANCE: .15 to 7 Henries, 7 to 7,000 Henries.
DECIBELS: —6 to +18, +14 to +38, +34 to +58.

The following components are all tested for QUALITY at appropriate test potentials. Two separate BAD-GOOD scales on the meter are used for direct readings.

All Electrolytic Condensers from 1 MFD to 1000 MFD.
All Selenium Rectifiers. **All Germanium Diodes.**
All Silicon Rectifiers. **All Silicon Diodes.**

Model 79 — SUPER-METER . . . Total Price $38.50 — Terms: $8.50 after 10 day trial, then $6.00 per month for 5 months if satisfactory. Otherwise return, no explanation necessary!

Model 79 comes complete with operating instructions and test leads. Use it on the bench—use it on calls. A streamlined carrying case included at no extra charge accommodates the tester, instruction book and test leads.......Only

$38.50 NET

SHIPPED ON APPROVAL
NO MONEY WITH ORDER—NO C.O.D.

Try for 10 days before you buy! If completely satisfied, send down payment after trial and pay balance at indicated monthly rate — NO INTEREST OR FINANCE CHARGES ADDED. If not completely satisfied, return to us, no explanation necessary.

SEE PAGE 95 FOR COMPLETE DETAILS

MOSS ELECTRONIC, INC. **3849 TENTH AVE., NEW YORK 34, N. Y.**

SUPERIOR'S NEW MODEL 82A

Multi-Socket Type TUBE TESTER

TEST ANY TUBE IN 10 SECONDS FLAT!

Model 82A—Tube Tester. Total Price $36.50
Terms: $6.50 after 10 day trial, then $6.00 monthly for 5 months if satisfactory. Otherwise return, no explanation necessary.

1. Turn the filament selector switch to position specified.
2. Insert tube into a numbered socket as designated on our chart (over 600 types included).
3. Press down the quality button —

THAT'S ALL! *Read emission quality direct on bad-good meter scale.*

Production of this Model was delayed a full year pending careful study by Superior's engineering staff of this new method of testing tubes. Don't let the low price mislead you! We claim Model 82A will outperform similar looking units which sell for much more — and as proof, we offer to ship it on our examine before you buy policy.

Primarily, the difference between the conventional tube tester and the multi-socket type is that in the latter, the use of an added number of specific sockets (for example, in Model 82A the noval is duplicated eight times) permits elimination of element switches thus reducing testing time and possibility of incorrect switch readings.

To test any tube, you simply insert it into a numbered socket as designated, turn the filament switch and press down the quality switch—THAT'S ALL! Read quality on meter. Inter-element leakage, if any, indicates automatically.

....FEATURES....

- Tests over 600 tube types.
- Tests OZ4 and other gas-filled tubes.
- Employs new 4" meter with sealed air-damping chamber resulting in accurate vibrationless readings.
- Use of 22 sockets permits testing all popular tube types and prevents possible obsolescence.
- Dual Scale meter permits testing of low current tubes.
- 7 and 9 pin straighteners mounted on panel.
- All sections of multi-element tubes tested simultaneously.
- Ultra-sensitive leakage test circuit will indicate leakage up to 5 megohms.

Model 82A comes housed in handsome, portable Saddle-Stitched Texon case. Only........ **$36.50 NET**

SUPERIOR'S NEW MODEL TW-11

STANDARD PROFESSIONAL TUBE TESTER

Model TW-11—TUBE TESTER . . . Total Price $47.50—Terms: $11.50 after 10 day trial, then $6.00 per month for 6 months if satisfactory. Otherwise return, no explanation necessary!

★ Tests all tubes, including 4, 5, 6, 7, Octal, Lock-in, Hearing Aid, Thyratron, Miniatures, Sub-miniatures, Novals, Sub-minars, Proximity fuse types, etc.

★ Uses the new self-cleaning Lever Action Switches for individual element testing. Because all elements are numbered according to pin-number in the RMA base numbering system, the user can instantly identify which element is under test. Tubes having tapped filaments and tubes with filaments terminating in more than one pin are truly tested with the Model TW-11 as any of the pins may be placed in the neutral position when necessary.

★ The Model TW-11 does not use any combination type sockets. Instead individual sockets are used for each type of tube. Thus it is impossible to damage a tube by inserting it in the wrong socket.

★ Free-moving built-in roll chart provides complete data for all tubes. All tube listings printed in large easy-to-read type.

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

EXTRAORDINARY FEATURE

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

The Model TW-11 operates on 105-130 Volt 60 Cycles. Comes housed in a handsome, portable Saddle Stitched Texon case. Only........ **$47.50 NET**

SHIPPED ON APPROVAL
NO MONEY WITH ORDER—NO C.O.D.

Try for 10 days before you buy! If completely satisfied, send down payment after trial and pay balance at indicated monthly rate — NO INTEREST OR FINANCE CHARGES ADDED. If not completely satisfied, return to us, no explanation necessary.

SEE FOLLOWING PAGE FOR COMPLETE DETAILS

MOSS ELECTRONIC, INC. 3849 TENTH AVE., NEW YORK 34, N. Y.

fm tv dx

By ROBERT B. COOPER, Jr.

THE summer of 1959 will go down in the record books as a very unusual one indeed. In certain areas of the country, E skip was more prevalent and occurred more often and lasted longer than in any year to recent memory. David Beal of Tucson made a 21-inch RCA and a 5-foot conical bring him 255 skip loggings on 23 days during June! Dxer Beal also logged a pair of new Mexican stations. XHNL is a new one on channel 2 in Monterrey. This station has been reported on channel 10 in the past, and has been heard on channel 2 on one occasion in California. Heard, we say, because to date no dxer has been able to frame a video signal to go with the XHNL sound. Another new station in Mexico is the channel 6 satellite operating in the area south of Mexico City, repeating XEW, channel 2, which originates in Mexico City.

El Salvador

Donald Ruland, dxing from Holly Hill, Fla., early on the evening of June 17 found YSU, channel 4, San Salvador, El Salvador, coming through with an excellent signal. Dxer Ruland also logged signals from the Dominican Republic (HIT-4), Puerto Rico (WKAQ, WAPA, WORA) and many Cubans during the summer months.

Strong Es and short Es

As a general rule of thumb, when E skip shortens down to 600 miles or less, it is a sign of a very dense and extremely strong opening. Walter Owen Jr. snagged WSYR, 3, Syracuse, N. Y., over a short 400-mile skip path on June 11. At the same time he was logging WSYR, an amateur in Massachusetts was logging 144-mc signals from a ham in Illinois. Until Owen's TV dx report of short 400-mile skip on channel 3 showed up, scientists were not sure how the vhf 144-mc signal got from Illinois to Massachusetts. *Now* they are fairly certain it was a rare form of E skip.

Rod Luoma, our uhf dx-pert from Detroit, Mich., reports engineers at WJBK, where he works, were surprised to log KOOK, Billings, Mont., on their *monitor in the station*, following the signoff of WJBK at 2 am on June 19.

Trops this summer

The usual good summertime extended-ground-wave conditions were with us during the entire warm weather season, but not nearly as widespread as in past summers. Bill Eckberg, Walnut, Ill., pulled an *oddy* on June 16 when he snagged a signal on ground wave from WKY, 4, Oklahoma City—612 miles, and then on the 17th he saw WKY again—this time on E skip!

On the Atlantic seaboard, Ronald Boyd, dxing from Truro, Nova Scotia, Canada, found conditions up and down the coast very hot for ground wave July 18–19 and 30–31.

Foreign Dxers

Alp A. Barlas of Bagdad, Iraq, sends us three photos taken on his receiver of Italian, Czech and Rumanian test patterns—all seen on European channel 3 within a matter of hours. This via sporadic E over distances up to 1,400 miles! Barlas's antenna is a three-element job some 140 feet above ground!

Otto Morroy dxes from Paramaribo, Surinam, on the northern coast of South America. His first television reception with a Philips receiver (built in Holland) was of the BBC from England last spring. Since that time Morroy has been using a revamped RCA and has found reception from Caracas, Venezuela (940 miles) and Puerto Rico (1240 miles) amazingly frequent. The Dominican Republic has been logged as well as the three stations from Venezuela (channels 2, 4 and 6) and Puerto Rico (2, 4, 5 and 6).

FM dx—E skip mostly

Several FM dx enthusiasts got their feet wet during the summer dxing season, and not a few heard their first E skip on the FM band. Bill Finn, Milwaukee, Wis., made his FM set really go to work on June 11 with 12 FM skippers heard in a 1-hour period. Finn's FM total—101 stations. The most experienced FM Dxer known to this writer, Bruce Elving, Duluth, Minn., heard E skip from New England, including WKBR-FM, Manchester, N. H., his 33rd state on FM on July 23. July 25 was a ground-wave day with four new hauls in the 400-mile range. S/Sgt. Donald Lee, stationed at Homestead AFB, Florida, logged stations in Texas and Ohio on skip.

From the FM dx reports of Wayne Baer, Meyersdale, Pa., and D. G. Bennie, Kinston, N. C., it appears there were probably at least 12 days for dxers in the area east of the Rocky Mountains during which FM E-skip reception was possible.

Predictions

E Skip: Reception in the 700–1,500-mile range dwindles considerably dur-

Meteor Showers		
Date	Max. Burst Rate	Best Direction
Nov. 22–30	1600–2000	NW–SE
	2300–0300	SW–NE
Dec. 10–14	0030	N–S
	0300	NW–SE
	2130–2300	SW–NE
	0500–0630	SW–NE

ing the months of November–December, although dxers can begin to look for E skip with more frequency after Dec. 10, with 95% of wintertime E-skip openings occurring between 4 and 8 p.m. Dxers in the southern USA will find skip more frequent than their northern cousins.

Trops: Wintertime ground-wave reception is poor at best. Fringe areas have pulled in from 100 to 150 miles in most dxing locations. What dx occurs will be over bodies of water (such as the Great Lakes, Gulf of Mexico) and then only for distances of 200–300 miles.

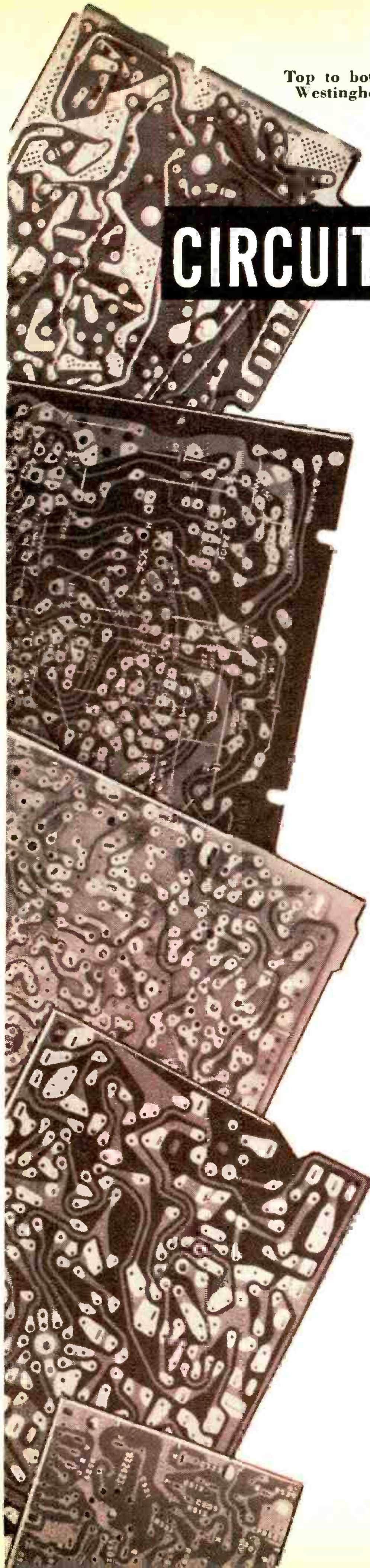
F2 Skip: The reason for watching BBC and other European television is now upon us, and it promises to be about the last such year for another six. Those dxers with converters for the European channels know the best hours are the mornings from 7 am LST to 12 noon. F2 dx will die down in intensity after the first week of December, but promises to pop back in for a 3-week run after the first of the year.

TURRET TROUBLE

Two drops of oil cost a customer of mine $6. The other day this customer phoned at 9:30 at night and told me to come over to his house and fix his TV set. He said he couldn't turn the station selector switch on his Philco, model 1475, farther than to the next channel and back again.

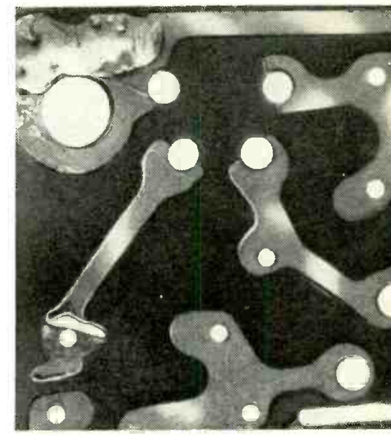
On the phone I advised him to check all rf and oscillator coils and to see that they were in place. But he wanted no part of that job. I had thought that one of the coils had worked itself loose jamming up the turret. I had wanted my customer to fix his set because I did not want to leave my shop at that late hour. Well, I went to his house.

After removing the chassis and examining the front end with the aid of my portable light (socket with clamp attached and 40-watt bulb) and magnifying lens (I find this handy when checking the fine brass springs to which are attached contact points) I found nothing broken or out of place. Therefore I could only assume that the shaft of the turret was jammed. I applied two drops of machine oil and that did the trick! Of course, I believe a customer is entitled to a little extra service like dusting the high-voltage department plus whatever adjustments are necessary that will make for a better picture. He was well satisfied.—*Edgar Reynolds*



Top to bottom: Motorola, Westinghouse, Emerson, Philco, RCA.

COVER FEATURE



Solder in left top corner was applied with 250-watt gun, using plenty of time. Conductor at lower left was lifted only with considerable difficulty.

CIRCUIT BOARDS ARE GETTING BETTER

By ERIC LESLIE

REPRESENTATIVES of a state federation of service technicians remarked last spring, after a conference with manufacturers: "Printed circuits are likely to be with us for some time, and we may have to learn to live with them." Fortunately, the very articulate reaction of the service field to certain features of these new components has made manufacturers examine their products from the points of view of serviceability, excellence of construction and reliability. Practically every 1960 TV set board has new features designed to make servicing quicker and easier. The four boards on this month's cover are by no means the only examples of such improvement.

The Motorola board used in their 17P6 portable is possibly the most interesting of the group on the cover (in the foreground). It is the only one of the four that has conductors on both sides. This has the advantage of permitting crossovers, thus making for straighter and simpler "wiring" patterns. The obvious disadvantage—difficulty in following circuit lines—is negated by using black lines to indicate conductors on the opposite side of the board. All conductors are color-coded to indicate their functions. A green line is immediately recognized as a grid circuit, for example, and a green line with red dots is a plate circuit. The type number of each tube is printed on the board and pin 1 indicated.

All leads to other parts of the receiver are terminated in a row of contacts along one edge of the board. The whole board can then be clipped into a strip near the front of the receiver, making all contacts almost instantaneously. With the help of a special extension harness (or less conveniently, by disconnecting the strip, which has leads long enough to clear the chassis) the board can be connected into the circuit while standing up behind the set for more convenience in servicing.

Philco approach

The Philco board, which appears just behind the Motorola on the cover, supplies a great deal of information to the technician. Tube type numbers and functions (6CG7, HOR OSC, 6DR7, VERT OUT) are both given, test points are indicated, and the lances that act as terminals and test points carry indications like "VERT HOLD, B + 275, 2 AUDIO." Conductors are all on one side of the panel, and the underchassis pattern is reproduced in a distinctive pale blue on the component side.

Security-sealed circuitry

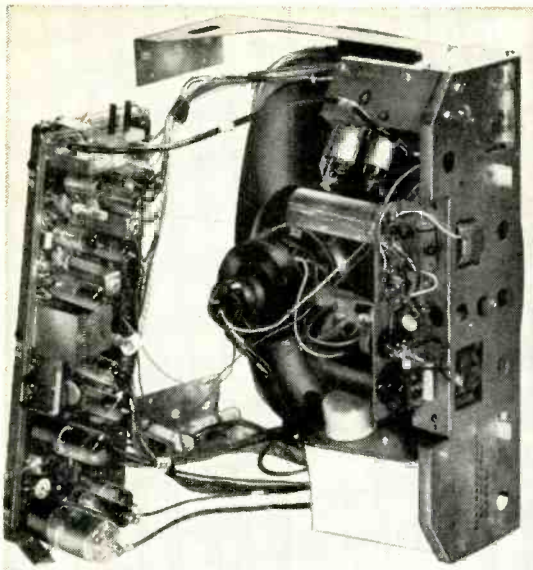
RCA refers to its board (third from front on the cover) as "road-mapped." All conductors are on one side of the board, and an exact replica of the wiring is carried on the other side in a white-dot pattern, as are all tube and component codes.

The road-map feature is a system of locating components. The diagrammatic views of the board in the service data are divided into a grid by a series of letters on the sides and numbers on top and bottom. Thus a component whose coordinates are, for example, A5, can be located immediately.

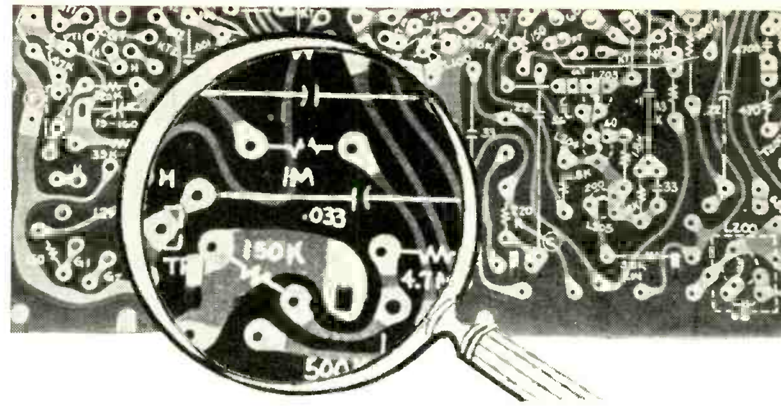
Terminals where leads leave the board are lettered, the same letters appearing at corresponding points on the schematic. Some of the earlier boards also had jumper wires between certain conductors. These were identified with double letters, one of which was J. Thus MJ on one part of the board is connected to MJ on another. The "security-sealing" refers to a coating of wax over the conductors, and to the firmness with which they are secured to the board.

Emerson board

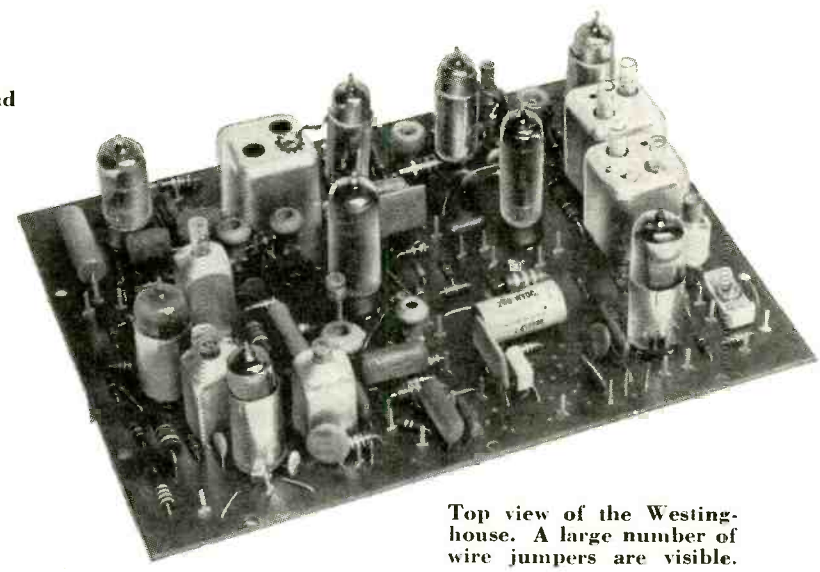
Some of the features of this board



Motorola board functions while standing behind chassis for servicing.



Magnified portion of a Westinghouse printed circuit board.



Top view of the Westinghouse. A large number of wire jumpers are visible.

(shown at rear) seem intended to help the assembler as well as the service technician. Component and tube codes are given, and the codes so printed as to indicate the mounting holes for the components. If resistors or capacitors are long, lines are drawn from the lettering to the mounting holes. Outlines of some parts, such as coils or capacitors standing on end, are also drawn on the board. Some triangles, and circles, which looked rather important at first, are for use in assembly. While inquiring about these, it was brought out that new boards in the design stage at Emerson will carry a great deal more information, including voltages.

This board is the only one that does not have the conductor pattern printed on the side of the board that has the component information. It is very translucent and obviously depends on the technique of using a light on the other side of the board to trace circuits.

A functioning schematic

The Westinghouse See-Matic board (not shown on the cover) has a number of interesting features. The component side of the board is absolutely blank—all lettering is on the conductor side. Since the conductors are right in sight, no circuit lines are necessary, and instead component symbols are drawn to show their position on the other side, with lines connecting to the proper conductors (see photo). The values of resistors and capacitors—rather than codes—are printed next to the symbols, together with pin type numbers and pin identification (G, P, K, etc.). Some components, such as coils and transformers, are identified by the component code near their symbols, and straight lines represent wire jumpers on the other side of the board. Test points are indicated by circled letters.

The result is that each Westinghouse board is its own built-in schematic, and in many cases the technician can repair it without any additional service data.

Some very useful features appear on the boards of other manufacturers not represented on the cover. In the G-E board, for example, ground-circuit conductors are indicated by the familiar triangular chassis symbol. Component codes and schematic symbols are both shown, and even the tubes are drawn in schematic style. Asterisked numbers refer to terminals at which leads go to components off the boards, and are of course duplicated on the schematic.

Other features

The boards inspected showed a strong tendency to group components for simpler mounting. Numbers of Centralab Couplates, Erie Pacs and similar combinations were found. Boards are in most cases more rugged than earlier ones, and the conductors can be soldered with little danger of peeling them from their support. Even after a 250-watt Weller gun was held on one small conductor for a full 2 minutes, it could be loosened only with difficulty. Large amounts of solder were flowed onto other conductors with no loosening effect on the foil.

Some of the boards have a wax layer over the conductors. It can be soldered through without difficulty. Practically all this year's boards have a solder-resist over all parts of the conductors except the portions where solder is desired. Thus solder is found only at points instead of covering the whole surface of the conductors.

One aid not supplied by a set manufacturer is the Circuitrace feature of Sam's PhotoFacts. Important points on the conductor side of the board are pointed out with arrows terminating in black squares with white numbers. The same black squares and white numbers appear at corresponding points on the schematic, making it possible to locate up to 40 test points on some boards. A somewhat similar service is performed in the manufacturers' data on "road-mapped" sets, like the RCA, G-E and Emerson. Tables of important components with their coordinates are printed, enabling the technician to locate them rapidly.

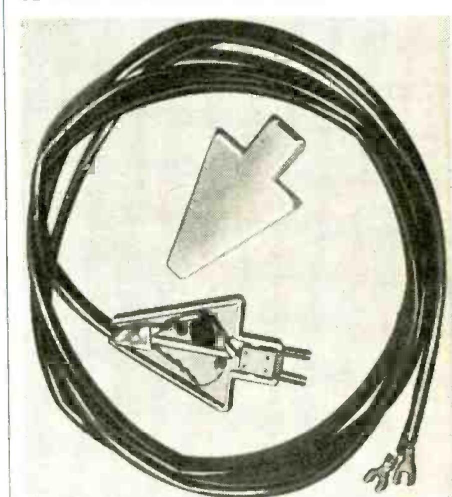
Another aid is RCA's 24-page booklet *Printed Circuit Servicing Techniques*. It describes general techniques, as well as the special features of a number of circuit boards, both of RCA and other manufacturers, and including both TV and radio circuitry. END

TELEVISION

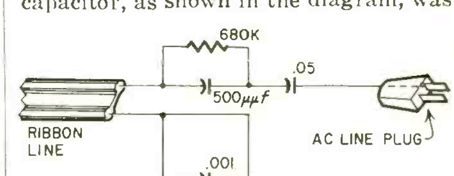
FIVE FEET OF WIRE— ONLY $4.95!

DAILY newspapers recently carried large advertisements for "Socke-t-enna" proclaiming, "Now you can throw away your old-fashioned rabbit-ear antenna and grace the top of your TV with decorative flowers . . . eliminate that unattractive roof antenna . . . this revolutionary electronic antenna turns all the wiring in your home into one giant antenna, bringing in ultra-sharp reception from all directions . . ."

RADIO-ELECTRONICS purchased one for $4.95 from a major department store and checked it out. Our tests showed that replacing an outdoor antenna with this unit would be extremely unwise. It provided far worse reception than either a V antenna just outside a window or a standard roof-top antenna. It was even noticeably less efficient than a few feet of wire thrown on the floor.



The circuitry in the oversize plug of Socke-t-enna appears to be good for safety—isolating the antenna circuit of the TV set from the ac power line—but has no other apparent utility. One capacitor, as shown in the diagram, was



shorted to itself and appeared to have no function beyond holding the wire in place! Since the cable had two parallel wires, most of the potential pickup on one wire was probably being cancelled out by pickup on the other one. A single wire would no doubt have been more effective.

The maker used a specially molded oversize plug to hold the simple isolating network and useless capacitor. He used such heavy lead-in wire that the spade lugs for the set hookup kept breaking off. Possibly he wanted to give purchasers the illusion they were buying something substantial to make up for the fact that Socke-t-enna actually gives them poorer reception.

Regular readers may recall that in earlier days of television, when numerous "midget wonder" antennas were advertised and sold, RADIO-ELECTRONICS tested some of them (page 8, May, 1954). At that time we found that ". . . these miracle antennas should work much like simple pieces of wire of similar dimensions." At least one of these has reappeared, apparently encouraged by the commercial success of more recent arrivals.

Other antennas that plug into the electric light socket are appearing. A supposedly "radar" type, with a short dipole as well as the socket connection, was also tested. It acted about as well as an indoor dipole of the same dimensions, and gave reasonably good pictures, though no difference was noted on inserting and removing the line plug or reversing it in the socket. An "improved" version, without the dipole, is rumored. If it appears, it may be expected to operate more like the Socke-t-enna. END

Customers Are Funny

EVERY so often, a drab day is brightened unexpectedly by a customer we could associate only with aggravation.

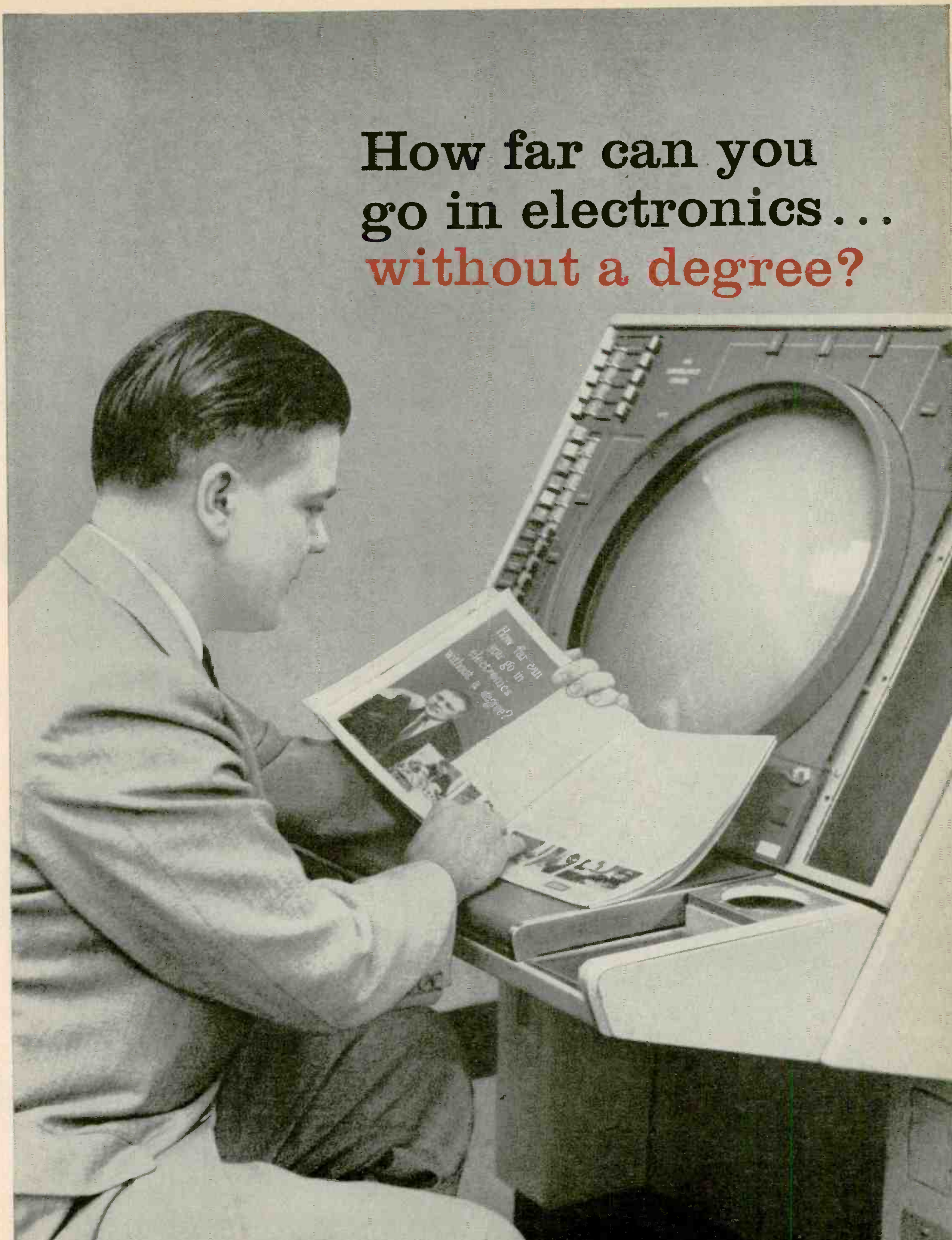
Two of us drove up to a lady's house one morning a few days ago. We planned to check the performance of her set while a test pattern sponsored by a distributor was being broadcast. Little did we realize that a half-hour later we would have liked to roar with laughter; the customer's past record of nuisance calls and nagging had conditioned us to expect the worst. That was the reason for two of us going on the call.

However electronically ignorant, despite the fancy home, she was as usual breathing down our necks as we made minor adjustments. As is customary, volume was turned all the way down, since we were not the least interested in 400-cycle audio.

I remarked that I'd take a look at the antenna and left the livingroom. Just as I kicked the tower, I noticed through the window that the test pattern was replaced with the distributor's commercial, picturing a stacked Lazy-X, identical to the one we had installed here. Upon my return, a minute or so later, the Indian head reappeared on the screen. As usual, there was nothing wrong with either set or antenna. But, suddenly, the lady was content. As we left, she blurted: "Hm! that's funny, I never knew you guys were using the TV to look at the aerial. A lot safer than climbing the tower, isn't it?!"

Fortunately, our ear-to-ear grins did not arouse any suspicions.

Ever since that day, she has been a model customer, convinced that our shop is tops!—*Paul Boller*


How far can you
go in electronics...
without a degree?

At the SAGE display console, Dick Brani reads 1957 magazine story about his IBM career.

Dick Brani (right) discusses the new SAGE "memory" with a field engineer.

Two years ago, when Richard F. Brani was first asked to review his field engineering progress at IBM, he'd been recently promoted to computer instructor. Now, he has a new and more crucial responsibility: Group Manager of 20 field engineers who keep a SAGE computer operating at its peak, bulwarking America's air defenses. Here's his story.

GIVEN IMPORTANT ASSIGNMENT. "In my first four years with IBM, my field engineering career has taken several giant steps forward—despite my lack of a college degree," reports Dick Brani. "When I joined the Company, my special training consisted of graduation from a technical school, an F.C.C. license, and some Army engineering training. Now, I have a responsible management job in the SAGE Project, my knowledge of electronics has grown tremendously, and my future looks as promising as I could wish it.

"How did I make this progress? IBM believes that—after comprehensive training—technicians like me can handle assignments generally performed by graduate engineers. And IBM has been proved right. Hundreds of technicians are now functioning successfully as IBM field engineers."

20 WEEKS' COMPUTER TRAINING. Dick Brani joined IBM in the fall of 1955. He was immediately enrolled in a 20 weeks' computer units training program. "You learn how the different units of large-scale computers like SAGE operate . . . how the computer itself can help diagnose and locate trouble . . . and how to make fast, precise repairs," he says. "Once assigned to a SAGE Site, field engineers may also attend classes—during regular working hours, by the way—to keep up with advanced developments in electronics. Our site, for example, recently had a course on the new, increased-capacity SAGE 'memory'."

ADVANCES RAPIDLY IN FOUR YEARS. "I know of few other companies that offer technicians better or more valuable training than IBM," Dick Brani says. "This training can prove an 'open sesame' to engineering and management opportunities not usually available to men lacking college degrees."

After his training, Dick Brani's abilities won him a position as instructor in IBM's education program. For two years, he taught courses in computer units and systems. Then, a little over a year ago, he was promoted to Group Manager of 20 field engineers assigned to install—and maintain—a SAGE computer at a new site. "I'm responsible for the successful operation of the computer. I have to check out repairs my men do, schedule maintenance activities and supervise all new engineering changes."

Introducing a new field engineer to SAGE operations.

WHAT IS SAGE? SAGE is a vital part of America's air defense system. At the core of the SAGE system is a network of fast, extremely reliable electronic computers. In each sector of our nation, a SAGE computer is constantly in operation, 24 hours a day, helping the Air Force prevent surprise aerial attacks. Here's how SAGE works: The computer receives radar data from many observation points. It checks this information against known air traffic for the sector and presents to the Air Force a pictorial display of the air situation. If need be, the computer can guide a BOMARC missile to a target for certain interception.

COUNSELING TO DEVELOP STRONG LEADERS. "My most challenging duty as a SAGE Group Manager? Helping the men in my group advance and develop," replies Dick Brani. "One way I do this is by periodically rotating my men so that they become familiar with all phases of large-scale computer operation. But the most effective way is through counseling—just sitting down with a man and discussing his progress, his prospects, his career goals. IBM encourages frequent and intensive counseling. By this method the Company finds and develops the strong leaders it needs to stay at the head of its field."

SAGE PROGRAM STILL GROWING. "My future? I can advance to still more important responsibilities in SAGE field engineering," says Dick Brani. "SAGE has grown tremendously since its inception a few years ago, and it's still growing rapidly. Or, I can move into major spots in education, personnel, management, development engineering—or nearly any activity you can name. My future at IBM is limited only by my ability as an individual."

* * *

If you have a minimum of 3 years' technical schooling after high school—or equivalent experience—you may be eligible for 20 weeks' training as a computer units field engineer. While training, you receive full pay plus living allowance. Your starting salary will be determined by the extent of your education and experience.

WRITE TODAY TO: **Mr. N. H. Heyer, Dept. 649L**
Military Products Division
IBM Corporation
Kingston, N.Y.

You'll receive a prompt reply. Personal interviews arranged in all areas of the United States.

IBM®

INTERNATIONAL BUSINESS MACHINES CORPORATION

TELEVISION

TOUGH-DOG DEPT.

Case No. 285,948,652,904: Here's a clue to the occasional TV set which burns out tubes at a disastrous rate

By **H. A. HIGHSTONE**

WEDNESDAY, 9:47 a.m. It was cold outside but the customer coming in with the Stewart-Warner 17-incher was hot, capital H. His box had gone dead again—fourth time in two weeks. In the shop it would sit sullenly on the bench, playing hour after hour without batting an eye. But, after a day or so back in the customer's house—out would go the 1-amp line fuse.

The customer's line voltage had been triple-checked. He vowed he'd never noted lamps burning overbright. If anything, he said, they sometimes burned a bit on the dim side. Even so, after this fourth visit, I asked the power company to hang a recording voltmeter on his house for 24 hours.

The power company's troubleshooter never got that far. Instead, he fixed the TV set for me, so to speak. Dropping into the shop afterward, he showed me how it's done. Refer first to Fig. 1, which shows the elementary layout for electric-power distribution. T is the familiar power transformer hung atop a pole in the street. Secondary voltage is 240. A center tap divides the winding into two 120-volt sources which supply lamps, TV sets, etc. in the house. Any conductor or wire connected to this center tap is called a neutral.

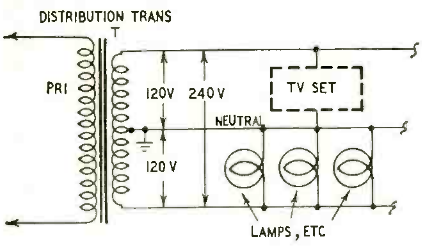


Fig. 1—Basic home-wiring circuit.

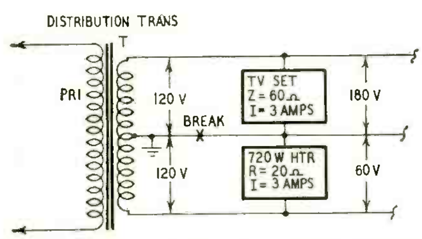


Fig. 2—Neutral line has been broken and 180 volts is applied to the TV set.

As long as the neutral remains intact, the power transformer behaves exactly like two isolated 120-volt sources. However, any time the neutral is broken, things really start happening.

In Fig. 2 the neutral has been broken at X. To simplify things, assume that the only devices connected at the moment are a TV set and an electric heater. Now we come to the big payoff. With the neutral broken, these two devices are automatically hooked *in series across 240 volts*. The arithmetic is painfully obvious—voltage supplied the TV set instantly rises to 180! (The small liberty of assuming that the hot and cold resistances of the heater are identical is taken.)

High resistance

Broken neutrals are rare. However, *high-resistance* neutrals are not uncommon. (It was a high-resistance neutral which had been clobbering our Stewart-Warner.) When appreciable resistance develops, it almost invariably does so in what is called the neutral bar of the main disconnect switch. Disconnect switches exposed to the weather are especially apt to develop this sort of trouble.

The neutral bar (see Fig. 3) is a solid piece of copper or brass to which are attached, with screw terminals, (A) the neutral conductor coming from the power transformer, (B) the neutral ground conductor for the residence, and (C) the neutral conductor leading into the house.

In this Stewart-Warner case, connection A (Fig. 3) had become so loose as to be practically open. This did not result in an open neutral, however. Current in the neutral took the alternate route through the ground conductor attached to B, then through the earth to the ground connection, *always* provided for power-transformer center taps.

Resistance of the earth between residence and power transformer ground may be considerable. Thus the neutral is not actually opened if A becomes disconnected but, on the other hand, it may be only half-closed. In Fig. 2 this would not result in 180 volts being thrown at the TV set, but voltages as high as 150 might appear.

It wasn't a heater, but a big home freezer which had been latched onto the transformer leg opposite the fuse-blowing Stewart-Warner. And impedance goes down pretty close to zero for an instant when the motor in such a freezer starts up.

We never checked, but the lights in the house were probably connected onto the same transformer leg as the freezer, thus explaining the customer's statement that his lights occasionally seemed a little dim but never overbright. Anyway, a brief workout with a screwdriver on the neutral bar wrapped up this case of trouble for good.

After explaining the facts of life, the power company man let me in on another little doozie which often baffles amateur electricians but good. It just might baffle you, too, so take notes.

Fig. 4 shows again the elementary schematic of a power transformer secondary supplying a home. Somehow or other, the fuse has blown in the bottom leg. Obviously this has no effect upon devices connected to the top leg of the transformer secondary. However, this blown fuse does *not* deprive the TV set of electricity. This happens because the TV is now in series with the 3,000-watt electric water heater, designed to operate on 240 volts. Voltage across this series combination is only 120, of course, which leaves the TV set with less than 90 volts to do business with. Enough to make the tubes light, the oscillator drop out and give a TV technician something closely resembling a bad time.

Not that bad times are any novelty for TV fixers, of course. . . . Anyone for joining the Foreign Legion and having things a little easier for a refreshing change? END

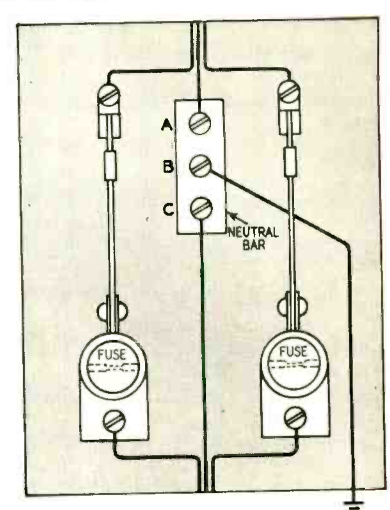


Fig. 3—The neutral bar—solid piece of copper or brass with screw terminals.

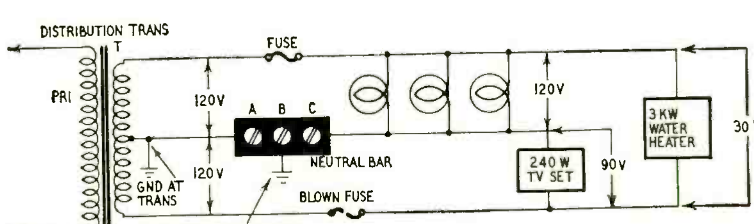


Fig. 4—Not a thing wrong with the TV here; nevertheless no sound, no picture.

Photographing TV DX

By GEORGE E. SIMKIN*

ONE of the most satisfying ways to log TV dx is to capture the test pattern or ID slide on film. However, most articles dealing with photographing cathode-ray tube images or TV pictures deal with strong, local signals. The TV dxer is often faced with trying to photograph a TV signal that is barely readable or very unstable to begin with. Both of these situations call for unusual photographic procedures for the dxer to get optimum results.

First, let's review some of the principles of getting a picture from your TV screen. Since the TV picture is a light source, your set should be in a darkened room—dark enough so the screen will photograph black when the TV is off. This is the blackest black you can get in the final picture. Of course, flash must not be used.

One complete frame of a TV picture takes 1/30 second, and a shorter exposure will not get a full frame. A slightly longer exposure generally does no harm so the standard 1/25 second is good. (In countries using a 25-frame-per-second system, the 1/25-second exposure is ideal.)

The light from the screen is usually low, and for this reason a fast film and lens are desirable. The actual combination varies with the condition of the TV set, but f2.8 with Tri-X film is a good starting point.

A large screen is easier to get in focus; but if you can focus the camera on the screen and have the screen almost fill the negative, there will be little difference between a 7-inch and a 27-inch set.

Shooting the unstable picture

What about unstable DX pictures? They may be unstable because of interference, rapid fading, ghosts, or combinations of these. Under these conditions, many TV sets synchronize differently on each field (half-frame), adding to the confusion. Under these conditions, a photograph of a single field will give the clearest picture. In other words, take your picture at 1/60 (or 1/50) second. This gives only every other line, but if interlace is not good you can get a clearer picture from a single field. Lens should not be opened

*Research assistant, College of Medical Evangelists.

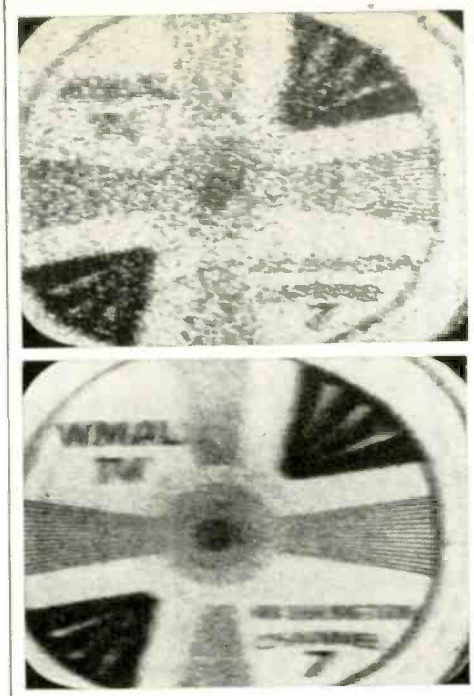


Fig. 1—(Top) The pattern on the screen. Snow makes it impossible to identify. (Bottom) A longer exposure tends to cancel the snow, giving a distinguishable picture: WMAL-TV, Washington, channel 7.

up any wider, as each line is just as bright as before. This method also applies to photographing a rapidly moving scene.

Weak signals

A more interesting case is where the signal is steady but weak, perhaps so weak that it is not readable. If synchronization is stable and the picture is the same for a second or more, a considerable photographic improvement is possible. Snow is really just random noise and, being random, it rarely occurs twice at the same spot. With a fixed picture, the picture details always fall at the same place. If the total light from each point is added, there could be about as much white as black at each point from the snow, while the white and black of the picture remain steady, causing increased detail to show.

This can be done photographically. Adjust the set's hold controls for maximum stability and turn the intensity down until the snow just vanishes in the blackest portion of the picture. Set the contrast just high enough to get good whites, but not so high that the white portions become defocused. Then increase the camera exposure to a second or so and stop down to around f16 to keep the longer exposure from overexposing the film. The results are amazing, as shown in Fig. 1. One photo (Fig. 1-a) was taken at f2.8, 1/25 second on Tri-X, and the other (Fig. 1-b) was taken immediately afterward at f16, 1 second on the same film. The TV was a 17-inch set with a cascode tuner and a short wire for an antenna, about 60 miles from the TV station. Almost all ID slides are shown for several seconds, and it is possible that this could be the sole identifying means for some TV dx.

One word of warning: cameras with focal-plane shutters may give peculiar results, especially at fast shutter speeds. These can be reduced if the camera is set so the focal-plane shutter operates from bottom to top. The shutter then tends to follow the scanning on the screen, as the image in the camera is inverted.

If you do your own photographic printing, one other method can improve your final print. Take several pictures of the same test pattern or ID slide with the camera in precisely the same place each time. Either underexpose them or underdevelop them, and then carefully stack the negatives so the picture elements all coincide and use the stack as a single negative. Although not as easy as the single long exposure, the principle is the same. It can also be done with rapidly fading or jittery pictures to give some improvement.

So the next time you are trying to read that very snowy or jittery test pattern or ID slide, try to ID it with your camera. You may be surprised by the results! END

Rob the TV Man—Pay the Undertaker

PULL that plug out of that wall! Don't work on that set with it turned on!"

I looked up to find that my customer was really serious. After explaining that we always work that way, I continued checking her television set.

"Don't kill yourself man. I just moved here and I want to live in this house!"

She then related this story:

The husband of her next-door neighbor in suburban Altadena, Calif., had electrocuted himself while attempting to repair his TV set. His wife came home to find him crouched behind the set with his hands on the chassis and his head against the high-voltage section.

The sight of the burned face had made a lasting impression on the women of the neighborhood who came in to assist and comfort the terrified wife.

On my return trip to the shop I stopped by the service shop of a friend, Mel Rector of Rector's Radio & Television in Pasadena, and related my experience. He told me that the same man had brought in some tubes to be tested. Two of them were bad, but when Mel put the new replacement tubes on the counter the man turned to walk out, explaining that he could get them "wholesale."

Later that day Mel received a call from the coroner asking the approximate time he had tested the tubes, as a clue in establishing the time of death.

The dead man's widow paid for a funeral because he tried to save the price of a service call.—*William G. Rhone*

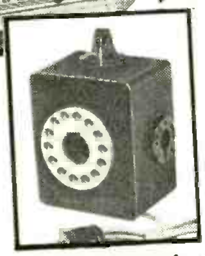
SHIPPED ON APPROVAL

NEW

CRT TESTER-REACTIVATOR

Model CRT-2

NOW . . . a TESTER-REACTIVATOR really designed to test, repair and reactivate EVERY PICTURE TUBE MADE — whether black and white or color . . . with exclusive features never before found in picture tube testers.



Housed in hand-rubbed oak carrying case — complete with MULTI-HEAD*

Model CRT-2 $57.50 Net

TERMS: $13.50 within 10 days. Balance $11 monthly for 4 months.

The CRT-2 steps in and solves the limitations and shortcomings of present day CRT Testers. Unlike ordinary CRT testers that keep entering the field with a limited range of operation, the CRT-2 employs a new brilliantly engineered circuit designed to test, repair and reactivate every black and white or color picture tube made. The CRT-2 eliminates the guesswork and risk that until now, has always been present when a picture tube is reactivated. It accomplishes this by providing perfect control of either the 'Boost' or 'Shot' method of reactivation.

THE CRT-2 DOES ALL THIS RIGHT IN THE CARTON, OUT OF THE CARTON OR IN THE SET

TEST

- for quality of every black and white and color picture tube
- for all inter-element shorts and leakage up to one megohm
- for life expectancy

REPAIR

- Will clear inter-element shorts and leakage
- Will weld opens between any two elements in the tube gun

REACTIVATE

- The unique controlled 'SHOT' (high voltage pulse) method of reactivation provided by the CRT-2 will restore picture tubes to new life in instances where it was not possible before. Furthermore the high voltage is applied without danger of stripping the cathode as you always have perfect control of the high voltage pulse.
- The 'BOOST' method of reactivation also provided by the CRT-2 is used effectively on tubes with a superficially good picture but with poor emission and short life expectancy. It will improve definition, contrast and focus greatly and add longer life to the picture tube.

1. **THE MULTI-HEAD** (patent pending) . . . **A SINGLE PLUG IN CABLE AND UNIQUE TEST HEAD** — A tremendous advance over the maize of cable and adapters generally found with other testers. Enables you to test, repair and reactivate every type of picture tube with greater convenience than ever before . . . 50 degree to 110 degree types from 8" to 30", whether 12 pin base, 8 pin base, 14 pin base . . . even the very latest 7 pin base. A special color switch on the MULTI-HEAD enables you to test, repair and reactivate each of the red, green and blue color guns separately.

2. **WATCH IT REACTIVATE THE PICTURE TUBE** — You actually see and control the reactivation directly on the meter as it takes place, allowing you for the first time to properly control the reactivation voltage. This eliminates the danger of stripping the cathode of the oxide coating. It enables you to see the speed of reactivation and whether the build-up is lasting. You will see if the cathode contamination is too great and if the picture tube is too far gone to be reactivated.

3. **CONTROLLED "SHOT" WITH HIGHER VOLTAGE FOR BETTER REACTIVATION** — Stronger than any found in other testers . . . high enough to really do the job — yet controlled to avoid damage to the picture tube.

4. **UNIQUE HIGH VOLTAGE PULSE CIRCUIT** — Will burn out inter-element shorts and weld open circuits with complete safety to the picture tube.

5. **VISUAL LIFE TEST** — Enables both you and your customer to see the life-expectancy of any picture tube right on the meter. The fact that your customer can see the results of your tests as you make them virtually eliminates resistance to picture tube replacement when necessary.

6. **TESTS, REPAIRS AND REACTIVATES SPECIAL LOW SCREEN VOLTAGE TUBES** — Many new type picture tubes use special low voltage of approximately 50 volts. The CRT-2 will test, repair and reactivate these types with the same thoroughness as the regular types with complete safety.

7. **SEPARATE FILAMENT VOLTAGES** — Including the very latest 2.35 volt and 8.4 volt types as well as the older 6.3 volt types.

8. **TESTS, REPAIRS AND REACTIVATES 'SF' PICTURE TUBES** — found in the newest Sylvania and Philco TV sets. These picture tubes have different base pin connections than standard picture tubes and there is always an element of risk that the tube may be burned out when tested with ordinary picture tube testers. The CRT-2 is designed to accommodate this new base pin arrangement and will test the tube with no danger of damage.

ADDITIONAL FEATURES

• Employs the time proven dynamic cathode emission test principle • Large 4½" meter with heavily damped movement for smooth action, accuracy and long life • Provides separate shorts test for each element in the picture tube • Filament continuity is shown on a separate glow indicator • An easy to read instruction manual contains all the latest testing information on old and new type picture tubes • Housed in handsome hand-rubbed oak carrying case with special compartment for MULTI-HEAD and line cord.

*patent pending

IN-CIRCUIT CONDENSER TESTER

Model CT-1

Here is an **IN-CIRCUIT CONDENSER** that **DOES THE WHOLE JOB!** The CT-1 actually steps in and takes over where all other in-circuit condenser fail. The ingenious application of a dual bridge principle gives the CT-1 a tremendous range of operation . . . and makes it an absolute 'must' for every serviceman.

in-circuit checks:

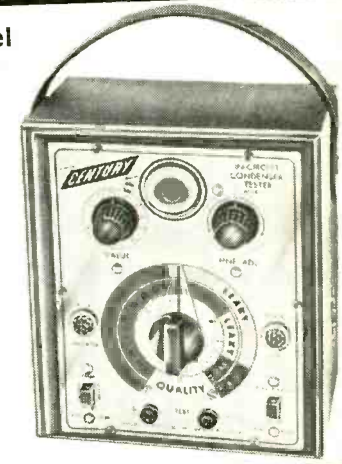
- Quality of condensers even with circuit shunt resistance . . . . (This includes leakage, shorts, opens, intermittents)
- Value of all condensers from 200 mmfd. to .5 mfd.
- Quality of all electrolytic condensers (the ability to hold a charge)
- Transformer, socket and wiring leakage capacity

out-of-circuit checks:

- Quality of condensers . . . (This includes leakage, shorts, opens and intermittents)
- Value of all condensers from 50 mmfd. to .5 mfd.
- Quality of all electrolytic condensers (the ability to hold a charge)
- High resistance leakage up to 300 megohms
- New or unknown condensers . . . transformer, socket, component and wiring leakage capacity

OUTSTANDING FEATURES

- Ultra-sensitive 2 tube drift-free circuitry
- Multi-color direct scale readings for both quality and value . . . in-circuit or out-of-circuit
- Simultaneous readings of circuit capacity and circuit resistance
- Built-in hi-leakage indicator sensitive to over 300 megohms
- Cannot damage circuit components
- Electronic eye balance indicator for every greater accuracy
- Isolated power line
- Housed in sturdy hammertone finish steel case . . . comes complete with test leads



Model CT-1 $34.50 Net

TERMS: $9.50 within 10 days. Balance $5 monthly for 5 months.

EASY TO BUY IF SATISFIED – *see order form on facing page*

FOR 10 DAY *FREE* TRIAL

Convince yourself at no risk that CENTURY instruments are indispensable in your every day work. Send for instruments of your choice without obligation . . . try them for 10 days before your buy . . . only then, when satisfied, pay in easy-to-buy monthly installments — without any financing or carrying charges added.

NOW a Battery Operated Peak-to-Peak

VACUUM TUBE VOLT METER

Model VT-1

WITH LARGE EASY-TO-READ 6" METER —

featuring the sensational new MULTI-PROBE * Patent Pending

No extra probes to buy! The versatile MULTI-PROBE does the work of 4 probes

❶ DC Probe ❷ AC-Ohms Probe ❸ Lo-Cap Probe ❹ RF Probe

The VT-1 is a tremendous achievement in test equipment. With its unique MULTI-PROBE it will do all the jobs a V.T.V.M. should do without the expense of buying additional probes. No longer do you have to cart around a maize of entangled cables, lose time alternating cables or hunting for a misplaced probe. With just a twist of the MULTI-PROBE tip you can set it to do any one of many time-saving jobs. A special holder on side of case keeps MULTI-PROBE firmly in place ready for use.

Housed in hammertone steel-case — complete with MULTI-PROBE

FUNCTIONS

DC VOLTMETER . . . Will measure D.C. down to 1.5 volts full scale with minimum circuit loading, and give accurate readings of scale divisions as low as .025 volts . . . Will measure low AGC and oscillator bias voltages from .1 volts or less up to 1500 volts with consistent laboratory accuracy on all ranges . . . Zero center provided for all balancing measurements such as discriminator, ratio detector alignment and hi-fi amplifier balancing.

AC VOLTMETER . . . True Peak-to-Peak measurements as low as 3 volts of any wave form including TV sync, deflection voltages, video pulses, distortion in hi-fi amplifiers, AGC and color TV gating pulses . . . Scale divisions are easily read down to .1 volts . . . Measures RMS at 1/20th the circuit loading of a V.O.M. . . . Unlike most other V.T.V.M.'s there is no loss in accuracy on the lowest AC range.

ELECTRONIC OHMETER . . . Measures from 0 to 1000 megohms . . . Scale divisions are easily read down to .2 ohms . . . Will measure resistance values from .2 ohms to one billion ohms . . . Will detect high resistance leakage in electrolytic and by-pass condensers.

RF and LO-CAP MEASUREMENTS . . . With these extra VT-1 functions you can measure voltages in extremely high-impedance circuits such as sync and AGC pulses, driving saw tooth voltages, color TV gating pulses, mixer output levels, I.F. stage-by-stage gain and detector inputs.

OUTSTANDING FEATURES

● Completely portable — self powered with long life batteries — permits use everywhere ● New advanced pentode amplifier circuit assures amazingly low battery drain ● Large 6" 100-microampere meter, many times more sensitive than meters used in most V.T.V.M.'s ● Laboratory accuracy performance — 2% of full scale on DC, 5% of full scale on AC ● Simplified multi-color easy-to-read 4-scale meter ● No heat operation assures rigid stability and accuracy ● Immune to power line fluctuations ● Amplifier rectifier circuit with frequency compensated attenator — a feature found only in costly laboratory instruments ● Meter completely isolated — practically burn-out proof ● Hand-crafted circuitry eliminates the service headaches of printed circuitry ● 1% resistors used for permanent accuracy ● Separate RF ground return for low-loss RF measurement ● Microphone type co-axial connector ● Matching cover protects instrument face — snaps on and off instantly.

SPECIFICATIONS

- **DC Volts** — 0 to 1.5/6/30/150/300/600/1500 volts
- **AC Volts (RMS and Peak-to-Peak)** — 0 to 3/12/60/300/1200 volts
- **Ohms** — 0 to a billion ohms, 10 ohms center scale — Rx1/10/100/1K/10K/100K/1M
- **RF** — Peak reading demodulator supplied for use on all DC ranges
- **Zero Center** — available on all DC volt ranges with zero at mid-scale
- **Decibels** — from —10 Db to +10/22/36/50/62 based on the Dbm unit: ODb-IMW in 600 ohms
- **Impedance** — 11 megohms DC, 1 megohm AC, 10 megohms Lo-Cap
- **Input Capacity** — 130 mmfd. RMS, 250 mmfd. Peak-to-Peak, 25 mmfd. Lo-Cap

Model VT-1 $58.50 Net

TERMS: $14.50 within 10 days. Balance $11 monthly for 4 months.

FAST-CHECK TUBE TESTER

Model FC-2

Simply set two controls . . . insert tube . . . and press quality button to test any of over 700 tube types completely, accurately . . . IN JUST SECONDS!

Over 20,000 servicemen are now using the FAST-CHECK in their every day work and are cutting servicing time way down, eliminating unprofitable call-backs and increasing their dollar earnings by selling more tubes with very little effort. See for yourself at no risk why so many servicemen chose the FAST-CHECK above all other tube testers.

Housed in hand-rubbed oak carrying case complete with CRT adapter

Model FC-2 $69.50 Net

TERMS: $14.50 within 10 days. Balance $11 monthly for 5 months.

PICTURE TUBE TEST ADAPTER INCLUDED WITH FAST-CHECK

Enables you to check all picture tubes (including the new short-neck 110 degree type) for cathode emission, shorts and life expectancy . . . also to rejuvenate weak picture tubes.

RANGE OF OPERATION

- ✓ Checks quality of over 700 tubes types, employing the time proven dynamic cathode emission test. This covers more than 99% of all tubes in use today, including the newest series-string TV tubes, auto 12 plate-volt tubes, OZ4s, magic eye tubes, gas regulators, special purpose hi-fi tubes and even foreign tubes.
- ✓ Checks for inter-element shorts and leakage.
- ✓ Checks for gas content.
- ✓ Checks for life-expectancy.

SPECIFICATIONS

● No time consuming multiple switching . . . only two settings are required instead of banks of switches on conventional testers ● No annoying roll chart checking . . . tube chart listing over 700 tube types is located inside cover. New listings are added without costly roll chart replacement ● Checks each section of multi-section tubes and if only one section is defective the tube will read "Bad" on the meter scale ● 41 phosphor bronze beryllium tube sockets never need replacement ● 7-pin and 9-pin straighteners mounted on panel ● Large 4½" D'Arsonval type meter is the most sensitive available, yet rugged — fully protected against accidental burn-out ● Special scale on meter for low current tubes ● Compensation for line voltage variation ● 12 filament positions ● Separate gas and short jewel indicators ● Line isolated — no shock hazards ● Long lasting etched aluminum panel.

NOTE: The Fast-Check positively cannot become obsolete . . . circuitry is engineered to accommodate all future tube types as they come out. New tube listings are furnished periodically at no cost.

CONVENIENT TIME PAYMENT PLAN — NO FINANCING CHARGES

ALL CENTURY INSTRUMENTS ARE GUARANTEED FOR ONE FULL YEAR

The extremely low prices are made possible because you are buying direct from the manufacturer.

CENTURY ELECTRONICS CO., INC.

CHECK INSTRUMENTS DESIRED

- ☐ Model CRT-2 CRT TESTER REACTIVATOR .... $57.50 — $13.50 within 10 days. Balance $11 monthly for 4 months.
- ☐ Model CT-1 In-Circuit Condenser Tester .... $34.50 — $9.50 within 10 days. Balance $5 monthly for 5 months.
- ☐ Model VT-1 Battery Vacuum Tube Volt Meter .... $58.50 — $14.50 within 10 days. Balance $11 monthly for 4 months.
- ☐ Model FC-2 Fast-Check Tube Tester .... $69.50 — $14.50 within 10 days. Balance $11 monthly for 5 months.

Prices Net F.O.B. Mineola, N. Y.

111 Roosevelt Avenue, Dept. 112, Mineola, New York

Please rush the instruments checked for a 10 day free trial. If satisfied I agree to pay the down payment within 10 days and the monthly installments as shown. If not completely satisfied I will return the instruments within 10 days and there is no further obligation. It is understood there will be NO INTEREST or FINANCING charges added.

Name ....

Please print clearly

Address ....

City .... State ....

TELEVISION

all-in-one TV and home service organizations growing?

ALL-IN-ONE service organizations which repair TV, appliances, windows, locks, plumbing and hi-fi sets, all paid for on a single monthly billing, are spreading. In February, 1959, RADIO-ELECTRONICS took note of an outfit called Mr. Service Club, operating in the Chicago area ("TV Service à la Carte," page 118). This 24-hour-a-day group is similar in many ways to a new one on Long Island called the Allied Homeowners Association. The AHA is located in Roslyn, N. Y., and may just possibly be the beginning of an important trend. In any case, it is well worth watching.

This organization has about 2,000 members who go through the association for any kind of home repair from roofing to radio. When a call for home service comes in, the AHA, having almost 200 different "contractors" from which to choose, picks out a service organization close to the homeowner and gives the call to him. The contractor does the job and bills AHA. At the end of the month, the group bills the customer for all the various repair work done for him, takes 10% of his payment and sends the rest to the contractors.

Many may ask why any repair technicians bother giving 10% of their hard-earned money away to a middleman? Out on Long Island many service technicians do it because being on the list of "contractors" for this service go-between brings them new customers they wouldn't otherwise get. Besides, these customers always pay their bills, with few or no kicks because they've been credit-checked before being accepted as group members.

Al A. Brown, of Page TV and Hi-Fi, Bethpage Long Island, says, "I always give priority to customers from the AHA. They never squawk about a reasonable bill, and they don't expect to get 20% off on tubes." Art has been a full-timer for 8½ years, with the group for a year.

Sol Feld, owner of Tower TV in Bellerose, N.Y. feels the same way. Says Sol, who's had his own place for 10 years, "I go out on all Allied Homeowners calls myself. I find that they are the best sort of customers to have. They're ready to trust me because they feel I've been 'recommended' by their organization's headquarters."

AHA has been in operation for just 2 years. It charges members $10 to join, $5 per year thereafter. Credit is checked by a regular credit agency before members are accepted.

After a job is completed, if there is any argument or disagreement between the repair organization and the customer, the organization's president, Arthur Yeckes, steps in to settle it. The organization has a powerful weapon because loss of status as a contractor can mean loss of a great many customers, and they're good paying customers, too. AHA says that three or four real complaints will throw any service dealer off their list as a contractor.

Around Roslyn, TV service technicians charge $4 per house call, get list for tubes and pull the set only if there's no other way to fix it.

The customer reaction

Customers like belonging to this organization for several reasons. One is that they can phone day or night, usually get much faster service than they've been used to in the past. Too, they like paying only one bill per month. They also have confidence in AHA contractors, because they feel they've been preselected, and know they have somebody to go to if there's any problem after the job has been done.

Service organizations say that, although they have to wait from 10 to 40 days on most bills, and sometimes even 60 days, they always get paid without any muss or fuss.

There are reports that the all-in-one home-repair club idea is spreading. There's one in Los Angeles called the United Home Services Club, and there are reports of others starting in Detroit and St. Louis. END

"I thought you said those guys made a lot of money."

TV Service CLINIC

conducted by

ROBERT G. MIDDLETON

EFFICIENT servicing requires that we recognize the common causes of waveform distortion. It is not enough to observe only that a waveform is distorted. We must try to *interpret* the distortion, and to get a clue to the circuit trouble which causes it.

The sawtooth wave is a basic waveform used in TV receiver circuitry. A typical sawtooth is shown in Fig. 1-a. Now, consider a situation in which the coupling capacitor in a sawtooth circuit opens partially, causing *differentiation* of the waveform. The distorted sawtooth then appears as in Fig. 1-b.

On the other hand, if the shunt circuit capacitance in a sawtooth circuit is excessive, the waveform becomes *integrated* as shown in Fig. 1-c. Unless we have studied waveform analysis, the distortion would remain meaningless.

The third basic distortion seen in sawtooth waveforms is *transient ringing*, illustrated in Fig. 1-d. This occurs only in L-C or L-C-R circuits. Most of the time, transient oscillation is damped out. In some instances, it is filtered out with a low-pass filter which passes the sawtooth frequencies but attenuates the ringing frequency.

There is practically no limit to the utility of a scope, if we learn to read the waveform distortions displayed by faulty circuits.

More data please

On page 100 of the May 1959 issue of RADIO-ELECTRONICS *you mentioned a type of video sharpening circuit which depends on gamma accentuation. Can you tell me where I can find more information on this?—C. E. W., Jr., Joelton, Tenn.*

The basic article on this technique appeared in *The Proceedings of the I. R. E.*, in October, 1951. See "A New Technique for Improving the Sharpness of Television Pictures," by P. C. Goldmark and J. M. Hollywood.

Practical conversion?

I would like to replace the 10BP4 in a Philco 49-1040 with a 17-inch rectangular picture tube. Could you recommend an inexpensive conversion?—J. N., Brooklyn, N. Y.

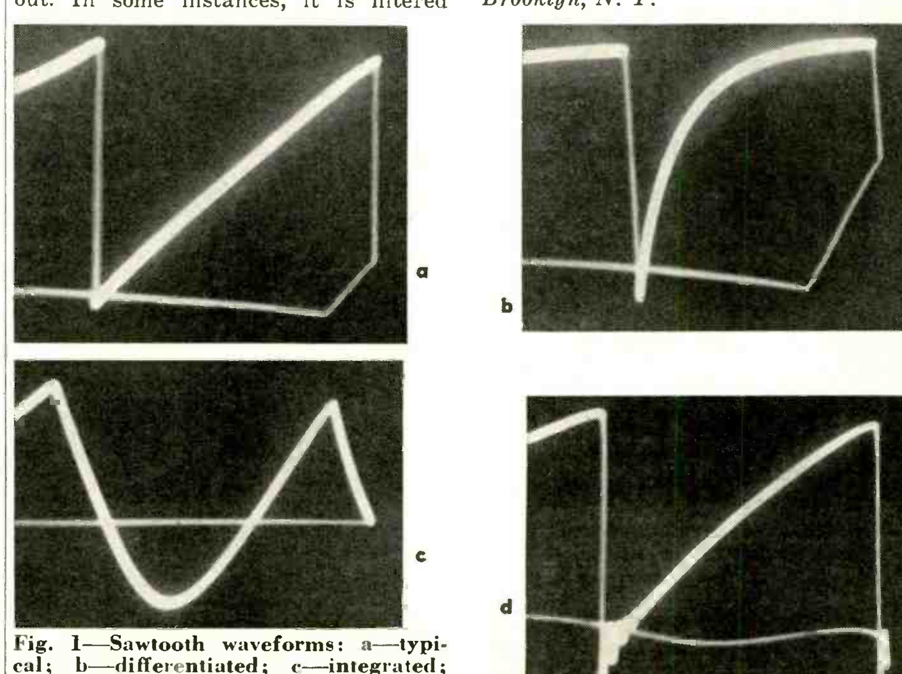


Fig. 1—Sawtooth waveforms: a—typical; b—differentiated; c—integrated; d—ringing.

Mounting the new tube would be a difficult job, and extensive circuit revisions are required. The sweep system and yoke would have to be completely reworked. We do not recommend this type of conversion.

New tuner

How can we install a Standard Coil Neutrode type cascode tuner in an RCA 6T54? Are any circuit changes necessary?—H. S., Brooklyn, N. Y.

The RCA 6T54 is a 21-mc split-sound receiver, but with the sound takeoff from the output of the second if stage. Hence, you can use the tuner intended for intercarrier receivers. Fig. 2-a shows the present coupling circuit from

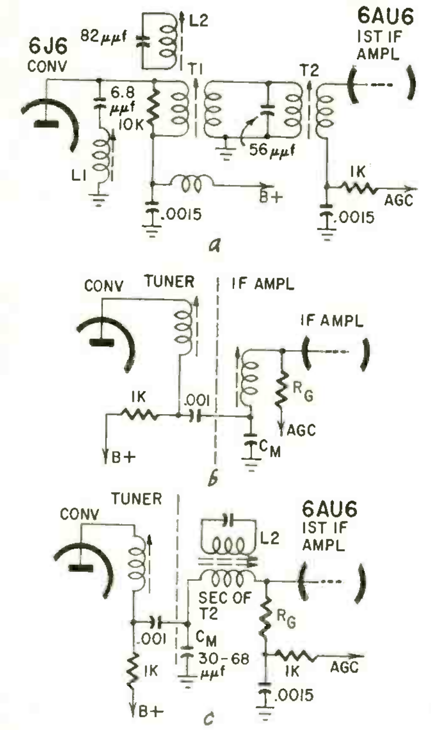


Fig. 2—If circuit revised to accommodate a Neutrode tuner: a—tuner output and if input of RCA 6T54 receiver; b—suitable plan for coupling from Neutrode tuner; c—T2's primary removed. Coupling capacitor C_M is added. L2 is the 19.5-mc trap in the original if circuit.

the tuner to the first if tube. The basic plan for conversion is shown in Fig. 2-b, which uses mutual-capacitance coupling. Wiring connections can be made as shown in Fig. 2-c. Note that T1's original primary is removed and the 19.5-mc trap, L2, is retained. Exact values for C_M cannot be given but will fall between 30 and 68 μμf. The value of R_G will fall between 1,000 and 10,000 ohms. To determine the values for best picture quality, use a sweep and marker generator. Adjust capacitor and resistor values for the correct if response curve. A larger value of C_M results in less bandwidth. Likewise, a larger value of R_G gives less bandwidth (and higher gain).

Scope patterns

In the Gernsback Library book Sweep

TELEVISION

and Marker Generators, *is the resting position of the scope beam always at center screen? If the horizontal sweep is increased, the pattern is spread out. When retrace is slower than the trace, it compresses the pattern (Fig. 3).—O. T., Los Angeles, Calif.*

It is customary to discuss scope patterns with the beam reference position at center screen. Of course, this is not

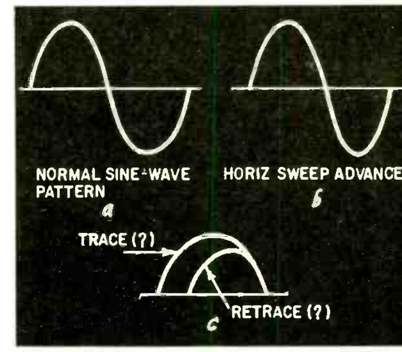


Fig. 3—Normal and distorted sine wave displays: a—When sweep oscillator generates linear sawtooth and there is no compression in horizontal amplifier, true sine wave is displayed: b—cramping at right of sine wave indicates sweep oscillator nonlinearity, or compression in the horizontal amplifier, or both: c—pattern can be caused by setting sync-amplitude control too high, causing double triggering of sweep oscillator.

mandatory. In fact, with pulse waveforms, the pattern will not be centered on the screen unless the vertical position control is suitably adjusted. Horizontal width or spread should not be confused with sweep nonlinearity. Your sketch illustrates a typical case of horizontal sweep nonlinearity. Likewise, the trace and retrace patterns are not what they are supposed to be—the sketch indicates possible double-triggering of the sweep oscillator.

Antenna matching

How critical is the impedance match of antenna to amplifier? I am in an area where I fight signal problems of all kinds and am concerned with the least discrepancy in the system. I used 72-ohm Yagis for several years, then was able to get only 300-ohm Yagis. Now I am using 600-ohm Yagis. The input to the single-channel amplifiers

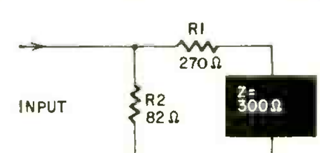
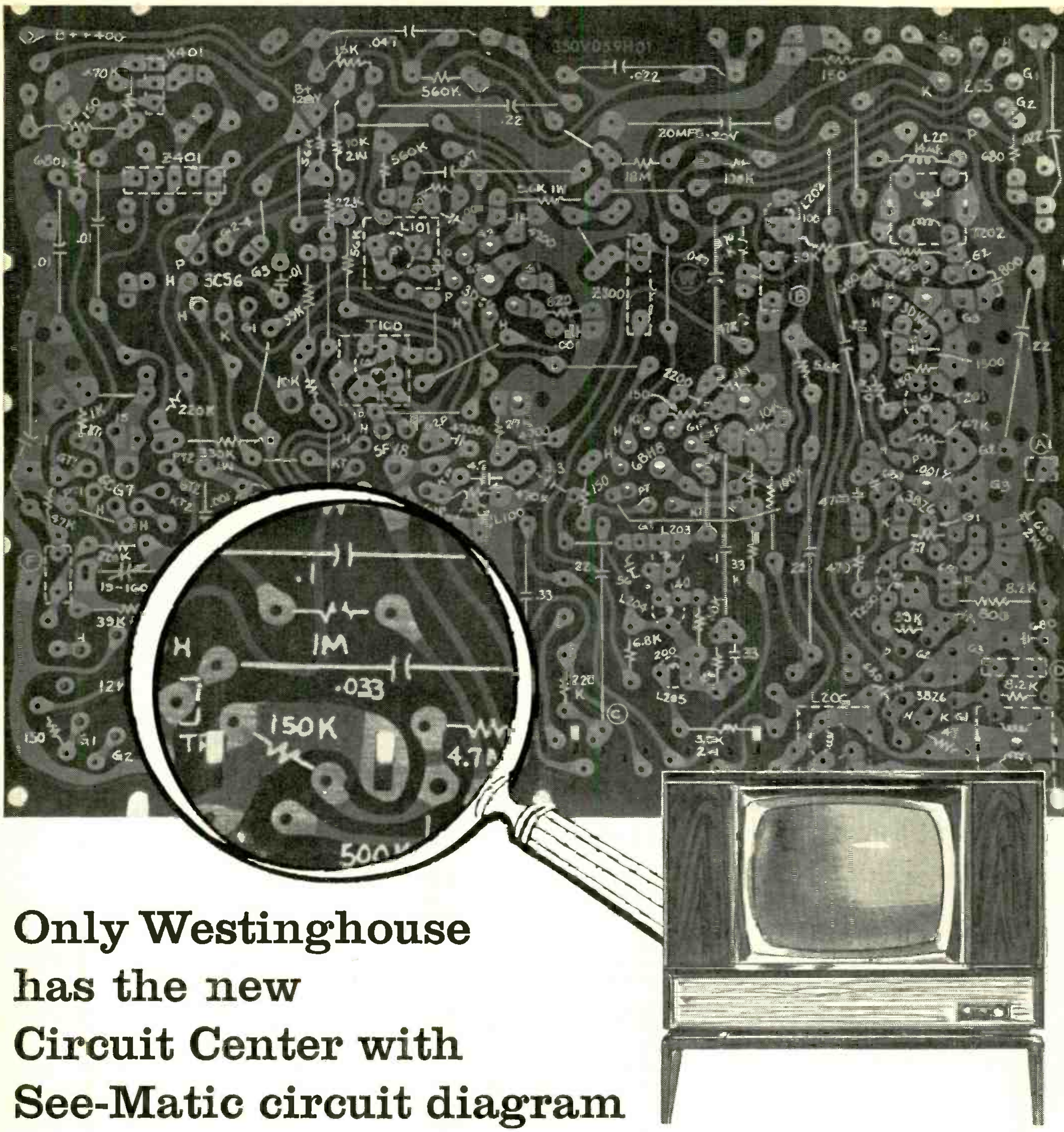


Fig. 4—R1's value can be changed considerably without greatly changing the input impedance to the pad.

uses the circuit shown in Fig. 4. It is evident that the input impedance does not change greatly with R1. RG-11/U and 59/U cables are used in the system.—L. G., Chicago, Ill.

Impedance matching throughout the

THE BIG IDEA...IN SERVICING



Only Westinghouse has the new Circuit Center with See-Matic circuit diagram

More than ever, Westinghouse is giving special attention to service technicians. The new Westinghouse "Circuit Center" is the industry's one new circuit board with a *complete* built-in schematic.

Now you can tell at a glance what type of component is connected from point-to-point and its value. Tube types and elements are shown . . . and all voltage supply lines and test points are identified.

No more "hide and seek" servicing—in many cases you don't even have to look at the manual! The See-Matic circuit diagram is printed right on the *work side* of the board . . . you save time, save work. It's another example of advanced engineering from Westinghouse.

For complete information about Westinghouse Tech-Lit Factory Direct Mailing Service, write to Service Department, Westinghouse Electric Corp., Metuchen, N. J., or your Westinghouse distributor.

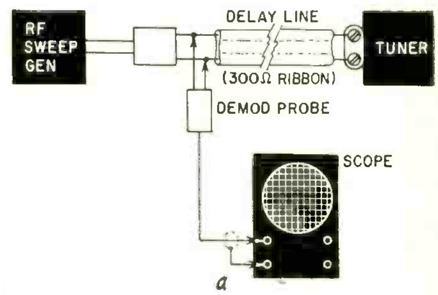
YOU CAN BE SURE...IF IT'S Westinghouse

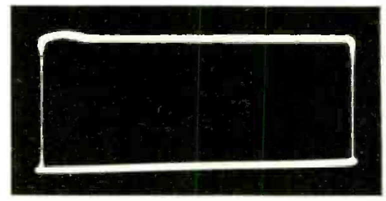
Westinghouse Furniture TV & Stereo

Westinghouse Electric Corp., TV-Radio Division, Metuchen, N. J. Watch "Westinghouse Lucille Ball-Desi Arnaz Shows"... CBS-TV, Fridays.

TELEVISION

antenna system is best for maximum signal transfer. Anyone who doubts it needs merely to see the improvement in contrast when proper impedance matches are made. A signal which is well down in the snow is often cleaned up remarkably. On the other hand, with long cable runs in strong-signal areas, correct impedance matching eliminates line ghosts and produces a sharper picture. In this instance, a mismatch must occur at *both* ends of a cable, to result in a line ghost. Line ghosts are re-





b

Fig. 5—Basic test setup to check 300-ohm rf impedance: a—300-ohm delay line about 5 feet long can be used to check tuner input impedance: b—If input impedance is 300 ohms, a practically flat trace is obtained on an rf sweep test.

reflections. In this type of work, do not assume any values. Tuner input impedances are often greatly different from 300 ohms. Antenna impedances can differ widely from rated values. Baluns give the best match with least signal loss. The match should be checked with a sweep generator and scope, on the operating channel frequency (Fig. 5).

FM with a TV tuner

How can I convert an rf tuner strip to receive FM stations? Channels 3, 6, 8 and 10 are vacant here, I have shunted capacitance across each coil, using a grid-dip meter. In some cases I could not pick up FM transmissions, and at other times the strip would not track. The receiver is a Tech-Master 1930-N.
—J. D., Brooklyn, N. Y.

The 1930-N is an intercarrier receiver, with the sound if tuned to 4.5 mc. This 4.5-mc frequency is generated by beating the TV FM sound against the picture carrier through the picture detector. In other words, an additional oscillator signal, removed by 4.5 mc from the broadcast FM signal, would have to be supplied. The fact that you occasionally managed to hear an FM broadcast was due to an interfering signal which happened to be removed 4.5 mc from the frequency modulated broadcast signal. END

TV SERVICE ON CREDIT?

By MIKE MARTYNEC

OUR shop is slightly more than 5 years old and employs three technicians. We extend credit to our customers on all service charges that run higher than $15. Yet losses due to bad debts are kept below ½% of our annual gross. How do we do it? Let's follow a normal call and find out.

The phone rings at the shop. "Good morning, Mike's TV." All necessary data are obtained: address, type of receiver, screen size, nature of the trouble, phone number, a.m. or p.m. call, and "Have we served you before?"

"No."

"How will you pay the technician? Check, or shall he bring change with him?"

At this point we know just where we stand. There is no chance of the technician going out, making his repair, and then having Mrs. Jones saying, "I'll be in Friday to pay you."

Of course, with an old customer, we check our files to see whether she has been prompt in paying as promised.

Assuming Mrs. Jones requested credit at the time of the original phone call, we point out that, if the repair is a normal one and costs between $10 and $15, cash will be expected. If it exceeds this, then the *balance* may be charged, *if* we are satisfied with: where her husband works, how long he has been there, where else she has charged and when she intends to pay the balance.

Extending the situation further, assume Mrs. Jones has received her monthly statement and is a month behind in payment. We call or write her, explaining it is necessary to complete the account. If there is no reaction within a week, we make another phone call and explain that we must turn her account over for collection by such and such a date. "I'll be in Friday."

If nothing happens Friday—she doesn't show up—Monday morning the account is turned over to a reliable collection agency. We lose 50% of the account this way, but it is well worth it. At this point we are dealing with a very small percentage of our customers and apparently came up with a bad credit risk.

By using a reliable agency, we do not always lose the customer. She will sometimes call again, and expect to be on a cash basis only.

How much credit the shop should extend is hard to say. But, as a general rule, credit should be extended until you start losing a little on bad debts. If a local credit union exists, you can check the customer's credit reference with them. There is a charge for this service.

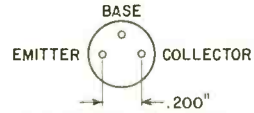
All we have at our disposal, in this phase of the service business, is general information and experience. How about your tricks of the trade? END

NEW TUBES and SEMI-CONDUCTORS

THIS month our foray into the world of new releases produces a group of high-frequency computer transistors, two high-voltage half-wave rectifiers, a triode-pentode for TV receivers and some silicon and selenium rectifiers for printed circuits.

2N356, 2N357, 2N358

A series of n-p-n germanium junction transistors designed for high-frequency computer switching and flip-flop circuits.



2N356,2N357,2N358

Absolute maximum ratings of these CBS-Electronics transistors are:

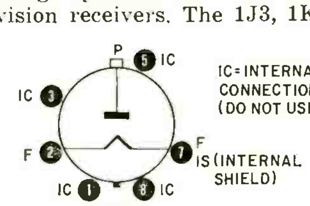
	2N356	2N357	2N358
V_{CBO}	20	20	20
V_{EBO}	20	20	20
V_{CEO}	18	15	12
P_{total} (mw)	100	100	100

Typical electrical characteristics at 25°C are:

	2N356	2N357	2N358
h_{FE} ($I_C = 100$ ma, $V_{CE} = 0.25$)	30	30	30
h_{fe} ($V_{CE} = 5$, $I_C = 1$ ma)	30	45	60
f_{ab} (mc) ($V_{CB} = 5$, $I_C = 1$ ma)	3	6	9

1J3, 1K3

Half-wave vacuum rectifiers intended for use as a rectifier of high-voltage pulses produced in the horizontal scanning systems of black-and-white television receivers. The 1J3, 1K3 have



1J3,1K3

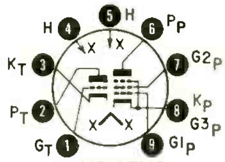
identical ratings. The only difference between the two tubes is that the 1K3 is ⅝ inch shorter than the 1J3.

Maximum ratings of these RCA rectifiers are:

V_P (inverse) (total dc and peak)	26,000
(inverse) (dc)	22,000
I_P (peak) (ma)	50
(Average) (ma)	0.5

5FV8, 6FV8

Triode-pentodes in 9-pin miniature envelopes, designed primarily for service in television receivers, with the triode serving as a vertical deflection oscillator and the pentode as a general-



5FV8,6FV8

purpose or if amplifier. Except for heater ratings, the 5FV8 is identical to the 6FV8. The 5FV8 heater is rated at 4.7 volts, 600 ma; the 6FV8 at 6.3 volts, 450 ma.

Design maximum ratings of these Tung-Sol tubes with the triode used as a vertical oscillator and the pentode as a class-A amplifier are:

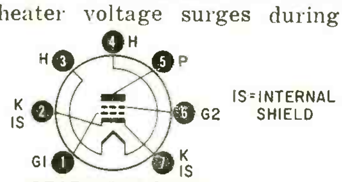
	Triode	Pentode
V_P	300	300
V_{G2} supply	—	330
V_{GL} (pos)	—	0
V_{G1} (peak neg pulse)	250	—
I_K (ma) (average)	20	—
I_K (ma) peak	70	—
P_P (watt)	2.0	2.3
P_{G2} (watts)		0.55

Typical operating characteristics are:

gm (umhos)	8,000	6,500
R_P (k ohms)	5	200
μ	40	—

3EA5, 2EA5, 6EA5

A sharp-cutoff tetrode in a 7-pin miniature envelope designed for high-plate-voltage operation as an rf amplifier in vhf television tuners. The heater's thermal characteristics are controlled so heater voltage surges during the



2EA5,3EA5,6EA5

warmup cycle are minimized. Except for heater ratings and warmup time, the 3EA5 is identical to the 2EA5 and 6EA5.

Typical operating characteristics of the Tung-Sol 3EA5 are:

V_{htr}	2.9
I_{htr} (ma)	450
V_P	250
V_{G2}	140
V_{G1}	−1
R_P (K ohms)	150
gm (umhos)	8,000
I_P (ma)	10
I_{G2} (ma)	0.95

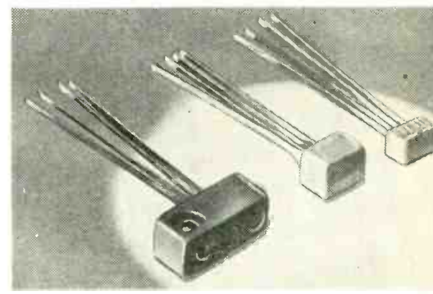
Rectifiers for printed circuits

A series of silicon printed-circuit rectifier assemblies that can be mounted in any desired configuration on high-temperature printed-circuit boards has been introduced by International Telephone & Telegraph. The diffused-junction rectifiers used in the assemblies come in versions for single- and three-phase power supply applications in half-wave, doubler, center-tap and

bridge circuits. They are hermetically sealed and operate at temperatures up to 150°C. Basic ratings are available up to 3 amps dc output and 800 volts in a single-phase assembly as well as up to 4.5 amps dc in three-phase units.

Instrument rectifiers

Conant Laboratories announces that all of their rectifiers in series 160, 160-C and 160-ERM, either copper



oxide or selenium, can be supplied with flat nickel-silver filiform leads. These leads are equivalent to No. 23 Awg solid wire and can be formed to fit printed conductors or turret terminals, or can serve as the sole mounting means. END

50 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 Modern Electrics on file for interested readers.

In December, 1909, *Modern Electrics*

Television and the Telephot, by H. Gernsback.

Airships and Wireless Telegraphy, by the Berlin Correspondent.

The Colin & Jeance Radiophone, by A. C. Marlowe.

Detectors, by George F. Worts.

Automatic Wireless Signaling.

New Marconi Spark Gap.

Construction of An Efficient Aerial, by George F. Worts.

The Measurement of Electric Waves, by M. A. Deviny.

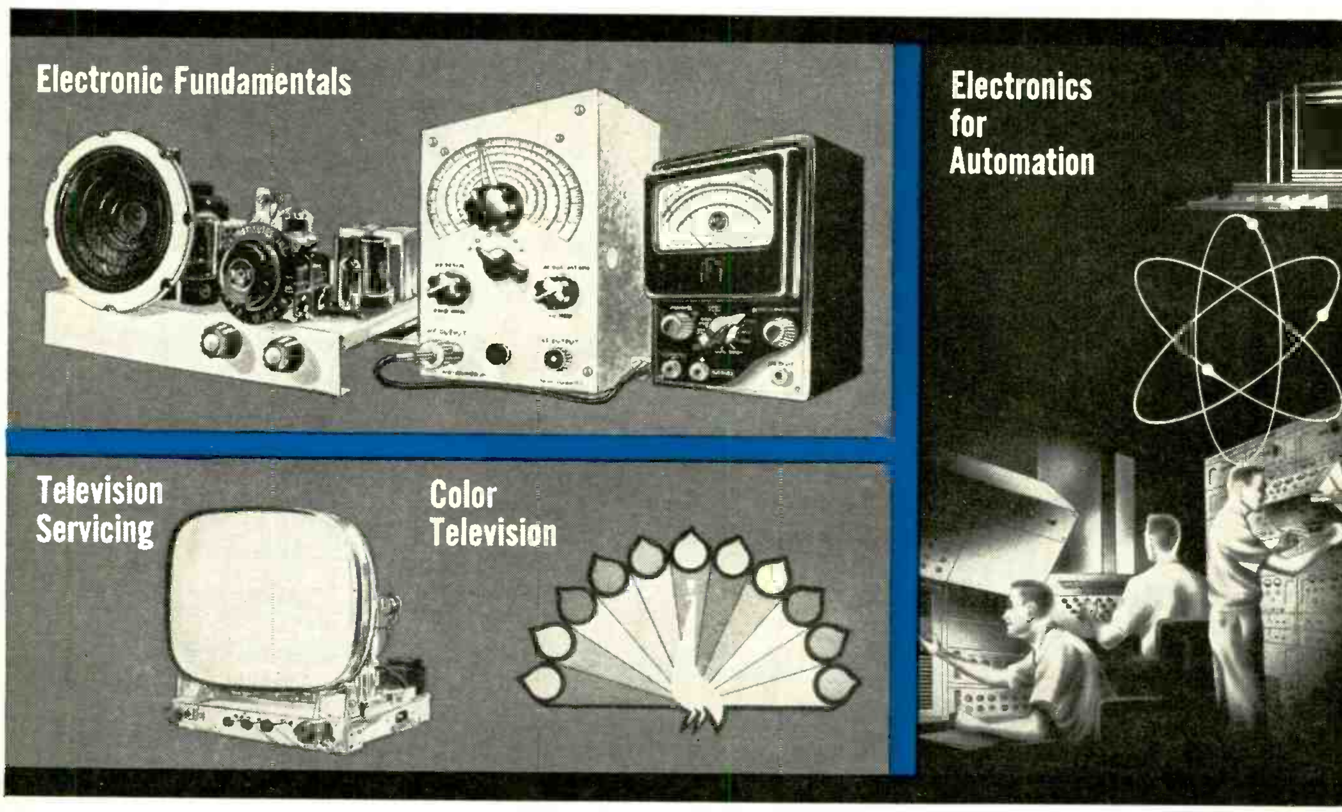
Silicon Detector, by James D. Thomas.

LET RCA TRAIN YOU IN ELECTRONICS

RCA Institutes celebrates Fifty Years of Electronic Training by introducing its newest Home Study Course . . .

ELECTRONICS FOR AUTOMATION

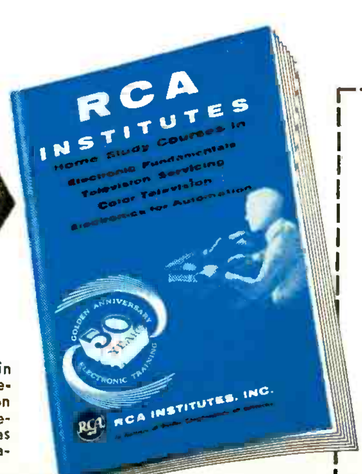
. . . Now you have *four* comprehensive courses for your electronic training . . . from basic electronic theory to the more advanced principles of color TV and Automation.



Practical work with the very first lesson. Pay-as-you-learn. You need pay for only one study group at a time.

Send for our 64 page Home Study Catalog

FREE!



Resident School courses in New York City offer comprehensive training in Television and Electronics. Day and evening classes start four times each year. Detailed information on request.

ANOTHER WAY RCA SERVES EDUCATION THROUGH ELECTRONICS

RCA INSTITUTES, Inc. Home Study School, Dept. RE-129
A Service of Radio Corporation of America
350 West Fourth Street, New York 14, N. Y.

Without obligation, send me the FREE catalog of Home Study Courses. No salesman will call.

Name ....
Please print

Address ....

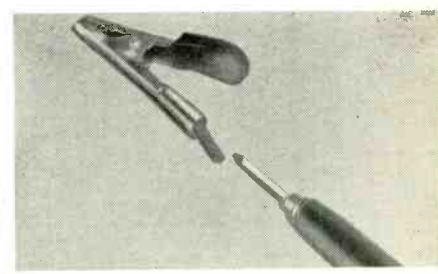
City .... Zone...... State......................

Korean Vets! Enter Discharge Date..

CANADIANS — Take advantage of these same RCA courses at no additional cost. No postage, no customs, no delay. Send coupon to:
RCA Victor Company, Ltd., 5001 Cote de Liesse Rd., Montreal 9, Quebec
To save time, paste coupon on postcard.

UNIVERSAL TEST-LEAD HINT

If you own a pair of universal test leads, you have probably tried fitting one of the test clips onto the end of one of the prods. Such an arrangement just doesn't work, for the clips are



specifically designed to fit only the larger-size banana plugs at the instrument end. To overcome this difficulty, take a 1-inch piece of wire solder and put it into the clip's barrel as shown. This will let the tip of the test prod make a snug force fit in the clip so that the prod can be clipped to a chassis or wire lead as desired.—*James C. Conrad*

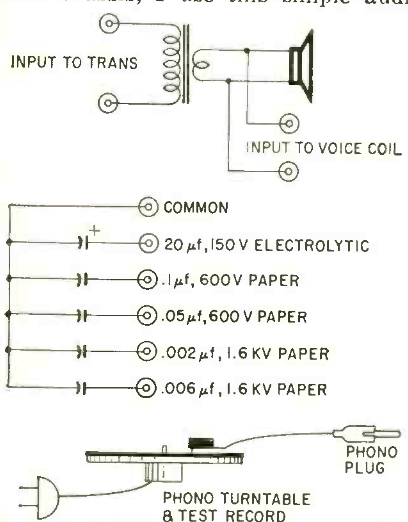
SOLDERING THE UNSOLDERABLE

A rather simple soldering technique developed at the University of California Chemistry and Metallurgy Laboratory now makes it possible to solder a wide range of materials previously joined only by ultrasonic processes.

The technique requires, in addition to the usual soldering materials, only a hand grinder with an abrasive grinding wheel of medium grit. To solder such "unsolderable" materials as stainless steel, aluminum, ceramics and glass, the grinder is turned on and the abrasive wheel (preferably preheated by grinding metal or by applying heat with a torch) is brought to bear on a soft solder such as Wood's metal or 40–60 lead–tin. The soft solder melts and flows onto the surface of the wheel; the solder-loaded wheel is then applied to the surface to be soldered until a slight amount of abrasion has taken place, using the pressure one would ordinarily use in grinding. The heat generated by the friction again melts the solder, which flows onto the freshly abraded surface and forms a positive bond. The surface of the other material is also given this treatment if it is not ordinarily tinned with solder alone. After this tinning operation, the soldering process is performed in the usual manner with standard 50–50 lead–tin solder. Soldering flux or surface cleaning is unnecessary. Pieces to be joined with this technique need not be of the same material—metals, ceramics, soft glass and Pyrex can be soldered in any combination desired.—*Warren J. Smith*

AUDIO TEST RIG

To save a trip to the shop with an audio chassis, I use this simple audio



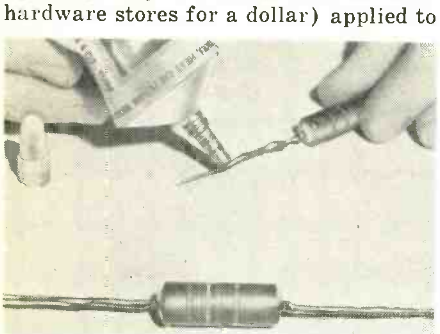
test rig—turntable, capacitor substitutor and output unit, as shown, built into a carrying case. It lets you check for a variety of common faults in the home and speeds servicing time.—*Harvey Muller*

RUSTPROOFING HARDWARE

To keep the bolts and nuts used in an antenna installation from rusting, I coat them with plastic rubber before I put the antenna up. I've found that this weatherproofing prevents rust and makes the antenna easier to dismantle when the customer decides to buy a new one. It's a real help in salt-water climates too.—*Chester A. Clifford*

"SPAGHETTI" IN A TUBE

Do you need some spaghetti for a short length of wire or the lead of a component? A coating of plastic rubber (you can buy a 4-ounce tube at most hardware stores for a dollar) applied to



the wire will form into insulating spaghetti in about 30 minutes. Once dry, the liquid latex rubber possesses about the same insulating qualities as latex rubber. It won't ever dry out and become brittle. If one coat of the insulation doesn't seem adequate, apply a second coat about 15 minutes after the first.—*J. C. Alexander* END

TECHNICIANS' NEWS

TEXAS DEFINES RETAILERS

The new Texas state tax law affecting electronic parts sales says in part, "*Retail sale* shall mean any transfer exchange or barter of any item taxable . . . to the *user. Retailer* shall mean and include any person in this state who manufacturers, produces . . . items for resale, distribution . . . to the *user.*"

"*Distributor* shall mean and include every person other than the retailer who distributes or sells any item under this chapter . . . If any distributor shall sell or distribute any item . . . *to any person not holding a* valid *permit* as required under this chapter, said distributor shall qualify as a *retailer.*"

TRIPLE GUARANTEE

The Television & Electronic Service Association of Greater Buffalo is running ads stressing a Triple Guarantee which Buffalo set owners get if they deal with members of the Association. The cooperative newspaper advertisements point out that work done by association members is backed up by the set maker and the Greater Buffalo Association as well as by the service organization which does the work.

RUMORS, OLD AND NEW

TSA (Seattle) *Service News* reminds us of some unhappy rumors which never came to pass, happily:

"1948 TV will destroy the radio industry.
1948 TV will destroy the movie industry.
1952 Western Union is going to capture all TV service business with a national service chain.
1955 Transistors will destroy the tube industry.
1956 The single gun color picture tube will solve all color TV problems.
1956 Discount houses will put set retailers out of business.
and now—
1959 Japanese imports will destroy our American standard of living." (We don't think so. —*Editor*)

NCFEA MARKS YEAR

The North Carolina Federation of Electronic Associations, Inc., has finished its first year and is looking forward to greater activity in the next 12 months. The NCFEA had its first annual meeting in Charlotte, N. C., in late September. The bulletin of the association, *The Printed Circuit,* is mailed to over a thousand service

ARE YOU ON THE LIST?

Radio-Electronics is publishing a detailed list of the known television service associations in North America. If you belong to an association that isn't on our list or want to get the name and address of the one closest to you, drop a postcard to: Association Editor, Radio-Electronics, 154 West 14 Street, New York 11, N.Y.

NORTH CAROLINA FEDERATION OF ELECTRONIC ASS'NS, INC.

520 Main St.
Durham, N.C.
Garland Hoke, Secretary

ASHEVILLE TV ASSN.
Creaseman Radio & TV Service
Asheville, N. C.
Steve Creaseman, President

CALDWELL COUNTY TV ASSN.
Box 17
Whitnel, N. C.
Herbert Griffin, President

CAPITAL AREA RADIO & TV ASSN.
407 Peace St.
Raleigh, N. C.
James Staugh, President

CATABA VALLEY RADIO & TV SERVICE ASSN.
Box 1585
Hickory, N. C.
Frank Starr, President

CUMBERLAND COUNTY RADIO & TV ASSN.
2731 Bragg Blvd.
Fayetteville, N. C.
Fred Owens, President

ELECTRONIC TECHNICIANS' ASSN.
Box 5193
Winston-Salem, N. C.
Dave Drage, President

GREENSBORO TV SERVICE ASSN.
Spring Garden St.
Greensboro, N. C.
Joe Woods, President

HIGH POINT RADIO & TV TECHNICIANS' ASSN.
1228 Montlieu Ave.
High Point, N. C.
Wm. Warren, President

ONSLOW TV TECHNICIANS' ASSN.
712 New Bridge St.
Jacksonville, N. C.
J. E. Midgett, President

RADIO & TV SERVICE ASSN. of N. C., INC.
4114 Monroe Rd.
Charlotte, N. C.
Don Metcalf, President

RADIO & TV SERVICE DEALERS ASSN.
Box 222, East Durham Station
Durham, N. C.
L. L. Leathers, President

ROWAN-CARBARRUS BUSINESS MEN'S ELECTRONIC ASSN.
Jackson Ave.
Kannapolis, N. C.
Ernest Reid, President

SURRY TV SERVICE DEALERS' ASSN.
Box 308
Mt. Airy, N. C.
Russell Hiatt, President

WILMINGTON TV SERVICE DEALERS' ASSN.
c/o Sutton's TV Service
Wilmington, N. C.
W. P. Sutton, President

TELEVISION ELECTRONIC SERVICE ASSOCIATION OF KANSAS, INC.

Box 81, Chanute, Kan.
Paul Metzinger, Secretary

WICHITA CHAPTER, TESA OF KANSAS
841 S. Poplar St.
Wichita, Kans.
Homer Miller, president

SALINA CHAPTER, TESA OF KANSAS
333 N. Chalfin St.
Salina, Kans.
Fred Wallis, president

MIDWEST CHAPTER, TESA OF KANSAS
2324 N. Main St.
Great Bend, Kans.
Carlos Taylor, president

DODGE CITY CHAPTER, TESA OF KANSAS
712 W. Wyatt Earp
Dodge City, Kans.
Peter Noggle, president

SOUTHEAST CHAPTER, TESA OF KANSAS
8th and Lewis Sts.
Coffeyville, Kans.
Clint Nettles, president

PRATT CHAPTER, TESA OF KANSAS
605 E. First St.
Pratt, Kans.
Lloyd Myers, president

ARK CITY CHAPTER, TESA OF KANSAS
426 North A St.
Arkansas City, Kans.
Roger Thompson, president

PITTSBURG CHAPTER, TESA OF KANSAS
1327 N. Broadway
Pittsburg, Kans.
Robert Moore, president

CHANUTE CHAPTER, TESA OF KANSAS
Box 81
Chanute, Kans.
Paul Metzinger, president

HUTCHINSON CHAPTER, TESA OF KANSAS
110 E. Sherman
Hutchinson, Kans.
Lloyd Murphy, president

JUNCTION CITY CHAPTER, TESA OF KANSAS
115 W. 11th St.
Junction City, Kans.
James Dodd, president

BETTER ELECTRONIC SERVICE TECHNICIANS OF ARIZONA

Box 1284
Phoenix, Arizona
David J. Gordon, Secretary

BEST-TUCSON
4215 East 22nd St.
Don Wallace, Secretary

technicians all over the state, not just to members of NCFEA. At the end of this department will be found a list of local North Carolina associations with addresses for technicians who'd like to consider joining to work for licensing and many other common objectives.

TEAM MEMBERS SUE K.C.

Two service technicians, acting for the Electronic Association of Missouri (TEAM), have brought suit against the Mayor of Kansas City, the Chief of Police and the city itself. They seek a judgment declaring the recently enacted technician licensing ordinance unconstitutional. They also asked the court to restrain the city from enforcing the licensing ordinance until final court determination of the suit. It is likely that it will take a year or more before the suit is finally tried and settled.

Other groups, including TESA of Missouri, issued statements indicating their support of the city and its new licensing ordinance.

TECHS IMPORTANT TO SALES

The service committee of the Electronics Industries Association (EIA) said recently at a meeting in Atlantic City, "The development of a second-set market depends on how well satisfied the customer is with the maintenance on his first set." The committee is planning a continuing program aimed at improving customer relations.

Said Robert Larsen, president of the Long Island Radio & TV Guild, ". . . a fine idea. I think the past shows that service is vital to sales . . . that servicemen backed Zenith TV because Zenith didn't use printed circuits in its sets."

Max Liebowitz, Associated Radio & Television Servicemen of New York, thinks the program, "sounds good—when does it start? It's nice to know we've finally been recognized by the manufacturers. Now all we need is for them to back us in a licensing bill in New York State."

HOW TO GET AHEAD

This advice from Marty Boxer, of the Associated Radio–TV Servicemen of N.Y.:

a. Be sure you belong to your local association.

b. Through your association campaign for professional recognition by the city and state.

c. Take advantage of any courses

offered to advance your technical knowledge and skill.

d. Take refresher courses whenever possible.

e. Start taking courses in various phases of electronics such as sound, hi-fi, medical electronics, air conditioning. New gadgets and devices are being made available to the home owner and business firms. Be ready for them.

f. Last but not least, campaign for licensing. A license to operate will gain for you professional recognition and prevent the harmful element from entering our field."

ETG (MASS.) MEETS

At the last two meetings of the Electronics Technicians Guild of Massachusetts talks and demonstrations by Philco (September) and Motorola (October) were scheduled. Mr. Hy Leve, treasurer of the group for 25 years, was honored with a Certificate of Lifetime Membership.

TUBE-TESTER FRAUD CASE

Five men charged with mail fraud in selling tube testers pleaded not guilty in St. Louis Federal Court before Judge Roy W. Harper, who set the trial for Jan. 4. All five were officials or employees of Midwest Electronics of St. Louis. The charges concerned misrepresenting a tube-testing machine sold by Midwest.

ST. LOUIS GROUP ELECTS

Television & Electronics Service Association of St. Louis elected Ray Wirtel president, succeeding Fred Reichman, who became chairman of the Board. Ralph Newberry was chosen executive vice president; Gene Love, first vice president; Morton Singer, secretary; Wilma Tompkins, treasurer; Al Wulf, sergeant-at-arms.

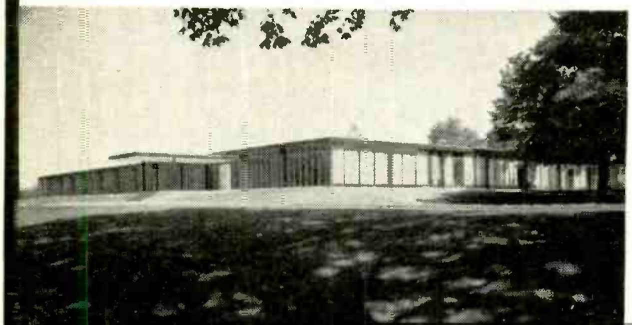
PITTSBURGH BBB REPORTS

A study by the Better Business Bureau of Pittsburgh reveals that there were 80 more customer complaints on TV sales and service in the first six months of 1959 (368) than in the first half of 1958 (288). The BBB checked 10 categories people complained about, finding more unhappy customers for home improvement and furniture and floor coverings, than for TV–radio.

There were 700 validated complaints involving unethical business practices in the home-improvement field in the area during the same period, an increase of 46 over 1958. Furniture and floor coverings caused 464 complaints, an increase of 81.

The complaints for TV–radio sales–service broke down for the 1959 period to: 22% were unhappy about nonfulfillment of contract or guarantee; 18% didn't like service or installation; 14% didn't get promised adjustment of some complaint; 10% got defective sets; 10% had goods misrepresented. It is interesting to note that most of these TV-radio complaints related to sales, not to service. END

CBS LABORATORIES
LEADER IN RESEARCH AND DEVELOPMENT



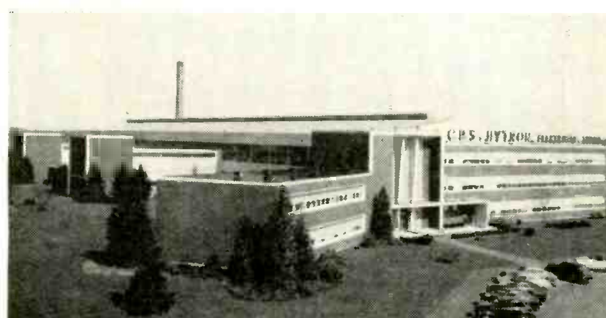
Pioneered in the creation of a practical color television system
Put on the air the world's first color TV broadcast
Developed airborne, guidance and electronic countermeasure systems
Produced revolutionary color television microscope
Co-operated with CBS Electronics in engineering improved electron guns and screens for color TV
Designed closed-circuit color TV for medical use
Also a leader in acoustics, recording, solid state physics, semiconductor, vacuum tube and advanced electronic systems research and development

CBS Laboratories, Stamford, Conn.

CBS ELECTRONICS
LEADER IN TUBE QUALITY AND DEVELOPMENT

Producers of receiving tubes top-rated by leading radio and TV set makers
Manufactured first practical color picture tube, CBS-Colortron
Introduced first Bantam GT receiving tubes
Originated first Bantam Jr. subminiature tubes
Pioneered the first rectangular picture tube
Designed first receiving tubes rated for Continuous Television Service

CBS Electronics, Danvers, Mass.



CBS DIVISIONS WORK TOGETHER FOR YOU...

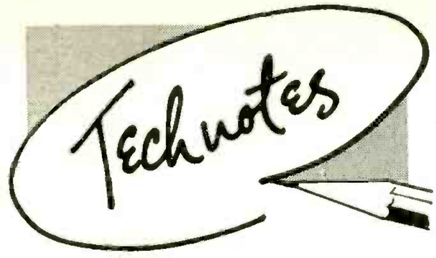
The CBS family habit of being first helps guarantee you the quality of performance that only leadership can deliver. This leadership is your further assurance that:

- CBS tube quality cuts your call-backs.
- CBS tube quality insures your customers of dependable performance.
- CBS tube quality guarantees profits for you.

Ask for the leader with the top-rated name your customers know and trust. Ask first for CBS.

CBS ELECTRONICS
Danvers, Massachusetts
Electronic manufacturing division of
Columbia Broadcasting System, Inc.

Receiving, industrial and picture tubes • transistors and diodes • audio components • and phonographs



PHILCO 51T1634

Complaint: Picture takes a long time to light. When it finally does, blooming is evident at high-brightness setting.

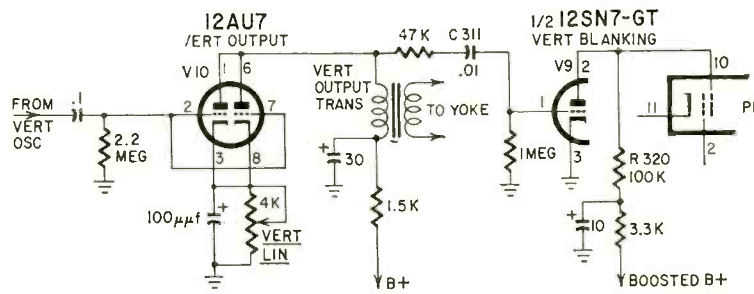
The two 2-megohm deposited-carbon resistors in the high-voltage cage had increased in value. They are connected between the plate and filament of the two 1X2's. Replace these resistors.—*Harry C. Keller*

G-E 16T, 16C, 17T, 17C SERIES

Lack of brightness, despite plenty of high voltage on some of these older models, can sometimes be confusing. I've run into two of these models in the past week with this trouble. In both cases the difficulty was traced to lack of sufficient voltage at pin 10 of the crt (grid 2). The .01-μf coupling capacitor, C311, had become leaky and the vertical-blanking half of V9, a 12SN7-GT, was drawing too much current, causing a large voltage drop across R320, the 100,000-ohm resistor coming from the B-boost, resulting in low voltage at the CRT.—*Eugene W. Klemm*

OSCILLATION AT 640 KC

A radio receiver was brought in with with weak volume. Even a nearby local station could barely be heard, and there was oscillation when it was tuned to 640 kc. Voltages, and resistances of coils and resistors, were closely checked against the values given in the servicing data, but none of the readings seemed abnormal. I was sure that the trouble was in the mixer stage but all readings were double- and triple-checked without results.

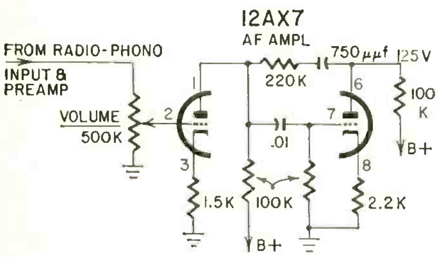


After almost despairing of ever finding the trouble, I thought of checking the capacitance of the mixer's plate load, the primary of the 455-kc input if transformer. This transformer was apparently normal since it seemed to tune to resonance at 455 kc. I bridged a small mica capacitor across the primary leads outside the shield. Volume increased and the set no longer oscillated at 640 kc. The transformer was replaced and the repair was completed.

The small capacitor in the if transformer was almost completely open. The remaining capacitance tuned the transformer primary to 640 kc. When the set was tuned to this frequency, it acted as a tuned-grid tuned-plate oscillator. *—Alfred L. Hollinden*

TINNY TAPE RECORDING

A Crescent tape recorder, model 907, developed the symptom of tinny recording. Trouble was found to be due to open-circuiting of the frequency-com-



pensating feedback capacitor. This capacitor is 750 µµf and is connected from pin 6 of the 12AX7 audio amplifier to a 220,000-ohm resistor. The other end of the resistor goes to pin 1 of the 12AX7.—*A. R. Clawson*

ZENITH 19K20

Complaint: No picture, no sound, good raster. The brightness control does not work.

The low-voltage rectifier circuit resistor between the 60- and 40-µf filters is open. This is a 4,000-ohm 10-watt unit. *—Harry C. Keller* END

"Our new set arrived, dear. It gets color, black-and-white, uhf, AM–FM, shortwave and who knows what else!"

STATEMENT REQUIRED BY THE ACT OF AUGUST 24, 1912, AS AMENDED BY THE ACTS OF MARCH 3, 1933, AND JULY 2, 1946 (Title 39, United States Code, Section 233) SHOWING THE OWNERSHIP, MANAGEMENT, AND CIRCULATION OF RADIO-ELECTRONICS, published monthly at Mount Morris, Ill., for Oct. 1, 1959.

1. The names and addresses of the publisher, editor, managing editor, and business managers are: Publisher, Hugo Gernsback, 154 W. 14 St., New York 11, N.Y.; Editor, Hugo Gernsback, 154 W. 14 St., New York 11, N.Y.; Managing editor, Fred Shunaman, 154 W. 14 St., New York 11, N.Y.; Business manager, None.

2. The owner is: (If owned by a corporation, its name and address must be stated and also immediately thereunder the names and addresses of stockholders owning or holding 1 percent or more of total amount of stock. If not owned by a corporation, the names and addresses of the individual owners must be given. If owned by a partnership or other unincorporated firm, its name and address, as well as that of each individual member, must be given.) Gernsback Publications Inc., 154 W. 14 St., New York 11, N.Y.; Hugo Gernsback, 154 W. 14 St., New York 11, N.Y.; M. Harvey Gernsback, 154 W. 14 St., New York 11, N.Y.

3. The known bondholders, mortgagees, and other security holders owning or holding 1 percent or more of total amount of bonds, mortgages, or other securities are: (If there are none, so state.) None.

4. Paragraphs 2 and 3 include, in cases where the stockholder or security holder appears upon the books of the company as trustee or in any other fiduciary relation, the name of the person or corporation for whom such trustee is acting; also the statements in the two paragraphs show the affiant's full knowledge and belief as to the circumstances and conditions under which stockholders and security holders who do not appear upon the books of the company as trustees, hold stock and securities in a capacity other than that of a bona fide owner.

5. The average number of copies of each issue of this publication sold or distributed, through the mails or otherwise, to paid subscribers during the 12 months preceding the date shown above was: (This information is required from daily, weekly, semiweekly, and triweekly newspapers only.)

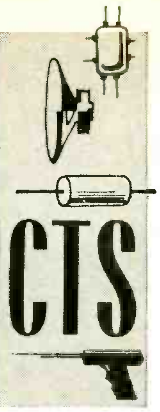
Hugo Gernsback, Publisher and Editor.

Sworn to and subscribed before me this 8th day of September, 1959.

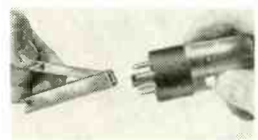
[SEAL] Joane Dodge, Notary Public.

(My commission expires March 30, 1960.)

new PRODUCTS



TUBE-PIN CRIMPER quick-operating tool slips over pin, crimps side of pin inward making positive contact with wire

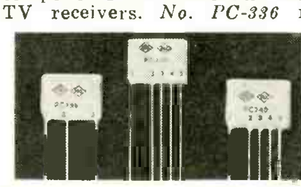


inside, eliminating soldering. End of tool wrench turns TV tuner channel-selector.—**Berns Mfg. Co.**, 9853 Chalmers, Detroit, Mich.

TV MASTER AMPLIFIER *model SA-23*, 38-db gain, two bands, channels 2–6 and 7–13.

Tilt and gain controls for each band. 6 lbs, 12 x 4½ x 5 in.—**Entron Inc.**, Box 287, Bladensburg, Md.

PACKAGED-CIRCUIT units, exact replacements for original components in Philco and RCA TV receivers. *No. PC-336* re-



trace suppression circuit, *PC-337* phase comparator circuit, *PC-340* agc voltage divider, *PC-338,339* sync time K network.—**Centralab Div. of Globe-Union Inc.**, 914 E. Keefe Ave., Milwaukee 1, Wis.

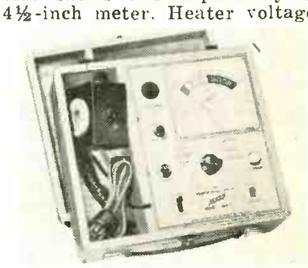
TV SET COUPLERS mount first, leads connect afterward. Weatherproof, snap-on cover. *No. 8917* for stations to 25

miles; *No. 8919* for fringe areas. —**General Cement Mfg. Co.**, 400 So. Wyman St., Rockford, Ill.

ADD-A-TESTER ADAPTERS plug into company's *model 260* volt-ohm-milliammeter to make it into: transistor tester *model 650* (shown), with beta ranges of 0–10, 0–50, 0–250 ±3%; dc

vtvm, *model 651;* temperature tester, *model 652;* ac ammeter, *model 653;* audio watt-meter, *model 654;* microvoltmeter *model 655;* or *battery tester, model 656.*—**Simpson Electric Co.**, 5200 W. Kinzie St., Chicago 44, Ill.

PICTURE-TUBE TESTER-REACTIVATOR *model CRT-2*, includes "multi-head" for connecting 8-, 12-, 14- and 7-pin bases. Handles 50°–110° tubes, 8–30-inch screens. Visual life test shows life expectancy on 4½-inch meter. Heater voltages

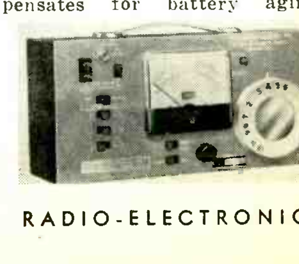


2.35, 8.4, 6.3.—**Century Electronics Co. Inc.**, 111 Roosevelt Ave., Mineola, N. Y.

TRANSISTOR RADIO SERVICE LAB includes three instru-

ments; *TRC Transistor Tester, PS103 Transipak Power Supply, HG104 Harmonic Generator,* permit complete testing, repair all transistor radios.—**Service Instruments Corp.**, 121 Official Road, Addison, Ill.

FIELD-STRENGTH METER. *Model TMT* transistor unit for TV technician field use weighs 4½ lb, uses four type-C cells. 100 μv to 2 volts in 8 switched ranges. Calibrating control compensates for battery aging.



THE WHOLE MULTI-MILLION DOLLAR MARKET HAS HEARD THAT

ASTATIC PLUG-IN CARTRIDGES

ARE THE ONLY COMPLETE LINE THAT MEETS EVERY SALES OPPORTUNITY

AS EASY AS CHANGING A LIGHT BULB
. . . NO INSTALLATION OR SERVICE PROBLEMS

You've had the message by now—that millions of plug-in phono cartridges have already been sold . . . that Astatic Plug ins represent a tremendous multi-million dollar replacement market . . . and that THE ONLY COMPLETE, SINGLE SOURCE PLUG-IN LINE ON THE MARKET IS ASTATIC'S!

So why not use the message? Act now to cash in on this RICH and SKY-ROCKETING MARKET. Get into the plug-in business and get into it all the way—never missing a single sale—with THE COMPLETE ASTATIC PLUG-IN LINE.

EASY, AUTOMATIC SALES WITH
ASTATIC MERCHANDISING PACKAGE

You sell from this plastic display-merchandiser which is pilfer-proof, holds an assortment of a dozen cartridges. Information under each cartridge tells the customer which model he needs. Colorful, attractive window card —free of charge—tells 'em you've got 'em!

CALL YOUR DISTRIBUTOR OR WRITE FOR FULL DETAILS

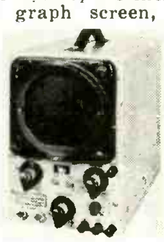
THE Astatic CORPORATION, CONNEAUT, OHIO
KNOWN THE WORLD OVER
IN CANADA: CANADIAN ASTATIC LIMITED, TORONTO, ONTARIO
EXPORT SALES: ROBURN AGENCIES INC., 431 GREENWICH ST., N. Y. 13, N. Y., U. S. A.

GO BY BRAND
—GO BUY ASTATIC

A MODEL FOR EVERY APPLICATION — STEREO OR MONAURAL — DIAMOND OR SAPPHIRE TIP

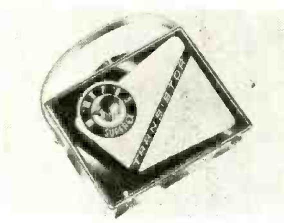
Checks antennas, couplers, TV distribution systems. — **Jerrold Electronics Corp.**, 15th and Lehigh Ave.. Philadelphia 32, Pa.

PROFESSIONAL SCOPE for TV and hi-fi applications. *Model S-16-A Craftscope:* 5-inch screen, edge-lit graph screen, vertical



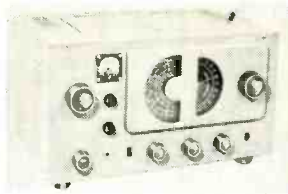
calibration, response dc–7 mc. 18 lb., 12½ x 7 x 10½ inches.—**Waterman Products Co., Inc.,** 2445 Emerald St., Philadelphia 25, Pa.

TRANSISTOR RADIO KIT *model DYN* 1 transistor, 1 diode. Earphone, ferrite antenna. Uses flashlight battery. Assembles



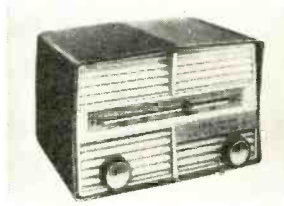
with screwdriver. — **Superex Electronics Corp.**, 4-6 Radford Place. Yonkers, N. Y.

COMMUNICATIONS RECEIVER *model HE-10*, 455 kc–31 mc in 4 bands; ham bands marked on dial, band spread. Sensitivity 1.25 μv, 10-db signal-



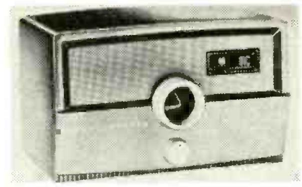
to-noise ratio, selectivity 60 db at 10 kc, image rejection 40 db at 3 mc. S-meter, bfo and rf gain controls, avc and noise limiter switchable, 8 tubes, hinged-top metal case. Available as kit, *model KT-200.*—**Lafayette Radio**, 165-08 Liberty Ave., Jamaica 33, N. Y.

FM RADIO RECEIVER *model R-20*, 6 tubes plus rectifier, 4-



inch speaker. Antenna supplied. 8⅝ x 5⅝ x 6⅞ in.—**Blonder-Tongue Laboratories. Inc.**, 9 Alling St., Newark 2, N. J.

FM COMMUNICATIONS RECEIVER *model PR-35*, 30–50 mc, temperature - compensated for drift, ratio detector, 4-inch speaker, 1.1 watts audio output,



sensitivity 10 μv, selectivity 100 kc. Similar receiver model *PR-155*, 152–174 mc.—**Monitoradio Div., I.D.E.A., Inc.**, 7900 Pendleton Pike, Indianapolis 26, Ind.

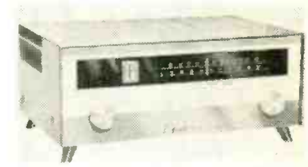
2-METER CONVERTER KIT *XC-2* for receivers tuning between 22 and 35 mc. Crystal control. Leads and chassis silver-plated. Companion 6-meter converter *XC-6*. Matches *Mohawk*

RX-1 receiver.—**Heath Co.**, Benton Harbor, Mich.

TWIN FM AND AM TUNERS *model SR-445* in one case with common power supply on FM

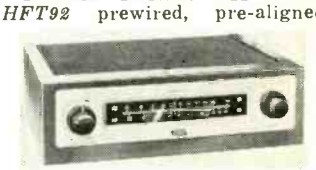
chassis, space for future insertion of multiplex adapter. FM sensitivity 2 μv, 40-db quieting, local–distant switch. AM rf stage, response 20–7,000 cycles, ferrite antenna. FM SR–443, or AM SR–442 available separately.—**Stromberg-Carlson Div. of General Dynamics**, Rochester 3, N. Y.

FM TUNER *model LT-80*. Sensitivity 1.5 μv, 20-db quieting. 8-tubes. Afc, Afc-defeat, tuning meter, image rejection 40 db, if

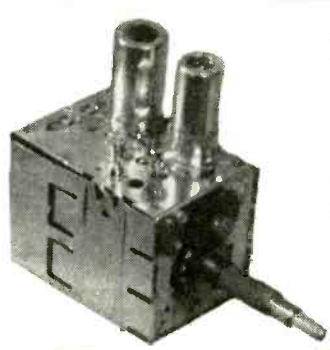


rejection 70 db, hum —60 db, factory wired and tested, complete with cage.—**Lafayette Radio**, 165-08 Liberty Ave., Jamaica 33, N. Y.

FM–AM TUNER KIT *model HFT92* prewired, pre-aligned

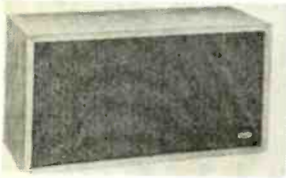


front end and if transformers. Dial indicator traveling "eye", cathode-follower output. Sensitivity FM 1.5 μv. 20-db quieting, AM 20 μv at 20-db signal-to-noise ratio. FM selectivity (if) 240 kc down 6 db, AM 6 db down 8 kc. FM drift 20 kc or less from



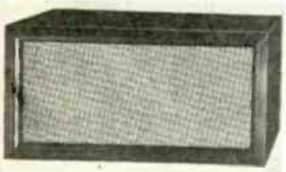
cold start, hum 60 db down, output 0.8 volt, FM image rejection 30 db, AM 40 db. AM distortion under 2% at 70% modulation. Ratio-detector slope 600 kc wide. Available factory-wired.—**EICO** 33-00 Northern Blvd., Long Island City 1, N. Y.

BOOKSHELF SYSTEM *TRIOU Tri-ette.* 3 drivers; 12-inch



woofer, 8-inch mid-range, horn tweeter, 2 crossover networks, tweeter and mid-range level controls. Enclosure unfinished gum hardwood, tube port, 25–15,000 cycles, 30 watts, 16 ohms. 13⅞ x 25 x 11⅝ in. Similar system, *DF-1U Duette,* 8-inch woofer, horn tweeter, 36–14,000 cycles; 25 watts, 16 ohms; 12½ x 24 x 10½ in.—**Jensen Mfg. Co.,** 6601 S. Laramie St., Chicago 38, Ill.

BOOKSHELF ENCLOSURE. Economy *model 108* partially rear-loaded resonator takes 8-

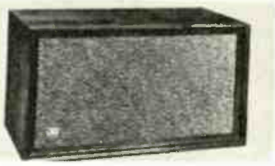


inch woofer or wide-range speaker. Panel removable for most tweeters. Finished on all 4 sides.—**Rockford Special Furniture Co.,** 2024-23rd Ave., Rockford, Ill.

BOOKSHELF SPEAKER *Monte Carlo* modified Helmholtz resonator, response 70–15,000

cycles, 12 watts continuous rating, 8 ohms impedance, separate tweeter and woofer. 4 concealed plastic feet. 15⅞ x 10¾ x 11⅞ inches. — **Frazier International Electronics Corp.,** 2649 Brenner Drive, Dallas 20, Tex.

ELECTROSTATIC SPEAKER SYSTEM *model KN-3000.* 12-inch woofer, 2 Janszen electro-



static tweeters with crossover filter and power supply in bookshelf speaker. Response 30–25,000, cycles, 50 watts power capacity, impedance 8 ohms, requires 115 volts ac.—**Allied Radio Corp.,** 100 N. Western Ave., Chicago 80, Ill.

TWEETER IN CABINET, *model S-348.* Variable level control, crossover included, re-

sponse 1,200–15,000 cycles, impedance 15 ohms. 3⅜ x 11 x 4¾ in.—**Olson Radio Corp.,** 260 S. Forge St., Akron, Ohio.

DISC CHANGER *model AG 1024* low-cost stereo 4-speed

unit, automatic intermix, push-button selection start, stop, reject. Manual operation with automatic stop at end of record, arm lift-off. Plug-in head shell, 5-wire system.—**North American Phillips Co., Inc.,** 230 Duffy Ave., Hicksville, N. Y.

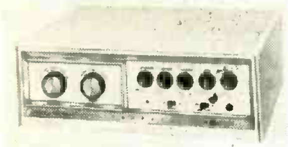
MOBILE TRANSISTOR AMPLIFIER *model KN-3225,* 25 watts, 100–10,000 cycles ±3 db, hum and noise —67 db, idling current under ¼ amp. 6 transistors, tone control, microphone, phono inputs. Power line plugs into cigarette-lighter receptacle in car or boat. 12-volt source. Output impedance 4, 8,

16 ohms. Metal cabinet, 10¾ x 6 x 3½ in high, shown with phono turntable mounted atop amplifier.—**Allied Radio Corp.,** 100 N. Western Ave., Chicago 80, Ill.

MINIATURE TAPE RECORDER made in Germany. 3-inch reels, 3¾ inches per second, uses 6 standard flashlight cells, speaker self-contained, output for headphones or ampli-

fier–speaker. 5 lbs, 7 x 3 x 11 in. **North American Industries,** Dept. GP-62, 101 W. 31st St., New York 1, N. Y.

STEREO AMPLIFIERS *series G-7600,* dual 20-watt power amplifier and control section, dual concentric bass and treble controls, balance, stereo reverse, loudness control, rumble filter, tape-head input, low-impedance tape outputs, distortion 1% at rated output, channel separation 40 db, hum and noise 58 db down. Similar *series G-7700* 28



watts per channel, add scratch filter, speaker phasing switch.—**General Electric Co.**, 1285 Boston Ave., Bridgeport, Conn.

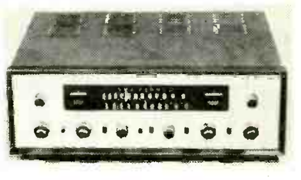
STEREO AMPLIFIER KIT *model SA-2*, dual 14-watt power

amplifiers, stereo control preamplifier, single chassis. Phono input sensitivity 3 mv; function switch mono, stereo, reverse; ganged tone controls, concentric friction-clutch volume controls. Speaker phasing switch. 2 ac utility outlets.—**Heath Co.**, Benton Harbor, Mich.

STEREO AMPLIFIER *model 360*. Dual 20-watt outputs with complete controls for each channel. 10 pilot lights indicate inputs in use. Noise and rumble filter switches. Null balance circuit uses switch to reverse phase of one channel while gain is adjusted for silence; releasing null

switch provides normal, balanced operation.—**Crosby Electronics, Inc.**, 135 Eileen Way, Syosset, N. Y.

STEREO TUNER CONTROL CENTER *model 202-T*, separate FM and AM tuners, master audio control. FM limits at 1 μv. AM rf stage, 10-kc filter, rotatable ferrite antenna, 2 volts AM output. Center-channel output for mid-channel power amplifier. Stereo preamp-control, hum



and noise −60 db, tape head inputs, loudness switch, AM broad–sharp switch, scratch and rumble filters, separate bass and treble controls each channel balance, stereo reverse. Wood cabinet optional.—**Fisher Radio Corp.**, 21-21 44th Drive, Long Island City 1, N. Y.

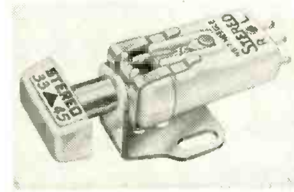
STEREO TAPE DECK *model MS-5*. 2-speed mechanism, response 30–16,000 cycles ±2 db, counter, pushbutton controls, rewind speed 110 seconds 1,200 feet. Plays and records quarter-

track at 3¾ and 7½ ips.—**Arkay International, Inc.**, 88-06 Van Wyck Expressway, Richmond Hill 18, N. Y.

STEREO CARTRIDGE *Stereodyne II*, twin moving coils, high

compliance, channel separation 30 db, flat response 20–15,000 cycles, low hum pickup.—**Dynaco, Inc.** 3916 Powelton Ave., Philadelphia, Pa.

CRYSTAL STEREO PICKUP cartridge *series 80* medium output; 0.8 volt, response 30–15,-

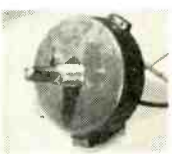


000 cycles, compliance 1.3 x 10^{-6} cm/dyne, separation 20 db, tracks 6–8 grams.—**Astatic Corp.**, Conneaut, Ohio.

STEREO PICKUP CARTRIDGE *model 380 Fluxvalve* response 2 db 20–20,000 cycles, output 15 millivolts, per channel, 4 terminals plus optional metal-case ground. Channel separation 25 db minimum. V-

Guard styli for stereo, mono and 78 discs slip into place readily.—**Pickering & Co., Inc.**, Plainview, N. Y.

NONCONTAMINATIVE POTENTIOMETER *series 61*, high-voltage wirewound control for use in food processing and



chemical production. 2½ watts, 10,000 volts dc, 2-inch diameter x ⅝ inch.—**Clarostat Mfg. Co., Inc.**, Dover, N. H. END

All specifications on these pages are from manufacturers' data.

Even SANTA shops by mail at RADIO SHACK!

Five fabulous bargains for mail-order Santas — typical of what you see month after month when you sign up to receive — FREE — Radio Shack's Bargain Bulletins. See coupon below!

STROMBERG-CARLSON $99.95 COAXIAL SPEAKER

60% off at Radio Shack!

$39.95 $2 down

SAVE $60 — 1959 Model RF483 true 2-way 15" coaxial speaker — for stereo, monaural, gifts!

The most extraordinary buy in hi-fi history — and we mean *high fidelity!* This chrome-and-red *fifteen pound* S-C master-piece features separately driven 100-watt 25 cps woofer, 115° dispersion tweeter that silks up to 18,000 cps, meticulously designed 3000 cps crossover. Radio Shack — and nobody else but Radio Shack — has this speaker to sell actually below dealer cost! Order one for quality monaural, two for an ultimate stereo system. Either way, you'll be getting a Rolls Royce for the price of a tin lizzie! 6¾" deep. 16 ohms. Ship. wt. 15 lbs.

RADIO SHACK'S TRANSISTOR GIFT SENSATION

Portable — built-in speaker, phone jack!

$9.95 *$19.95 value*

Ours exclusively — smashes all transistor radio prices! Order one for yourself, 2 more for friends, shut-ins, students, office — get all *three* radios for what you'd expect to pay for *one.* Excellent reception of every major station in metropolitan areas. Has built-in 2½" speaker, antenna, jack for earphone listening, Conelrad markings. Handsome molded case. Ship. wt. 2 lbs. each. Accessory earphone, battery extra (see coupon).

AMAZING "BASIC-10" CLASSICAL LP OFFER

A library of 10 reg. $4.98 famous-fidelity, famous-label (in disguise) records — literally a disk-opedia of music — at a history-making low price of less than $1.10 per record!

★ *NOT $2 chain store or supermarket disks!*
★ *EXACTLY the same music, "masters", and vinyl as this maker's reg. $4.98 label!*

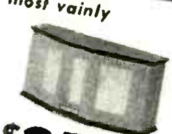
ALL 10 RECORDS $10.95 *$49.80 value!*

A Radio Shack exclusive! The great classics you've always wanted to give (or get) — nearly ten hours of great music — at a price that says order one set for your own collection, one or two others for gifts, for your school, your club! Superb highest-fidelity recordings, every one, pressed for a terminated Record Club offer. Radio Shack bought the entire remaining inventory and agreed not to disclose the maker's name, the artists or the world-renowned orchestras! (Though we've disguised the labels, when you hear these records you'll instantly recognize the virtuoso artists, the top-rated performances!). Included are: **Beethoven's Symphony No. 5; Schubert's "Unfinished" Symphony No. 8 and Symphony No. 5; Dvorak's "New World" Symphony; Bizet's Carmen Suite; Grieg's Peer Gynt Suite; Rimsky-Korsakoff's Scheherazade; Franck's Symphony in D minor; Tchaikovsky's 1812 Overture, Capriccio Italien, Piano Concerto No. 1, and Symphony No. 5; and a collection of Strauss Waltzes.** Every record is individually factory-sealed and handsomely jacketed. The entire group is in one easy-to-mail package — or break it up for 10 perfect single-record gifts. Ship. wt. 10 lbs.

INTERNATIONALLY ACCLAIMED ELECTROSTAT-3

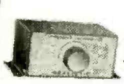
The REALISTIC masterpiece . . . the most vainly imitated tweeter in audio history!

Add unbelievably clean transparency and "spaciousness" to your speaker system with the super-high frequency tweeter *twice* top-rated as the "best — regardless of price"! 25,000 cps response when used with any of the better high compliance speakers. Complete, in cabinet 11⅞" x 5⅞" x 4½". Ship. wt. 7 lbs.



$27.50 $2 down

ELECTROSTAT-3 CROSSOVER NETWORK



$6.95 *$13.95 value*

Designed for Realistic Electrostat-3, but may be used with any 8 or 16 ohm tweeter-woofer combination for perfect balance between speakers. Ship. wt. 2 lbs.

33-FT. CHRISTMAS TREE LIGHTS

Always a sellout! 24-lite set at fabulous savings!

$1.79 *worth $5 a string!*

2 for $3.39

Sparkling decoration for any Christmas tree, wreath or mantle! 24 tiny red, yellow, blue, green and white lamps that twinkle on every 3 seconds. Green lamp-bases and wire, only 11" between bulbs, a full 33 feet long. A Radio Shack exclusive at this low price. Hurry! Ship. wt. 1½ lbs.

New 1960 Radio Shack ELECTRONIC BUYING GUIDE only 35c

50,000 sold! Practically an electronics education in itself.. 312 book-size 8½ x 11 rotogravure pages, profusely illustrated, crammed with articles, engineering data, complete specifications for over 40,000 electronic, hi-fi, optical, tool, record, gift items.

RADIO SHACK CORPORATION

RADIO SHACK CORPORATION, Dept. 12E
730 Commonwealth Avenue, Boston 17, Mass.
Send:
☐ Monthly Bargain Bulletins — FREE!
☐ Stromberg-Carlson speaker, 90LX215 @ $39.95
☐ Portable transistor radio, 90L601 @ $9.95 ea.
( ) Accessory earphone, 91L166 @ 69c
( ) Battery, 95L030 @ 59c
☐ "Basic-10" LP Library, 93W1889 @ $10.95
☐ Electrostat-3 tweeter @ $27.50 ea.
( ) 36CX017Y, mah.
( ) 36CX041Y, blond ( ) 36CX059Y, wal.
☐ Electrostat-3 crossover @ $6.95
( ) 91L534, 8 ohms ( ) 91L531, 16 ohms
☐ Christmas lights, 98L278 @ $1.79
☐ 1960 Electronic Buying Guide @ 35c
Name ________
Address ________
City ________ Zone ____ State ____
☐ Check ☐ Money Order ☐ C.O.D.

167 WASHINGTON STREET, BOSTON 8, MASS. • 730 COMMONWEALTH AVENUE, BOSTON 17, MASS. • 230-234 CROWN STREET, NEW HAVEN 10, CONN.

new PATENTS

ELECTRONIC BASS ORGAN

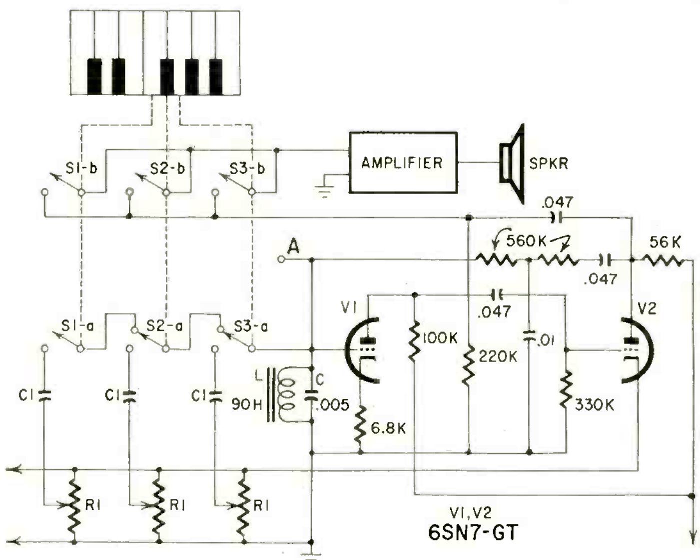
Patent No. 2,879,388

Thomas J. George, Los Angeles, Calif.

This solo instrument can serve as the pedal bass source for an electronic organ. V1 produces audio oscillations which overdrive V2. Limiting keeps the output constant, and the rich harmonics produce reedlike tones.

Each key controls a ganged switch pair, S1, S2, S3. Normally the tank (LC) determines the frequency, but this tone is not audible when a key is not depressed. When a key is depressed, the corresponding switch pair closes. S1-a connects the desired C1 capacitor to tune the desired frequency and S1-b transmits the signal to the amplifier.

If the arm were set at the grounded end of R1, the corresponding C1 would shunt L and lower the Q. If it were set at the other end, C1 would be across the V1's grid and V2's cathode. These elements are out of phase with relatively large potential difference (due to amplification). As a result, a relatively small capacitor at C1 can tune very low frequencies. Normally, R1 is set to mid-range and can vary frequency over about a 20% variation. As an example of the low capacitance required, C1 may be only .012 μf for 55 cycles. For 62 cycles use .009 μf; for 58 cycles, .01 μf.



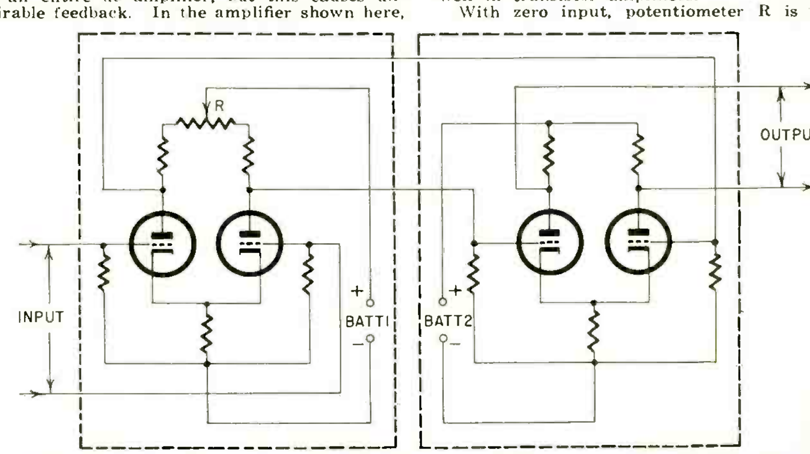
Note the second output from V2 to terminal A, through a low-pass filter. This output simulates a flute and may be used in place of the reedlike output if desired.

DIRECT-COUPLED AMPLIFIER

Patent No. 2,892,043

Louis Doshay, Van Nuys, Calif.

It is convenient to use a single power supply for an entire dc amplifier, but this causes undesirable feedback. In the amplifier shown here, the problem is avoided by separate supplies for each stage. Two stages are shown, each balanced in push-pull. This makes possible a cascade amplifier which does not have to have decoupling networks. The method described works equally well in transistor amplifiers.

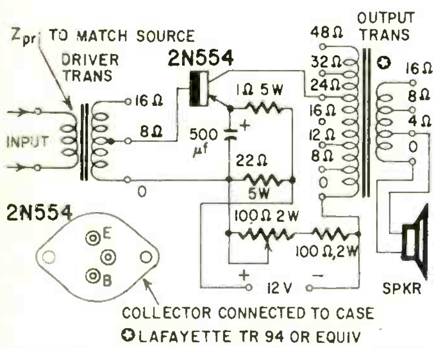


With zero input, potentiometer R is set for equal dc plate currents in the first stage. This assures that the dc component will not be passed on to the second stage. There is no feedback between stages because there are no common grounds. END

NOTEWORTHY CIRCUITS

CLASS-A POWER AMPLIFIER

This circuit provides a high-quality one-transistor audio power amplifier. The driver transformer's primary must be matched to the source impedance for optimum performance. This trans-



former's secondary matches the 2N554 on either the 8- or 16-ohm tap. Try both and use the one that gives the best results.

The output transformer is a universal transistor output type. The 24-ohm tap provides the best match with a 2N554. Power output of this stage is 2 watts with 7% or less distortion. Typical power gain is 34 db and current required is approximately 0.5 amp. —*Motorola Semiconductors*

LINEAR-SCALE OHMMETER

The standard ohmmeter has a scale which is rather nonlinear and gives poor accuracy in the high values because of crowding. An interesting idea has been proposed in the Russian magazine *Radio*

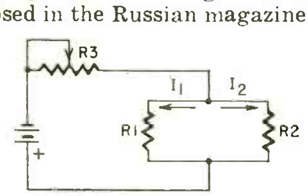


Fig. I

(Moscow, 3-59). It uses the fundamental circuit shown in Fig. 1. In this circuit, resistor R1 is a reference resistance and resistor R2 the unknown resistance. Then:

$$R2 = R1 \times \frac{I_1}{I_2}$$

which shows that R2 is proportional to I_1, and that a meter measuring I_1 will be linear in terms of R2 if I_2 is kept constant. Moreover, since the result is a relative measurement, it is independent of variations of the supply voltage or even of sensitivity.

Practically, measurement is made in

two steps. First, the meter is placed in series with R2, and potentiometer R3 is set to give a full-scale reading. Second, the meter is placed in series with R1, and resistance R2 is read directly off the meter's ohm scale. Need-

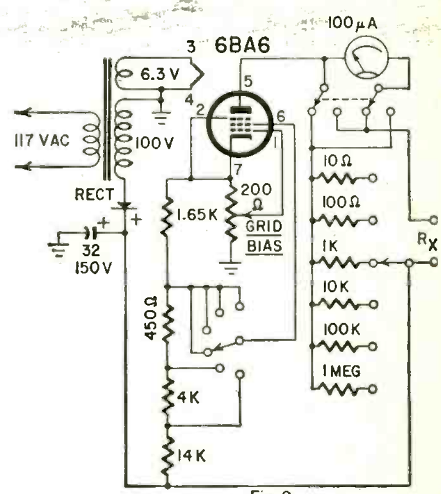
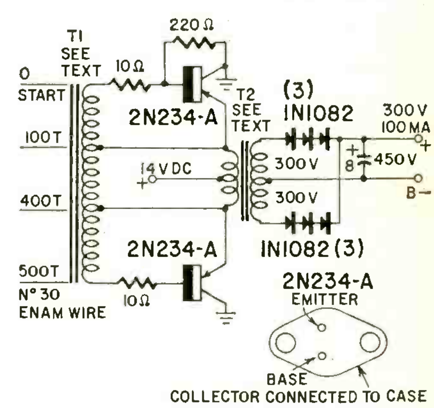


Fig. 2

less to say, reference resistances R1 are in powers of 10 for simplicity and single scale. Widely different values of R3 are needed for the various ohm scales. This difficulty is eliminated by using the internal resistance of a pentode tube as illustrated in Fig. 2. This resistance is adjusted by steps through the screen grid voltage, and the grid bias control becomes a vernier adjustment.—*A. V. J. Martin*

POWER PACK

The transistor power pack can be used to operate 20–50-watt amateur transmitters or other devices in that power class. T1 is wound with 500 turns of No. 30 enameled wire tapped and connected as shown. It may be wound on



a core salvaged from any small transformer with a ½-inch square center leg. T2 is a 12-volt vibrator transformer whose secondary is rated at 600-volt ct, 100-ma.

When higher power outputs are required, two transistor packs are connected in series at the output to give 600 volts at 100 ma with a 300 volt tap. If the circuit does not oscillate, phasing is wrong. To correct, reverse T2's primary leads. — *Bendix Semiconductors.* END

BUSINESS and PEOPLE

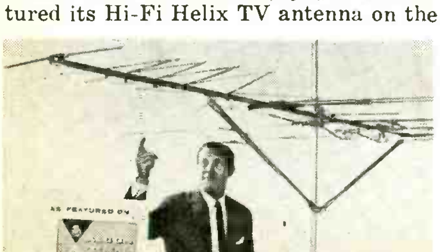
General Electric, Receiving Tube Dept., Owensboro, Ky., designed a new receiving tube display rack to help service technicians streamline tube sales and simplify inventory control.

Winegard Co., Burlington, Ia., is in the midst of a promotion program to boost antenna sales. The trade promotion is backed by a national Big TV

Show Time consumer campaign. Ads in *Life*, *Better Homes & Gardens* and other consumer magazines, feature TV stars Loretta Young, Ward Bond and Walter Brennan.

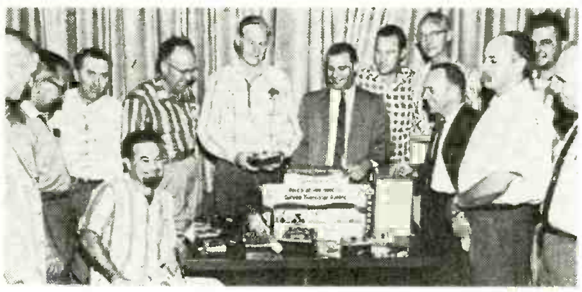
Heath Co., Benton Harbor, Mich., for the second successive year was awarded one of advertising's top honors, a certificate from the Direct Mail Advertising Association for its outstanding campaign. The award was made to Clifford M. Edwards, Heath director of advertising and sales promotion, at the DMAA Awards Breakfast during its convention in Montreal this fall.

JFD Electronics, Brooklyn, N. Y. featured its Hi-Fi Helix TV antenna on the



"Alcoa Presents" ABC-TV network program last month. Announcer Brooks Taylor did the commercial which was supplemented by advertisements in *TV Guide* and other consumer and trade publications and direct mail.

Henry Lehne was elected senior vice president of Sylvania Electric Products with overall responsibility for the Electric Systems Div. He had been vice president and general manager of that division in Waltham, Mass., and will continue to make his headquarters there.



Sencore, Addison, Ill., recently held a Time-Saving Clinic for the Van Nuys (Calif.) Society of Radio & TV Technicians, showing the advantages of troubleshooting with Sencore equipment. California representative Mark Markman (pointing to the new Sencore transistor radio service lab) and Ed Flaxman, Sencore sales manager (in dark suit), are shown explaining the equipment.

Pyramid Electric Co., Union City, N. J., is under full sail on four service technician promotions—on its transistor radio maintenance kit, Bakers' Dozen silicon rectifier promotion, Sweetheart Assortment (with a gift for the ladies) and VIP special assortment (the technician receives attache case with a purchase of an assortment of TD capacitors). Reps Jim Williams, William White, "Roly" Wedemeyer, Mike Stobin and Jack Berman (left to right) are shown receiving their VIP badges from Jack K. Poff, Pyramid sales manager, Distributor Div. The badges will also be awarded to distributor countermen in line with the promotion.

Mort Gaffin was appointed manager, special advertising and sales promotion programs, for RCA. He was formerly director, new Business and promotion, NBC spot sales.

Winegard Co., Burlington, Iowa, has been granted US Patent No. 2,891,748 for its universal tripod antenna roof mount introduced in 1956. The Jigger mount, as it is called, permits quick installation on any type of surface without guy wires or chimney brackets. A hammer is the only tool required in making an antenna installation.

Edward J. Keenan was named director of RCA Institutes Home Study School. He comes to the company from Franklin Institute, Rochester, N. Y., where he held a similar position.

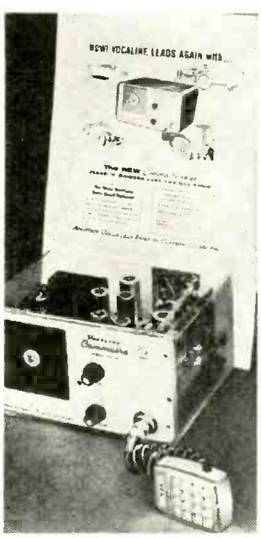
P. R. Mallory & Co., Inc., recently broke ground for a new 12,000-square-feet addition to its Distributor Div. warehouse in Indianapolis. Ray Sparrow, executive vice president, is shown digging the first shovelful of dirt as

J. E. Templeton, Distributor Div. manager, swings the pick at the informal ground-breaking ceremony.

Edward J. Naretta (left) was named sales director of G-C-Textron, Inc. (Rockford, Ill.), newly formed super sales division's Group 1 which includes five manufacturing divisions: General, Cement, Telco Electronics, G-C Electro-

craft, G-C Electronics Div. and the G-C Industrial & Government Div. Previously he was sales manager of G-C's Walsco Divisions. **Dan O'Connell** (right) joined G-C Textron as sales director of Group 2 which comprises Walsco Electronics, Audiotex and American Microphone. He comes to the company from Radion where he was one of the company's vice presidents.

Vocaline Co. of America, Old Saybrook, Conn., designed an Inside Story display for its new Commaire Citizens band radio. The display consists of a complete transceiver housed in a clear plastic case to show chassis, circuitry and parts.



EIA PRODUCTION AND SALES

(first 8 months)	*1959*	*1958*
Receiving tube factory sales	273,808,000	251,657,000
TV picture tube factory sales	5,943,985	4,952,862
TV set production	3,680,520	2,950,455
Radio production	8,946,044	6,193,529
FM radio production	290,862	134,653
TV retail sales	3,126,981	2,862,452
Radio retail sales	4,357,421*	3,806,519*

*Excluding auto receivers

END

new 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.

FM-AM TUNER is shown with full technical details and pictures illustrating use of controls of the model 320 tuner. *Catalog sheet 320.*—**H. H. Scott, Inc.,** 111 Powdermill Rd., Maynard, Mass.

TIPS ON SOLDERING for experimenters and production engineers, 2-page bulletin, *No. 101,* covers effects of rare metals, use of antimony in solder, and silver scavenging. Charts of physical characteristics are also included.—**Alpha Metals, Inc.,** 56 Water St., Jersey City 4, N. J.

SILICON POWER RECTIFIERS are described with complete specifications showing surge ratings, temperature range and dimensions in 1-page bulletin, *No. 71059.*—**Syntron Co.,** 604 Lexington Ave., Homer City, Pa.

BATTERY CHARGERS for 6- and 12-volt storage batteries in cars and boats are pictured and described. One page leaflet includes prices on these two compact chargers.—**Terado Co.,** 1068 Raymond Ave., St. Paul, Minn.

ADDITIONAL 1959 TV MANUAL is 4-page brochure describing a manual of supplementary data on 1959 sets along with all other service manuals published by the company.—**Supreme Publications,** 1760 Balsam Road, Highland Park, Ill.

MATCHING EQUIPMENT CABINETS identical with the company's speaker enclosures are shown with detailed dimensions.—**R. T. Bozak Co.,** Darien, Conn.

MOVIES ON TUBE MANUFACTURE and associated subjects are described with running time. Five subjects are included in this 2-page listing of 16-mm sound films available on free loan to organizations. Produced in England by Mullard. —**International Electronics Corp.,** 81 Spring St., New York 12, N. Y.

ARE YOU DESTROYING TRANSISTORS? is bulletin No. 2, Vol. 2, in the company's "Tube Tips" series. It's a 4-page discussion aimed at the practicing technician.—**CBS Electronics,** 100 Endicott St., Danvers, Mass.

SEMICONDUCTOR DIODES are listed with complete data and dimensions in 12-page *Characteristics and Replacement Guide.* The company's entire line of diodes is included along with a chart listing Sylvania replacements for many EIA types.—**Sylvania Electric Products, Inc.,** 1100 Main St., Buffalo, N. Y.

SEMI-CONDUCTOR DIRECTORY is 12-page listing of all transistors, diodes and rectifiers stocked by this mail-order house. Shows hundreds of types by number, manufacturer and application.—**Lafayette Radio,** 165-08 Liberty Ave., Jamaica 33, N. Y.

PICTURE-TUBE WALL CHART. *Bulletin PF-288* lists electrical characteristics, dimensions, basing and replacement possibilities for 360 TV picture-tube types.—**CBS Electronics,** 100 Endicott St., Danvers, Mass.

TRANSISTOR DESIGN DATA for entertainment devices is contained in 32-page booklet *Entertainment Transistors for Every Design Approach.* Over 50 transistors are thoroughly detailed for use in high fidelity, organs, toys, intercoms, radios, portables and car radios.—**Sylvania Electric Products, Inc.,** 1100 Main St., Buffalo 6, N. Y.

TRANSISTOR DISSIPATION RATINGS *for Pulse and Switching Service* is the title of 4-page *Bulletin AN-181,* for circuit design engineers and technicians. Nomographs show permissible peak dissipation when used with the table supplied.—**RCA Semiconductor & Materials Div.,** Somerville, N. J.

CABINETS AND ENCLOSURES for equipment and speakers *Bulletin R-14* shows add-on furniture, stereo consoles and record cabinets.—**Rockford Special Furniture Co.,** 2024 23rd Ave., Rockford, Ill.

PHONOGRAPH PICKUP CHART *Bulletin PF-285* is an 8-page cross-reference guide to 27 cartridges which replace over 500 models of various manufacture. Exact-size silhouettes are shown along with each model number.—**CBS Electronics,** 100 Endicott St., Danvers, Mass.

SERVICING PRINTED WIRING in typical radio and TV receivers is explored and explained in a 24-page manual, *Printed Circuit Servicing Techniques.* Use of manufacturers' data, soldering, component removal and replacement are thoroughly dealt with.—**RCA-Victor TV Div.,** Camden 8, N. J. **$1.** END

CORRECTION

The values of capacitors C16, 17, 19 and 20 are incorrect in the parts list for the transistor transceiver on page 56 of the October issue. These capacitors are all 100-μf, 3-volt units, as indicated on the schematic. We thank C. W. Burkland of Newton, Iowa, for calling this to our attention. (See also Correspondence Column.)

new BOOKS

ECHOES OF BATS AND MEN, by Donald R. Griffin. Anchor Books, Doubleday & Co., Garden City, N. Y. 4¼ x 7 in. 156 pp. 95¢

This charming little book is No. 4 of a Science Study Series created by the MIT Physical Science Study Committee (RADIO-ELECTRONICS, February, 1959, page 46). In language highly understandable to the layman, but quite readable to the engineer, the story of echoes is presented as a phenomenon in straight physics, from a biological point of view, and as applied in sonar and radar.

The author, who with Robert Galambos ("Bats and Radar", RADIO-CRAFT, April, 1945) performed some of the earliest experiments with modern apparatus on bats, gives some interesting examples of the use of echoes by other animals. He also details experiments in finding obstacles by sound that the reader can perform, and tells of experiments designed to find how blind persons "sense" obstacles. The chapter on sonar and radar contains some interesting comparisons between man's equipment and that of the bat.

Other titles in the series are *Magnets*, *Soap Bubbles* (a fascinating story of surface tension), *How Old Is the Earth*, and *The Neutron Story*.—*FS*

UNDERSTANDING TRANSISTORS, by Milton S. Kiver. Allied Radio Corp., 100 N. Western Ave., Chicago 80, Ill. 6 x 9 in. 64 pp. 50¢.

This little book introduces transistor fundamentals to those who already have some vacuum-tube background. In addition to providing a brief but sound theoretical foundation, it includes sections on the various types such as junction, drift, tetrode, surface barrier and other transistors. It illustrates practical applications in typical circuits.

This short introduction provides enough background to set the technician or student right in working with transistors.

CHAMBER'S TECHNICAL DICTIONARY (3rd edition revised, with supplement). Edited by C. F. Tweney and L. E. C. Hughes. Macmillan Co., 60 Fifth Ave., N. Y. 11, N. Y. 5½ x 8½ in. 1,028 pp. $7.50.

Long accepted as the authority by all who use technical words, this new edition contains "60,000 terms from 120 branches of scientific and industrial activity" ranging from acoustics through automation, electronics, guided missiles, radio, television and thermionics to zoology.—*FS*

PRINTED CIRCUITS, by Morris Moses. Gernsback Library, Inc., 154 W. 14 St., N. Y. 11, N. Y. 5½ x 8½ in. 224 pp. $2.90.

This book tells how to repair, paint, print and photograph your own printed circuits, and how to replace components on printed boards.

There are chapters providing actual layouts for making printed circuitry for a radio, an oscillator, radio controls and a wristwatch transmitter.

One section describes the latest miniature batteries and other parts associated with printed boards. Others show how to calculate inductance and capacitance in these circuits, and how to mount and solder parts on them. This book is required reading for everyone planning to work with printed wiring.—*IQ*

HAM RADIO HANDBOOK, by Robert Hertzberg, W2DJJ. Arco Publishing Co., Inc., 480 Lexington Ave., N. Y. 17, N. Y. 6½ x 9¼ in. 144 pp. $2.50.

Many books have been written to provide the would-be amateur radio operator or "ham" with the technical training he needs to get on the air. This book does not attempt that job. Instead it provides a wealth of practical information: what hams are, how to get a ham license, how to operate on the air.

Much equipment for sending, receiving and simple test work is shown, with prices. Numerous amateur stations in operation are shown. There are sections on selecting gear, mobile operation, the "Q" signals and other important items.

TRANSISTOR MANUAL, 4th edition. Semiconductor Products Dept., Adv. & Sales Promotion, General Electric Co., Charles Bldg., Liverpool, N. Y. 5½ x 8½ in. 227 pp. $1.

This new edition is for experimenters who want to know more than how to build from diagrams, without going into higher theory. It contains much useful information not easily obtainable elsewhere. It begins with semiconductor theory, transistor construction and characteristics. Biasing networks, amplifiers, hi-fi are explained with the help of equations and schematics. Practical information is given on service techniques, switching, computers.

It explains transistor specifications and symbols and contains a complete JEDEC listing and interchangeability guide. Diagrams show receivers, amplifiers, triggers, oscillators, etc.—*IQ*

PRINCIPLES OF ELECTRONICS, by M. R. Gavin and J. E. Houldin. D. Van Nostrand Co., Inc., Princeton, N. J. 5½ x 8½ in. 348 pp. $5.75.

This basic text on electronics for the serious student has numerous clear illustrations and clear physical descriptions. It provides good preparation for further study in engineering or physics. Familiarity with elementary calculus is assumed.

The book begins with electrons in motion and emission. Tube and transistor fundamentals follow. Feedback, oscillators, amplifiers, high-frequency tubes, detectors, wave shapers, noise, are included. About 250 probelms taken from school examination papers, with answers, appear at the end.—*IQ* END

1959 ANNUAL INDEX

Vol. XXX, January–December, 1959 RADIO-ELECTRONICS

KEY TO SYMBOLS AND ABBREVIATIONS

* Construction Articles
† Section of Full-length article
CI .... Television Clinic
Corr .... Correction
Corres .... Correspondence
NB .... News Briefs
NC .... Noteworthy Circuits
Pat .... New Patents
Tech .... Technotes
TTO .... Try This One
WN .... What's New

Regular departments not itemized are Business and People, New Books, New Literature, New Products (On the Market), Technicians' News.

SCHOOL DIRECTORY

LEARN
RADAR MICROWAVES
COMPUTERS—TRANSMITTERS
CODE • TV • RADIO
Phila. Wireless Technical Institute
1533 Pine St. Philadelphia 2, Penna.
A Non-Profit Corp. Founded in 1908
Write for free Catalog to Dept. R12-59

CODE SENDING RECEIVING SPEED

Be a "key" man. Learn how to send and receive messages in International Morse code. Communicate with operators around the globe. Learn at home quickly through famous Candler System. Used by best operators. Qualify for Amateur or Commercial License. Write for FREE BOOK.

CANDLER SYSTEM CO.
Dpt.3-0, Bx.9226, Denver20, Colo, USA

ELECTRONICS

Prepare for unlimited opportunities in electronics!

ENGINEERING DEGREE IN 27 MONTHS

B.S. Engineering degree (27 mo.): Mathematics, Electrical Engineering, TV, advanced Radio Theory and Design. B.E. (36 mo.): Aeronautical, Chemical, Civil, Electrical, Mechanical, Metallurgical Eng. B.S. (36 mo.): Math., Chem., Physics. Also preparatory courses. Earn board. G.I. approved. 20 bldgs., dorms, gym. Enter Dec., March, June, Sept. Catalog. Keeping pace with progress.

INDIANA TECHNICAL COLLEGE
1512 E. Washington Boulevard, Fort Wayne 2, Indiana

GET INTO
ELECTRONICS

V.T.I. training leads to success as technicians, field engineers, specialists in communications, guided missiles, computers, radar and automation. Basic and advanced courses in theory and laboratory. Assoc. degree in electronics in 29 mos. B.S. in electronic engineering obtainable. ECPD accredited. G.I. approved. Graduates in all branches of electronics with major companies. Start February, September, Dorms, campus. High School graduate or equivalent. Catalog.

VALPARAISO TECHNICAL INSTITUTE
Dept. C Valparaiso, Indiana

ELECTRONICS

PREPARE FOR A GOOD JOB!
BROADCAST ENGINEER
RADIO SERVICING AUTOMATION
TELEVISION SERVICING
BLACK & WHITE—COLOR
APPROVED FOR VETERANS AND SURVIVORS OF VETERANS
BUILDING AIR CONDITIONED
SEND FOR FREE LITERATURE
BALTIMORE TECHNICAL INSTITUTE
1425 EUTAW PLACE, BALTIMORE 17, MD.

REALIZE YOUR DREAM

Become a graduate Electronics Engineer. Share rewards awaiting college men . . . higher income, rapid advancement. Important firms interview seniors here regularly.

Electrical Engineer in 27 Months

B.S. degree in Electrical (Electronics or Power major), Mechanical, Civil, Chemical, Aeronautical Engineering. *In 36 Months* a B.S. in Business Administration (General Business, Accounting, Motor Transport Management majors). For earnest, capable students. Small classes. More professional class hours. Mature students. Well-equipped labs. Modest costs. Veteran approved. Year-round operation. Enter Jan., Mar., June, Sept. *Write J. G. McCarthy, Director Admissions, for Catalog and "Your Career" Book.*

TRI-STATE COLLEGE
24129 College Ave. Angola, Ind.

Learn Transistor Electronics At Home!

■ Prepare now for a profitable career in this growing field. Learn theory, construction and applications of all types of transistors with this proven home-study course from the Philco Technological Center.

FOR FREE INFORMATION PLEASE WRITE TO:
PHILCO®
TECHNOLOGICAL CENTER
Lehigh Ave. at 22nd, Philadelphia 32, Pa.

ENGINEERING COURSES

E.E.
Option Electronics or Power
Mechanical, Civil & Physics
Also in Liberal Arts & Business Administration
presented through
HOME STUDY
Resident Classes Also Available if Desired
PACIFIC INTERNATIONAL COLLEGE OF ARTS & SCIENCES
Primarily a correspondence school

PACIFIC INTERNATIONAL C.A.S.

5719 G. Santa Monica Blvd., Hollywood 38, Calif.

ENGINEERING
HOME STUDY COURSES

Courses written by world authorities in all branches of engineering and science and proved successful by thousands of our graduates. One hour each day in your spare time will start you off to higher pay, security and prestige. Personalized instruction methods ensure rapid progress. Fill in the coupon and indicate the course of interest. We will send you a complete outline of the course and a booklet describing the Institute and our advanced teaching methods.

RADIO
ELECTRONICS
TELEVISION
CIRCUIT MATHEMATICS
ELECTRICAL ENG.
TELEPHONY
CIVIL ENG.
SURVEYING
ARCHITECTURE
FORESTRY
MINING
STRUCTURAL
MECHANICAL ENG.
INDUSTRIAL ENG. & MANAGEMENT
REFRIGERATION
DRAFTING
PLASTICS
AERONAUTICAL ENG.
HIGH SCHOOL
CHEMICAL
MATHEMATICS
JOURNALISM
ACCOUNTING

MAIL THIS COUPON TODAY

CANADIAN INSTITUTE OF SCIENCE & TECHNOLOGY LIMITED
730 Century Bldg., 412, 5th St. N.W., Wash., D.C.

NAME....................
ADDRESS....................
CITY.................... STATE....................
COURSE OF INTEREST....................

Canadians: Send to C.I.S.T., 730 Garden Bldg., 263 Adelaide St. West, Toronto, Ontario.

C. I. S. T.

FREE CAREER BOOKLET

to guide you to a successful future in

ELECTRONICS
RADIO-TV
COMPUTERS
ELECTRICAL ENGINEERING

This interesting pictorial booklet tells you how you can prepare for a dynamic career as an Electrical Engineer or Engineering Technician in many exciting, growing fields:

MISSILES • RADAR • RESEARCH
ELECTRICAL POWER • ROCKETRY
AUTOMATION • AVIONICS
SALES • DEVELOPMENT

Get all the facts about job opportunities, length of study, courses offered, degrees you can earn, scholarships, part-time work — as well as pictures of the Milwaukee School of Engineering's educational and recreational facilities. No obligation — it's yours free.

MILWAUKEE SCHOOL OF ENGINEERING

MAIL COUPON TODAY!

MILWAUKEE SCHOOL OF ENGINEERING
Dept. RE 1259, 1025 N. Milwaukee St.
Milwaukee, Wisconsin MS-113

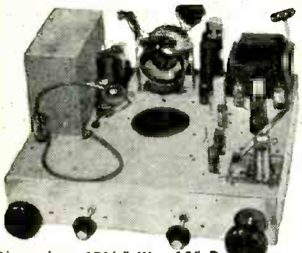
Please send FREE "Your Career" booklet
I'm interested in ☐ Electronics ☐ Radio-TV
☐ Computers ☐ Electrical Engineering
☐ Mechanical Engineering
(PLEASE PRINT)

Name.................... Age....
Address....................
City.......... Zone..... State..........
☐ I'm eligible for veterans education benefits.
Discharge date....................

1959—ANNUAL INDEX

DX-16 Super Deluxe TV KIT

70° or 90° — operating all 17", 21", 24" and 27" PICTURE TUBES



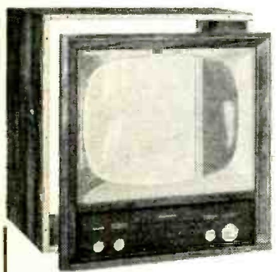
Dimensions 17½" W x 16" D
Shipping weight 40 lbs.

- ★ Produces a 16-Tube Chassis with 30-Tube performance.
- ★ Latest Intercarrier Circuitry and Multi-section Tubes.
- ★ Standard Neutrode Tuner for Selectivity & Fine Definition.
- ★ All Video and I.F. Coils factory pre-aligned and tuned.
- ★ Large 250ma Power Transformer for dependable service.
- ★ 12" Speaker or Twin-cone 6" x 9" Speaker.

Includes **LIFE-SIZE** step-by-step Building Instructions
Most Up-To-Date and Practical Course in Television

COMPLETE KIT
with SET of WESTINGHOUSE TUBES $93.49
4—6CB6, 6U8, 6T8, 6C4, 12BH7, 6SN7, 6BO6, 6W4, 6K6, 1X2B, 5U4, 6BN4, 6GC8, incl. in the Tuner (less CRT)

Also sold on **EASY-PAYMENT-PLAN** Buy LIFE-SIZE Instructions—$2.49—and buy Parts as you build.



BUILD YOUR OWN CABINET FOR ANY TV CHASSIS

Comparable to the type that Top Mfrs. use on high priced TV sets.

CABINET KIT with 90% of the job done, includes—
FRONT SECTION in Solid Mahogany, Walnut or Blond Korina. **TOP, SIDES, BACK, MASK, SAFETY GLASS, ETC.**
And EASY-TO-FOLLOW ASSEMBLY INSTRUCTIONS

Front, Top and Sides supplied in a beautiful Piano Finish ● Knob panel undrilled ● For matching Mask specify type or number of CRT used. Same price—Mahogany, Walnut or Blond. (Shipping weight 36 lbs.)

21" CABINET KIT 26"H, 25"W, 22"D $26.97

17" TV Cabinet Kit . . $24.97 24" or 27" TV Cabinet Kit . . $38.47 24" or 27" Front Panel Assembly . . $24.97

VM CHANGER 4-speed incl. Stereo Cartridge. . .	$26.94
RC-121 STEREO GARRARD CHANGER 4-speed	29.97
RC-88 STEREO GARRARD CHANGER 4-speed. .	44.62
RC-98 STEREO GARRARD CHANGER 4-speed	53.24
G.E. STEREO DIAMOND CARTRIDGE #GC7.	11.97
RONETTE or SONOTONE STEREO CART. .	3.49
RECORD CHANGER BASE. any type, any finish	3.41
RECORD CHANGER BOARD any type, unfinished	1.49
$99 NORELCO 12" HI-FI SPEAKER #9762M	35.97
$16 NORELCO 8" HI-FI SPEAKER #9770M .	6.94
12" UNIVERSAL TWIN-CONE SPKR. 6.8 magnet	5.97
PHONO MOTOR 4-speed complete with T.T. etc.	4.61
PHONO ARM complete with 4-speed Cartridge .	3.38
TWO-STATION INTERCOM. complete with tubes	15.38
110° TV CONVERSION KIT all Essential Parts	$17.42
90° TV CONVERSION KIT all Essential Parts. .	15.98
70° TV CONVERSION KIT all Essential Parts. .	13.97
AGC KIT complete w/6AU6 and Instructions . . .	4.59
UNIVERSAL 70° FLYBACK TRANSFORMER	4.86
UNIVERSAL 90° FLYBACK TRANSFORMER	5.24
UNIVERSAL 110° FLYBACK TRANSFORMER	5.74
17" TV MASK gray 13¾" x 17¼"	1.49
21" TV MASK gray 18" x 22½"	2.38
21" TV SAFETY GLASS 18" x 22½".	5.16
24" or 27" TV MASK gray 21" x 26"	4.93
24" or 27" TV SAFETY GLASS 21" x 26". . . .	5.87
AC-DC PHONO AMPLIFIER incl 12AT6, 50C5, 35W4	5.98
$27 4-SPEED PORTABLE PHONO. complete . .	13.78

Literature on CONVERSION & AGC KITS—Free on request. Stereo Changers and Cartridges we supply, play all records.

TUBULAR CONDENSERS—85°C TOP QUALITY—Equally as good for Radio or TV work

.0047-400v, .01-400v, .02-400v, .047-400v, .001-600v, .0047-600v, .01-600v, .02-600v, .03-600v 5¢ ea.
.1-400v, .25-400v, .47-400v, .047-600v, .1-600v, .25-600v, .001-1000v, .0047-1000v, .01-1000v. 8¢ ea.
.035-1000v, .047-1000v, .1-1000v, .007-1600v, .03-1600v, .05-1600v, .005-3000v, .001-6000v, 14¢ ea.

ELECTROLYTIC CONDENSERS—85°C

1-50v, 1-150v, 2-450v, 8-150v, 10-150v 19¢ ea.
20/20-150v, 50/30-150v, 40-150v, 10-450v, 20-450v, 30-450v, 40-450v, 60-450v, 80-450v. . . . . . 34¢ ea.

CARBON RESISTORS—Regular factory stock in Stackpole, Speer, etc.

½ WATT 10% 10, 39, 47, 100, 120, 150, 270, 330, 390, 470, 560, 680, 820, 1k, 1800Ω. . . . 2¢ ea.
½ WATT 10% 2700, 3300, 3900, 4700, 5600, 6800, 8200, 10k, 15k, 18k, 22k, 27k, 33kΩ. . . . 2¢ ea.
½ WATT 10% 39k, 47k, 50k, 56k, 68k, 82k, 100k, 120k, 150k, 180k, 220k, 270k, 330kΩ. . . . 2¢ ea.
½ WATT 10% 390k, 470k, 560k, 680k, 820k,Ω 1, 1.2, 1.5, 2.2, 6.8, 10, 15 MEGΩ. . . . . . 2¢ ea.
1 WATT 10% 3.3, 10, 39, 100, 120, 150, 330, 470, 560, 680, 820, 1k, 1800, 2700, 4700Ω. . 3¢ ea.
1 WATT 10% 6800, 10k, 15k, 18k, 22k, 27k, 33k, 39k, 47k, 68k, 82k, 100k, 150k, 470k, 680kΩ 3¢ ea.
2 WATT 10% 18, 22, 82, 100, 180, 2200, 3900, 4700, 6800, 8200, 18k, 22k, 100k, 470kΩ. . . . 4¢ ea.

WIREWOUND RESISTORS

5-5w, 16-10w, 20-10w, 47-5w, 100-5w, 140-5w, 220-5w. 16¢ ea.
280-10w, 390-5w, 470-5w, 600-10w, 680-10w, 820-5w, 1K-5w, 1K-10w, 1500-5w, 2K-10w. . . . 16¢ ea.
2500-5w, 3K-10w, 4700-5w, 5K-10w, 6K-10w, 7K-10w, 8200-5w, 10K-5w, 15K-5w, 22.5K-12w. . . 16¢ ea.

CERAMIC CONDENSERS 1, 2, 3, 5, 6.8, 10, 22, 25, 47, 50, 51, 56, 82, 100, 120, 150 mmf . . 3¢ ea.
CERAMIC CONDENSERS 220, 250, 270, 330, 470, 1k, 1200, 1500, 2k, 5k, 6800, 10k mmf . . . . 3¢ ea.
MICA CONDENSERS 5, 10, 25, 50, 56, 68, 75, 100, 120, 150, 220, 270, 330, 470, 510 mmf . . . . 3¢ ea.
MICA CONDENSERS 560, 680, 820, 1k, 1500, 2k, 2500, 3300, 4700, 6k, 6800, 8k, 10k mmf . . 3¢ ea.

☐ 200—SELF TAPPING SCREWS #8 x ½" $1	☐ 2—SELENIUM RECTIFIERS 100 ma $1	☐ 25'—INSULATED SHIELDED WIRE $1	☐ $15—"JACKPOT" TELEVISION PARTS $1
☐ 50—WING NUTS #6 chrome plated $1	☐ 1—SELENIUM RECTIFIER 450ma $1	☐ 32' TEST PROD. WIRE deluxe (red or black) $1	☐ 600—ASST. HDWARE screws, nuts, riv., etc. $1
☐ 1—2 MEGOHM RESISTOR 20w for #630 $1	☐ 1—LB. SPOOL ROSIN CORE SOLDER 40/60 $1	☐ 100'—FINEST NYLON DIAL CORD best size $1	☐ 8—ASST. LUCITE CASES handy for parts $1
☐ 1—SILICON RECTIFIER 750 ma 500v $1	☐ 3—TV ALIGNMENT TOOLS assortment #1 $1	☐ 1—$7 INDOOR TV ANT. hi-gain 3 sec. $1	☐ 75' MINIATURE ZIP CORD 2 Conductor $1
☐ 5—DIODE CRYSTALS 2—1N21 2—1N22 1—1N64 $1	☐ 3—TV ALIGNMENT TOOLS assortment #2 $1	☐ 1—RCA 70° FLYBACK TRANS. 75240 $1	☐ 2—KENRAD 6SH7 TUBES $1
☐ 3—DIODE CRYSTALS 1—1N60, 1—1N64, 1—1N69 $1	☐ 3—TV ALIGNMENT TOOLS assortment #3 $1	☐ 1—90° FLYBACK TRANS incl. schematic $1	☐ 3—RCA 6C4 TUBES $1
☐ 2—SELENIUM RECT.- 1—65 ma & 1—250ma $1	☐ 3—TV ALIGNMENT TOOLS assortment #4 $1	☐ 1—$11 TODD 60° DEFLECTION YOKE $1	☐ 2—GENERAL ELEC. 35W4 TUBES $1
☐ 2—SELENIUM RECT.- 1—75ma & 1—150 ma $1	☐ 3—TV ALIGNMENT TOOLS assortment #5 $1	☐ 2—ELECTRIC MOTORS 1½ volt. 1001 uses $1	TOP BRAND TUBES—1B3, 1X2B, OZ4, 5U4, 6SN7, 6CB6, 6U8, 6J6, 6V6, 6K6, 6X8, 6AX4, 12AU7 EACH $1
	EACH ALIGNMENT TOOL is different & valued at over $1	☐ 6—SOCKET WRENCHES 3/16" to 7/16" $1	

"ONE DOLLAR" Buys

As much as $24 worth — Everything Brand New and sold to you with a money back guarantee.

DEDUCT 10% ON ANY ORDER OF $10 OR OVER (ON DOLLAR BUYS)

Plus a FREE SURPRISE PACKAGE

10-TUBES #1U4 . . $1

Brand New, Mfd. by TUNG-SOL. Regular list price $2.40 ea. Also serves as a 1T4. 40,000 to go, without limit or reserve. First come first served. 10% off on orders over $10 applies.

☐ 1—3" PM SPEAKER alnico #5 magnet $1	☐ 100—ASST. ½ WATT RESISTORS some 5% $1
☐ 1—4" PM SPEAKER alnico #5 magnet $1	☐ 70—ASS'TED 1 WATT RESISTORS some 5% $1
☐ 1—5" PM SPEAKER alnico #5 magnet $1	☐ 35—ASS'TED 2 WATT RESISTORS some 5% $1
☐ 1—3½" TWEETER SPEAKER for Hi-Fi- $1	☐ 25—ASST. PRINTED CIRCUIT SOCKETS $1
☐ 3—AUDIO OUTPUT TRANS. 50L6 type $1	☐ 50—ASST. TUBULAR CONDENSERS $1
☐ 3—AUDIO OUTPUT TRANS. 6K6 or 6V6 $1	☐ 20—TUBULAR CONDENSERS .047-600v $1
☐ 2—AUDIO OUTPUT TRANS. 6K6 push-pull $1	☐ 15—TUBULAR CONDENSERS .47-600v $1
☐ 15—ASST. TV COILS sync, peaking, width $1	☐ 20—TUBULAR CONDENSERS .001-1000v $1
☐ 3—I.F. COIL TRANSFORMERS 456 kc $1	☐ 20—TUBULAR CONDENSERS .005-600v $1
☐ 3—I.F. COIL TRANSFORMERS 10.7 mc FM $1	☐ 20—TUBULAR CONDENSERS .01-600v $1
☐ 3—I.F. COIL TRANSFORMERS 262kc(auto) $1	☐ 15—TUBULAR CONDENSERS .25-600v $1
☐ 4—OVAL LOOP ANTENNAS ass't hi-gain $1	☐ 10—HV TUB. CONDENSERS .007-1600v $1
☐ 3—LOOPSTICK ANT. new ferrite adjustable $1	☐ 10—ASST. RADIO ELECTROLYTIC COND. $1
☐ 3—VARIABLE COND. super 420/162 mfd $1	☐ 5—ASST. TV ELECTROLYTIC COND. $1
☐ 3—ASST. SIZES RADIO CHASSIS PANS $1	☐ 2—ELECTROLYTIC COND. 40/40—450v $1
☐ 12—RADIO OSCILLATOR COILS 456 kc $1	☐ 3—ELECTROLYTIC COND. 80-450v $1
☐ 3—½ MEG. VOLUME CONTROLS w/switch $1	☐ 3—ELECTROLYTIC COND. 50/30—150v. $1
☐ 5—50K VOLUME CONTROLS less switch $1	☐ 30—FP CONDENSER MOUNTING WAFERS $1
☐ 5—ASST. 4 WATT WIREW'D CONTROLS $1	☐ 50—ASST. MICA CONDENSERS some in 5% $1
☐ 10—ASST. VOLUME CONTROLS less switch $1	☐ 50—ASST. CERAMIC COND. some in 5% $1
☐ 5—ASST. VOLUME CONTROLS w/switch $1	☐ 50—ASSORTED FUSES popular sizes $1
☐ 100—VOLUME CONTROL HEX NUTS $1	☐ 25' SPONGE RUBBER 1¼"x¼" many uses $1
☐ 10—SURE GRIP ALLIGATOR CLIPS $1	☐ 50—100KΩ ½ WATT RESISTORS 5% $1
☐ 1—GOLD GRILLE CLOTH 14x14 or 12x18 $1	☐ 50—470KΩ ½ WATT RESISTORS 10% $1
☐ 5—SETS SPEAKER PLUGS wired $1	☐ 50—2.2 MEGΩ ½ W. RESISTORS 10% $1
☐ 10—SETS PHONO PLUGS and PINJACKS $1	☐ 10—ASST. WIREW'ND RES. 5, 10, 20 watt $1
☐ 2—$2.50 SAPPHIRE NEEDLES 5000 plays $1	☐ 40—ASST. PRECISION RESISTORS best sizes $1
☐ 20—ASST. PILOT LIGHTS popular types $1	☐ 35—ASST. DISC CERAMICS best numbers $1
☐ 10—PILOT LT. SKTS. bayonet type, wired $1	☐ 35—DISC CERAMICS 5000 mmf $1
☐ 50—ASST. TERMINAL STRIPS 1, 2, 3, 4 lug $1	☐ 25—ASSORTED MICA TRIMMER Conds. $1
☐ 20—ASSORTED TUBE SHIELDS best sizes $1	☐ 10—6' ELECTRIC LINE CORDS w/plugs $1
☐ 35—ASST. RADIO KNOBS. scr. & push. $1	☐ 5—TV CHEATER CORDS w/both plugs $1
☐ 75—KNOB SPRINGS standard ⅜" x ½" $1	☐ 4—50' SPOOLS HOOK-UP WIRE 4 colors $1
☐ 100—ASSORTED KNOB SET-SCREWS $1	☐ 50—STRIPS ASST. SPAGHETTI best sizes $1
☐ 25—ASST. RADIO DIAL POINTERS $1	☐ 100—ASST. RUBBER GROMMETS best sizes $1
☐ 25—ASS'TED CLOCK RADIO KNOBS $1	☐ 100'—TWIN LEAD-IN WIRE 300Ω heavy duty $1
☐ 15—ASST. ROTARY SWITCHES $15 worth $1	☐ 50'—FLAT 4-COND. WIRE many purposes $1
☐ 3—TOGGLE SWITCHES spst, dpdt, etc. $1	☐ 35—MICA COND. 20-5mmf & 15-25 mmf $1
☐ 6—SLIDE SWITCHES spst, dpdt, etc. $1	☐ 35—MICA COND. 20-50 mmf & 15-68mmf $1
☐ 4—BAKELITE KNIFE SWITCHES dpdt $1	☐ 35—MICA COND. 20-100mmf, 15-270mmf $1
☐ 35—ASST. SOCKETS octal, nov. & miniature $1	☐ 35—MICA COND. 20-470mmf, 15-680mmf $1
☐ 5—TV CRT. SOCKETS with 18" leads $1	☐ 35—MICA COND. 20-820mmf, 15-1000mmf $1
☐ 3—TV CARTWHEEL CONDENSERS 20 kv $1	☐ 35—MICA COND. 20-2200, 15-2400mmf $1
☐ 2—TV CARTWHEEL CONDENSERS 30kv $1	☐ 35—MICA COND. 20-3300, 15-4700mmf $1
☐ 3—HV RECTIFIER SOCKETS 1B3 m'nted $1	☐ 35—MICA COND. 20-6800, 15-10,000mmf $1
☐ 3—HV RECTIFIER SOCKETS 1X2 m'nted $1	☐ 35—CERAMIC COND. 20-5mmf, 15-10mmf $1
☐ 20—ASST. TV KNOBS, ESCUTCHEONS, etc. $1	☐ 35—CERAMIC COND. 20-25mmf, 15-47mmf $1
☐ 25—ASST. PEAKING COILS popular types $1	☐ 35—CERAMIC COND. 20-56mmf, 15-82mmf $1
☐ 1—RCA SYNCHRO-GUIDE COIL #205R1 $1	☐ 35—CERAMIC COND. 20-100, 15-150mmf $1
☐ 1—RCA SYNCHROLOC COIL #208T8 $1	☐ 35—CERAMIC COND. 20-270, 15-470mmf $1
☐ 1—STANDARD AGC COIL 1R4AG $1	☐ 35—CERAMIC COND. 20-1000, 15-1500mmf $1
☐ 1—RATIO DETECTOR COIL 4.5 mc $1	☐ 35—CERAMIC COND. 20-2000, 15-5000mmf $1
☐ 1—RATIO DETECTOR COIL 10.7 mc $1	

HANDY WAY TO ORDER—Simply tear out advertisement and pencil mark items wanted (X in square is sufficient); enclose with money order or check. You will receive a new copy of this ad for re-orders.

ON SMALL ORDERS—Include stamps for postage, excess will be refunded. Larger orders shipped express collect.

BROOKS RADIO & TV CORP., 84 Vesey St., Dept. A, New York 7, N.Y.

TELEPHONE COrtland 7-2359

1959—ANNUAL INDEX

(Continued on page 154)

LAFAYETTE'S
1960 CATALOG
308 GIANT SIZED PAGES

Our 39th Year

The Complete Catalog Featuring
"The Best Buys In The Business"

FREE

FOR THE NEWEST AND FINEST IN STEREOPHONIC HI-FI EQUIPMENT AND SYSTEMS

- TAPE RECORDERS
- PUBLIC ADDRESS SYSTEMS
- AMATEUR EQUIPMENT
- INDUSTRIAL SUPPLIES
- MINIATURE COMPONENTS
- RADIO & TV TUBES AND PARTS
- EXCLUSIVE LAFAYETTE TRANSISTOR & HI-FI KITS

Send for Lafayette's FREE Catalog—the most complete, up-to-the-minute electronic supply catalog crammed full of everything in electronics at our customary down-to-earth money-saving prices.

CONTAINS HUNDREDS OF EXCLUSIVE LAFAYETTE ITEMS NOT AVAILABLE IN ANY OTHER CATALOG OR FROM ANY OTHER SOURCE — SEND FOR YOUR COPY NOW!

A "must" for the economy-minded hi-fi enthusiast, experimenter, hobbyist, engineer, technician, student, serviceman and dealer.

Leaders in Hi-Fi

The most complete selection and largest stocks of hi-fi components and systems—available for immediate delivery at the lowest possible prices. Save even more on Lafayette endorsed "best-buy" complete systems.

EASY PAY TERMS Available on orders over $20
Only 10% down—Up to 18 months to pay

Lafayette Radio

"Everything in Electronics"

FREE
308 GIANT SIZED PAGES

CUT OUT AND PASTE ON POST CARD

LAFAYETTE RADIO, Dept. JL-9
P.O. Box 222, Jamaica 31, N. Y.

SEND FOR THE WORLD'S LEADING ELECTRONICS, RADIO, T.V., INDUSTRIAL, AND HI-FI GUIDE

☐ Send FREE LAFAYETTE Catalog 600

Name ....
Address ....
City .... *Zone* .... *State* .....

Lafayette Superior Quality Hi-Fi Kits

50 WATT INTEGRATED STEREO AMPLIFIER

KT-250 IN KIT FORM **64.50**
LA-250 COMPLETELY WIRED **89.50**

● 50 WATTS MONAURALLY—25 WATTS EACH STEREO CHANNEL ● RESPONSE 17-21,000 CPS ± 1 DB (at normal listening level) ● UNIQUE "BLEND" CONTROL ● PREMIUM EL86 OUTPUT TUBES ● SEPARATE BASS AND TREBLE CONTROLS ● CLUTCH-OPERATED VOLUME CONTROL ● 3RD CHANNEL OUTPUT

A completely new stereo high fidelity amplifier with a high quality of reproduction, versatility of operation, and distinctive styling. A full range of controls enable you to enjoy the utmost in listening pleasure in any situation. Deluxe features include: unique "Blend" control for continuously variable channel separation—from full monaural to full stereo, 4-position Selector, Mode, Loudness and Phase switches. Also provided are outputs for 4, 8 and 16 ohm speakers. Hum-free operation is insured by the use of DC on all preamp and tone control tubes. Harmonic distortion, less than 0.25%. IM distortion, less than 1%. Hum and noise, 74 db below full output. Designed with the kit builder in mind, assembly is simple—no special skills or tools required. Complete with deluxe cabinet and legs, all parts, tubes and detailed instruction manual. Shpg. wt., 26 lbs.
KT-250 Stereo Amplifier Kit....................6.45 Down....................Net 64.50
LA-250 Stereo Amplifier, wired....................8.95 Down....................Net 89.50

LAFAYETTE PROFESSIONAL STEREO MASTER AUDIO CONTROL CENTER

Solves Every Stereo/Monaural Control Problem!

KT-600 IN KIT FORM **79.50**
LA-600 COMPLETELY WIRED **134.50**

- UNIQUE STEREO & MONAURAL CONTROL FEATURES
- AMAZING NEW BRIDGE CIRCUITRY FOR VARIABLE 3d CHANNEL OUTPUT & COSS-CHANNEL FEED
- PRECISE "NULL" BALANCING SYSTEM
- RESPONSE 5-40,000 CPS ± 1 DB
- 6 CONCENTRIC FRONT PANEL CONTROLS

A REVOLUTIONARY DEVELOPMENT IN STEREO HIGH FIDELITY.

Provides such unusual features as a Bridge Control, for variable cross-channel signal feed for elimination of "ping-pong" (exaggerated separation) effects. Also has full input mixing of monaural program sources, special "null" stereo balancing and calibrating system. 24 equalization positions, all-concentric controls, rumble and scratch filters, loudness switch. Clutch type volume controls for balancing or as 1 Master Volume Control. Has channel reverse, electronic phasing, input level controls. Sensitivity 2.2 millivolts for 1 volt out. Dual low-impedance outputs (plate followers), 1500 ohms. Response 5-40,000 cps ± 1 db. Less than .03% IM distortion. Uses 7 new 7025 low-noise dual triodes. Size 14" x 4½" x 10⅝". Shpg. wt., 16 lbs. Complete with printed circuit board, cage, profusely illustrated instructions, all necessary parts.
LAFAYETTE KT-600—Stereo Preamplifier kit ....7.95 Down........Net 79.50
LAFAYETTE LA-600—Stereo Preamplifier, Wired....13.45 Down....Net 134.50

Outstanding Design—Incomparable Performance

LAFAYETTE STEREO/MONAURAL BASIC POWER AMPLIFIER KIT

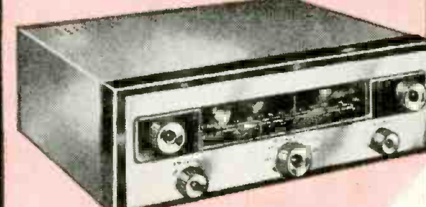
KT-310 IN KIT FORM **47.50**
LA-310 COMPLETELY WIRED **72.50**

- 36-WATT STEREO AMPLIFIER—18-WATTS EACH CHANNEL
- 2 PRINTED CIRCUIT BOARDS FOR NEAT, SIMPLIFIED WIRING
- EMPLOYS 4 NEW PREMIUM-TYPE 7189 OUTPUT TUBES
- RESPONSE BETTER THAN 35-30,000 CPS ± ½ DB AT 18 WATTS ● LESS THAN 1% HARMONIC OR INTERMODULATION DISTORTION

A superbly-performing basic stereo amplifier, in easy-to-build kit form. Dual inputs are provided, each with individual volume control, and the unit may be used with a stereo preamplifier, for 2-18 watt stereo channels, or, at the flick of a switch, as a fine 36-watt monaural amplifier—or, if desired, it may be used as 2 separate monaural 18-watt amplifiers! CONTROLS include 2 input volume controls, channel Reverse switch (AB-BA), Monaural-Stereo switch, DUAL OUTPUT IMPEDANCES are: 4, 8, 16 and 32 ohms permitting parallel (monaural) operation of 2 speaker systems of up to 16 ohms. INPUT SENSITIVITY is 0.45 volts per channel for full output. TUBES are 2-6AN8, 4-7189; GZ-34 rectifier. SIZE 9-3/16" d (10-9/16" with controls) x 5¼" h x 13¼" w. Supplied complete with perforated metal cage, all necessary parts and detailed instructions. Shpg. wt., 22 lbs.
KT-310 Stereo Power Amplifier Kit..................4.75 Down..................Net 47.50
LA-310 Stereo Power Amplifier, Wired..............7.25 Down..............Net 72.50

LAFAYETTE STEREO TUNER KIT

The Most Flexible Tuner Ever Designed



KT-500 IN KIT FORM **74.50**
LT-50 COMPLETELY WIRED **124.50**

● Multiplex Output for New Stereo FM ● 11 Tubes (including 4 dual-purpose) + Tuning Eye + Selenium rectifier Provide 17 Tube Performance ● Pre-aligned IF's ● Tuned Cascode FM ● Dual Cathode Follower Output

More than a year of research, planning and engineering went into the making of the Lafayette Stereo Tuner. 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.
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 stereo programs. Simplified tuning is provided by magic eye. Automatic frequency control "locks in" FM signal permanently. 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., 22 lbs.
KT-500 ....7.45 Down ....Net 74.50
LT-50 Same as above, completely factory wired and tested.
12.45 Down ....Net 124.50

LAFAYETTE RADIO

165-08 LIBERTY AVE., JAMAICA 33, N. Y.
AXtell 1-7000

NEW YORK, N. Y.	BOSTON, MASS.	BRONX, N. Y.	NEWARK, N. J.	PLAINFIELD, N. J.
100 6th Ave.	110 Federal St.	542 E. Fordham Rd.	24 Central Ave.	139 W. 2nd St.
WOrth 6-5300	HUbbard 2-7850	FOrdham 7-8813	MArket 2-1661	PLainfield 6-4718

NEW! Lafayette 50 Watt Complete Stereo Phono System

COMPLETE STEREO SYSTEM
174.50

COMPONENTS

LAFAYETTE LA-250 50-WATT STEREO AMPLIFIER	89.50
GARRARD RC121/11 STEREO CHANGER	41.65
NEW GE VR-22 (.7 MIL) DIAMOND STEREO CARTRIDGE	24.45
LAFAYETTE PK-111 WOOD CHANGER BASE	3.95
2-LAFAYETTE SK-58 FAMOUS FREE EDGE 12" COAXIAL SPEAKERS at 29.50	59.00
Regular Catalog Price	~~218.55~~

YOUR GUARANTEED BEST STEREO SYSTEM BUY!

YOU SAVE 44.05

This superb system will add a new dimension in living to your home with all the excitement and realism of a live concert. The new **Lafayette LA-250** 50-watt stereo amplifier (25 watts each channel) forms the heart of this outstanding stereo hi-fi phonograph music system—the features, versatility and advanced circuitry of this unit are second to none—all the necessary inputs and outputs are provided if you wish to add stereo tape and stereo FM/AM later. A unique blend control allows continuously variable channel separation—from full monaural to full stereo. Also included is the famous **Garrard RC121/11** intermix 4-speed automatic record changer with full manual or automatic operation supplied with your choice of stereo cartridges—the new **GE VR-22** (.7 mil) diamond stereo cartridge, **Pickering 371.7D** (.7 mil) diamond stereo cartridge, **Shure M7D** (.7 mil) diamond stereo cartridge or the new **Electro-Voice 31MD7** (.7 mil) diamond stereo cartridge. Supplied with the Lafayette **PK-111** wood base cut for the RC121 in your choice of finishes. These outstanding components are coupled with the 2-famous free-edge **Lafayette SK-58** 12" Coaxial speakers with built-in crossover network and brilliance level control. System supplied with plugs, cables and simple instructions. Shpg. Wt., 67 lbs.

HI-FI STEREO PHONO SYSTEM with choice of cartridge and mahogany, walnut or blond changer base (please specify).
HF-681. .... 17.45 Down ....Net **174.50**

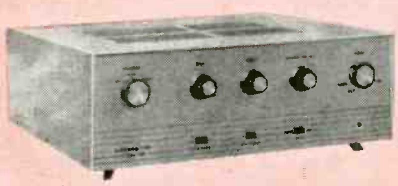
Same as *HF-681*, but with 2-Lafayette Eliptoflex Series Bookshelf Enclosures (please specify finish.) Shpg. Wt., 143 lbs.
HF-683. .... 22.99 Down .... Net **229.95**

STEREO AM-FM-PHONO SYSTEM: Same as HF-681 but including the new Lafayette LT-50 stereo tuner. Shpg. Wt., 85 lbs.
HF-682. ....28.75 Down ....Net **287.50**

Unquestionable Economy—Elegant Styling

LAFAYETTE 36-WATT INTEGRATED STEREO AMPLIFIER KIT

NEW! KT-236 IN KIT FORM 52.50

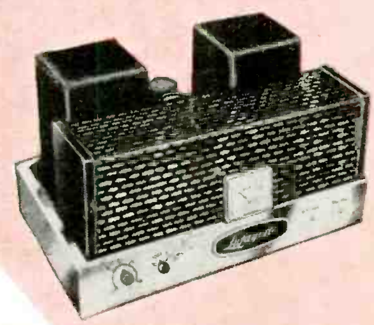


- 36 - WATTS MONAURALLY - 18 - WATTS PER CHANNEL
- FREQUENCY RESPONSE 15-30,000 CPS ± 1 DB
- UNIQUE "BLEND" CONTROL
- CONCENTRIC CLUTCH - OPERATED VOLUME CONTROL
- DUAL CONCENTRIC BASS AND TREBLE CONTROLS.
- 4 - EL84 TUBES IN PUSH PULL.

An outstanding achievement in kit engineering . . . This exciting new amplifier kit combines dual preamplifiers and dual 18 watt power amplifiers on one compact chassis. It's complete versatility allows connecting both stereo and monophonic sources permanently, with instant selection provided by the turn of a switch. Controls include an amazing new "Blend" control which provides continuously variable channel separation from full monophonic to full stereo, thus insuring the correct degree of stereo separation for individual listening tastes and room acoustics. Additional features are: Concentric clutch-operated volume control for independent or simultaneous level adjustments of both channels; Dual concentric bass and treble controls furnish 4 independent tonal adjustments; Selector Switch provides for Aux, Tuner and Phono. Dual output impedances are: 8 and 16 ohms. Harmonic distortion is less than 0.15% at normal listening level. IM distortion is less than .3%. Hum and noise 70 db below rated output. Complete with cage, legs and detailed instructions. Shpg. wt., 24 lbs.
KT-236 Stereo Amplifier Kit .... 5.25 Down .... Net **52.50**

DELUXE 70 WATT BASIC AMPLIFIER

KT-400 IN KIT FORM 69.50
LA-70 COMPLETELY WIRED 94.50



- 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 ± 1 db. 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—In Kit Form .... 6.95 Down .... Net **69.50**
LA-70—Completely Wired .... 9.45 Down .... Net **94.50**

MONEY-BACK GUARANTEE

Lafayette Kits are exclusive products of Lafayette Electronics. Each Lafayette Kit must meet or exceed its published specifications, or your money is refunded in full.

FREE! 1960 CATALOG — CUT OUT AND PASTE ON POST CARD

LAFAYETTE RADIO
P.O. BOX 222
JAMAICA 31, N. Y.
DEPT. JL-9

Name..
Address..
City.......................... Zone....... State..............

1959—ANNUAL INDEX *(Continued from p. 150)*

ADVERTISING INDEX

Radio-Electronics does not assume responsibility for any errors appearing in the index below.

SCHOOL DIRECTORY PAGE 147

Baltimore Technical Institute
Canadian Institute of Science & Technology
Candler System Co.
Indiana Technical College
Milwaukee School of Engineering
Pacific International College of Arts & Sciences
Philadelphia Wireless Technical Institute
Philco Techrep Division
Tri-State College
Valparaiso Technical Institute

BRANCH ADVERTISING OFFICES: Chicago: 5500 N. Menard Ave., Chicago, SPring 4-1444. **Los Angeles:** Harker-Husted-Coughlin, 600 South New Hampshire, Tel. DUnkirk 7-2328. **San Francisco:** Harker-Husted-Coughlin, 444 Market St., Tel. GArfield 1-2481.
FOREIGN AGENTS: Great Britain: Atlas Publishing and Distributing Co., Ltd., 18 Bride Lane, London E.C. 4.
Printed in the United States of America

The transcription turntable that's

HARD TO GET *but* WORTH WAITING FOR

It's the Thorens TD-124 . . . hailed by hi-fi fans . . . acclaimed by critics . . . highly recommended by leading technical and consumer publications

Demand for the famous Thorens TD-124 transcription turntable has exceeded expectations. We've had trouble keeping up with orders in some cases. We are pleased at the unexpected demand, but unhappy that we cannot serve all of you immediately.

Looking back now, we can see how irresistible these TD features (most of them lacking in competing turntables) are to the person who wants true stereo fidelity:

- 4 speeds . . . TD-124 gives you all of them: $16\frac{2}{3}$, $33\frac{1}{3}$, 45, 78.
- $11\frac{1}{2}$ pound table for smooth running . . . 12" TD-124 gives you more rotating mass than professional 16-inch turntables.
- Exclusive double-table with clutch for fast starts . . . lets you start record with needle in groove.
- Precision, hairline adjustment for all speeds . . . a simple knob that's easy to turn while record is playing . . . no screwdriver, no special wrench, no mechanic's license needed.
- Built-in illuminated strobe . . . you can see it and use it while record is playing to set electrically exact speed (or you can adjust speed by ear to musically exact pitch to play record along with any musical instrument).
- Easy arm installation or change . . . no metal drilling, no unsightly holes after arm change.
- Built-in precision circular level . . . same kind used on precision instruments . . . plus large knurled leveling screws . . . lets you check and adjust turntable level any time.

These are just a few of the outstanding features of the precision Swiss-crafted Thorens TD-124. See them all and hear this fabulous turntable at your franchised Thorens dealer's today. You'll agree that it's the turntable you've been waiting for.

9.18

Guaranteed for one full year. Sold only through carefully selected franchised dealers

THORENS SWISS MADE PRODUCTS—MUSIC BOXES • HI-FI COMPONENTS • SPRING-POWERED SHAVERS • LIGHTERS

New Hyde Park,
New York

$99.75 net