Radio-Electronics

JANUARY 1960

IND

New Series: Design Your Own Preamplifier

HUGO GERNSBACK, Editor

Repair Your Own Volt-Ohm-Milliammeter

How Infrared Guides Missiles

Faster Servicing For Record Changers

Citizens Band Radios Constructed from Kits

See page 110

More Articles on Industrial Electronics

50c

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Ceramic Model 333 is a wide-range microphone offering a similarly high new level of perfection for tape recording, P. A. Systems, etc.

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Model	Type	Output	Frequency Range	Impedance	Finish	List Price
331	Ceramic	-56 db	300- 5,000	High	Black Body and Grille, Chrome Cap	$17.90
333	Ceramic	-58 db	30-12,000	High		17.90
335H	Dynamic	-56 db	50-12,000	High	TV Grey Body, Chrome Cap and Grille	26.50
335L	Dynamic	-57 db	50-12,000	Low		23.50

NOTE: Model 331 has momentary-on, spring-return switch, is furnished with hang-up bracket. Cable provides for audio and relay connections. All other models have slide switch with "lock-on" position, are complete with lavalier and stand adaptor with 5/8"-27 thread.

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JANUARY, 1960

Radio-Electronics

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

EDITORIAL

INDUSTRIAL ELECTRONICS

TELEVISION

AUDIO-HIGH FIDELITY

TEST INSTRUMENTS

ELECTRONICS

RADIO

ON THE COVER

(Story on page 110)

The author's son proves that at least some of the operations of wiring up a Citizens radio set are so simple as to be boy's play.

Color original by Jacques Saphier

Average Paid Circulation Over 187,000

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News Briefs

FM KEEPS GROWING after slump several years back threatened its very existence. Growth is shown by increased sales of FM–AM sets, more FM-only models, and more stations authorized and on the air. (See also page 8, October, 1959.)

Of the 8,500,000 radios sold in 1957 only about 2% included FM. In 1958, the percentage was up half again to 3% of total radio sales, and last year's sales of FM and FM–AM radios was close to 5% of all sets sold. (These figures don't include hi-fi components.)

Zenith, who manufactured an FM-only set years ago, is again putting out such a receiver. Now Sylvania is introducing an FM-only set, and Granco Products has been making FM-only sets for about 3 years. Other big manufacturers are reported about to go into the market with similar table models for FM only.

Recent FCC figures indicate that FM stations on the air were up (as of October, 1959) to 646 over the 578 of Dec. 31, 1958. In addition, 157 more FM stations are authorized to go ahead with construction.

MARS NET SCHEDULE for January is set for Wednesdays, SSB, 9:00 pm EST on 4030 kc upper sideband: Jan. 6—"The Atomicron," Philip Heath; Jan. 13—"Antenna Multicouplers," Carl Southeimer; Jan 20—"TV and the Amateur Operator," G. G. Lentzakis; Jan. 27—"Reinforced Plastics in Communications Products," W. H. Greenberg and J. H. McCoy.

The First Army Military Affiliate Radio System (MARS Net) presents lectures with open discussion on 4030 kc following the talks every Wednesday except during the summer.

SALT WATER CUTS METALS better than more conventional tools, using a stream of brine around a copper bit to etch away super-hard jet-age metals. Developed by the Anocut Engineering Co. (Chicago), this process follows somewhat the same approach as the etching of surface-barrier transistors. The se-

Electronic Highlights of 1959

As advertised in advance, 1959 became the biggest year yet, measured by numbers of new developments and inventions, and units of electronic gear manufactured and sold. It was a year that saw electronics guiding satellites and space probes around the earth, moon and sun, as well as sending back information from many of these vehicles. (The US launched 9 of the 12 successful space travelers during the first 11 months.) There were numerous interesting new applications of electronics to medical ends: controlling heartbeats, improving artificial larynxes, providing proton-beam brain scalpel, to mention three.

Ultrasonics (and sonics) kept spreading, new uses ranging from measuring the thickness of meat on cattle to controlling the combustion rate of rocket fuel.

As the sky filled nearer to capacity with ever-faster aircraft our industry developed more complex and better radar and communications techniques to keep pace.

There was continuing development of long-range propagation techniques, at ever-higher frequencies aided by better masers and paramps. As always, the emphasis was on preparation of warlike devices (for example, long-range missile detection), pointing to vastly improved products for peacetime communications for commerce, education and entertainment.

While the first short TV movie was sent over the new trans-Atlantic cable via slow-scan facsimile, a first step toward overseas TV, over 20 countries were linked here, in Europe, Africa and Asia via cables and microwaves for 3 hours of high-quality radio broadcasts on United Nations Day. And the Post Office made a large appropriation to research facsimile transmission of letters coast to coast.

This was the year which saw more Japanese semiconductors, tiny transistor radios, vacuum tubes and other components imported than in all previous years combined.

High fidelity marched ahead, too, however uncertain some of the steps seemed. Although 16 2/3-rpm discs still existed primarily for Braille Talking Books, highway hi-fi got set to try again—RCA put standard 45-rpm records in new DeSotos and Plymouths. Stereo discs and playback systems became commonplace (and fashionable). The tape cartridge was reintroduced; this time machines to play it were actually in the stores. Meanwhile, most of the magnetic recording industry got together, bringing out quantities of reel-to-reel four-track tape at 7½ inches per second. And every recorder maker brought out a stereo machine, many of them stereo recorders. More stereo broadcasts than ever before went onto regular weekly schedules over numerous stations, while the stereo multiplex situation remained unresolved, though progress was made. Music lovers were gladdened by a magic ingredient RCA put into its discs to kill snap, crackle and pop due to static attraction of dust to the grooves.

Electricity was generated directly from gas by four teams here and in England. One model powered a 3,000-pound electric tractor on propane.

The unfinished dream of Tesla, sending power by radio waves, took a large step toward practical achievement as Raytheon brought out the Amplitron, a high-power tube with high conversion efficiency and improved heat dissipation, which promised to take raw ac and beam many watts miles overhead to sky stations.

The year 1959 saw the 25th anniversary of the FCC with almost 5,000 commercial broadcast stations, over 200,000,000 receiving sets, more than 1,500,000 mobile and portable communications stations, and over 185,000 radio amateurs licensed. By year's end there were probably more than 50,000 Citizens band radio users, and scores of thousands more were expected shortly.

Jan. 20
Cold-cathode tube eliminates heater, points to much greater tube reliability; Tung-Sol and Signal Corps. *(March, p. 6; April, p. 98)*

Feb. 17
Vanguard II, first weather-reporting satellite, launched.

March 5
Sylvania, General Telephone merge into General Telephone & Electronics Corp.

March 11
Nuvistor, very small rugged vacuum tube. High reliability, extremely long life. Production predicted for 1960 by developer, RCA. *(May, p. 6; June, p. 40)*

March 19
Radar contact with Venus verified. *(May, p. 47)*

March 23
Field-effect tetrode. Semiconductor can be transformer, isolator, stable short-circuit resistance and operate in other complex ways previously impossible without extensive circuitry. *(June, p. 16)*

May 25
First truly portable TV set uses transistors. Philco. *(June, p. 10; July, p. 56; August, p. 46)*

May 28
G-E announces fuel cell using hydrogen and oxygen combining directly to generate dc at 60% thermal efficiency. *(August, p. 6; November, p. 6; December, p. 16)*

July 20
Tunnel diode shown here by G-E. Oscillates and amplifies at frequencies possibly up to 10,000 mc. Very low noise, extremely low power required. Invented in Japan by Esaki in 1958. *(September, p. 6)*

Aug. 7
Explorer VI, "paddle-wheel," launched. Extensive instrumentation employing solar cells. Crude picture of clouds sent back. *(October, p. 10)*

Aug. 17
ITU (International Telecommunications Union) starts once-every-10-years meeting in Geneva to consider 5,000 proposals, mostly frequency allocations. *(November, p. 6; December, p. 12)*

Aug. 18
Avalanche diode (compensated), three-layer silicon device with low dynamic resistance, low noise and low temperature coefficient announced by Shockley Transistor Div., Beckman Instruments.

Aug. 24
Phonograph for autos using standard 45-rpm discs introduced by Plymouth, DeSoto, RCA for 1960 cars.

Sept. 22
Second Atlantic Cable opened for service, connecting phone networks of US and western Europe. *(November, p. 6)*

Oct. 2
Lunik III orbits moon, taking crude pictures of unseen side, transmitting pictures to earth.

Oct. 27
G-E announces electricity made directly from hot gas. Efficiency of engine reported 50%, 90% ultimately possible.

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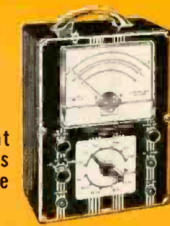

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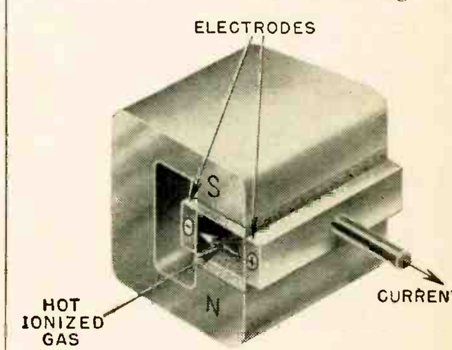
2068

cret is in the use of direct current with the brine to etch the metal in a sort of reverse of electroplating. Besides providing greater speed than ordinary methods, the Anocut process preserves the bit's cutting edge.

MICROWAVE LINK TO ALASKA will run 1,250 miles across Canada, using 50 towers spaced an average of 25 miles apart. The system will have two broadband links, one a standby, each capable of carrying up to 120 telephone or telegraph channels, or even a TV program.

The United States plans to lease one link for 10–15 years, thus financing the job, estimated at about $20,000,000. RCA-Victor Ltd. of Montreal will build the system for Canadian National Telegraphs.

MAGNETOHYDRODYNAMIC generation of power (MHD) is the name given by General Electric scientists to a new way of producing electricity direct from heated gas. The method is based on the movement of an electrical conductor through a magnetic field. In this case, the conductor is a plasma of heated air or other gas. As the drawing shows, the hot ionized gas, which is a conductor, is directed through the magnetic



field. The effect is the same as if an infinite number of copper wires, with their ends contacting the front and rear electrodes, were pushed through the space between the magnets. Current is taken from the electrodes.

In tests, a single unit produced—for a short time—900 watts at approximately 30 volts, with an efficiency of 50%. This is already more efficient than the best steam units, and theoretically much higher efficiencies are possible. The unit is essentially a homopolar generator, and produces direct current.

MHD power generation could be utilized in a space vehicle in either a closed cycle for continuous power or an open cycle for short bursts of power. In the closed-cycle system, solar energy or a nuclear reaction would be used as the heat source and the gaseous conductor would be continually recirculated. The open cycle could use a small solid-fueled rocket motor for a heat source. Rocket motors now exist to provide from 1 to 3 second's operation, sufficient, for example, to provide the high power necessary to transmit a television image from a space vehicle on the moon.

(Continued on page 14)

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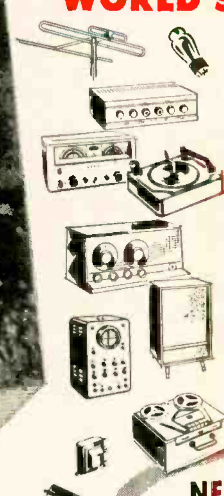

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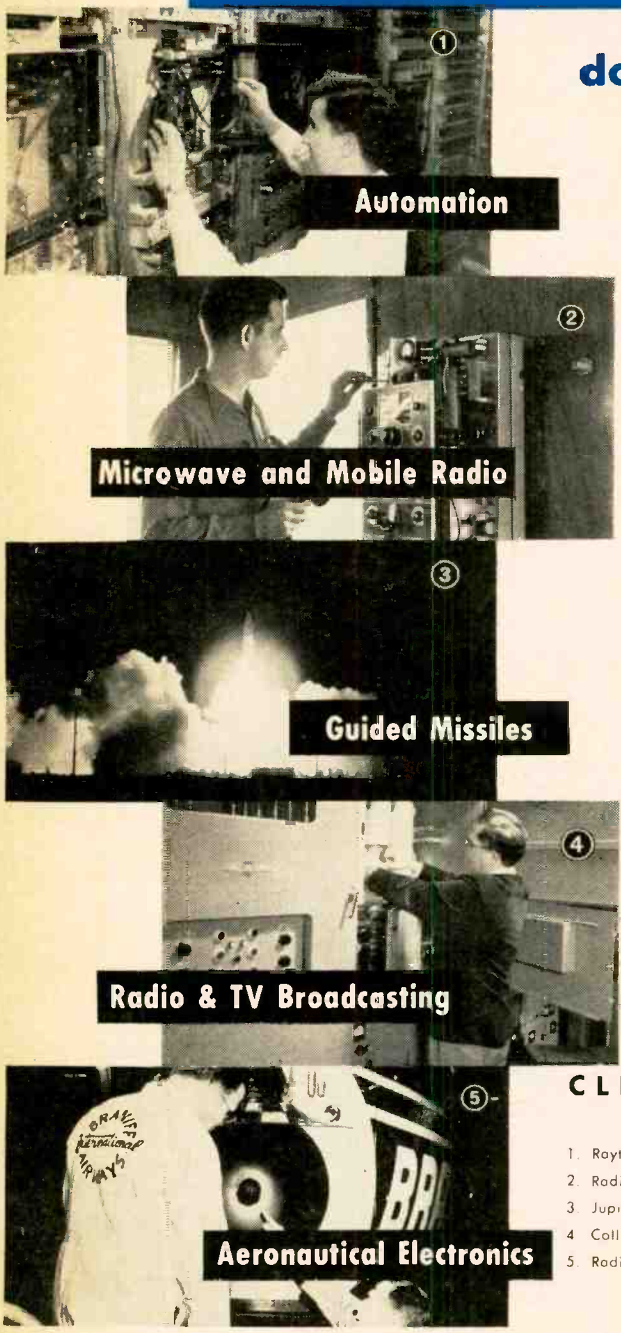

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You will also find out which jobs require the FCC License . . . where technicians are needed . . . what a technician needs to know about electronics . . . and many other facts about opportunities for you in electronics.

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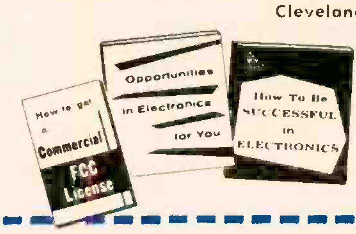

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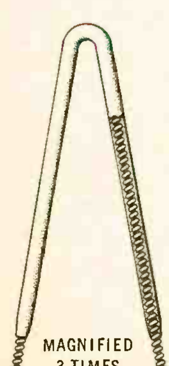

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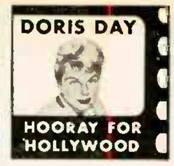

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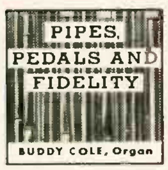

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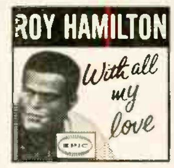

40. I Miss You So, Speak Low, Time After Time, 9 more

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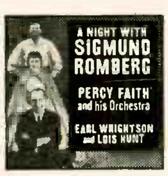

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You may accept the monthly selection for your Division, take any other records offered (classical or popular), or take NO record in any particular month.

Your only obligation as a member is to purchase five selections from the more than 150 Columbia and Epic records to be offered in the coming 12 months . . . and you may discontinue your membership at any time thereafter.

FREE BONUS RECORDS GIVEN REGULARLY: If you wish to continue as a member after purchasing five records, you will receive a Columbia or Epic stereo Bonus record of your choice free for every two selections you buy — a 50% dividend.

The records you want are mailed and billed to you at the regular list price of $4.98 (Classical and Original Cast selections, $5.98), plus a small mailing and handling charge.

MAIL THE COUPON TODAY!

NOTE: Stereo records must be played only on a stereo phonograph

COLUMBIA (Lp) RECORD CLUB Terre Haute, Indiana

SEND NO MONEY — Mail coupon to receive 6 stereo records for $4.98

COLUMBIA (Lp) RECORD CLUB, Dept. 202-6
Stereophonic Section, Terre Haute, Indiana

I accept your offer and have circled at the right the numbers of the six records I wish to receive for $4.98, plus small mailing and handling charge. Enroll me in the following Division of the Club:

(check one box only)

☐ Stereo Classical ☐ Stereo Popular

I agree to purchase five selections from the more than 150 records to be offered during the coming 12 months, at regular list price plus small mailing and handling charge. For every two *additional* selections I accept, I am to receive a 12" Columbia or Epic stereo Bonus record of my choice FREE.

Name..
(Please Print)

Address..

City..........................ZONE....State..........................

ALASKA and HAWAII: write for special membership plan
CANADA: address 1111 Leslie St., Don Mills, Ontario

If you want this membership credited to an established Columbia or Epic record dealer, authorized to accept subscriptions, fill in below:

Dealer's Name..

Dealer's Address..21

CIRCLE 6 NUMBERS:

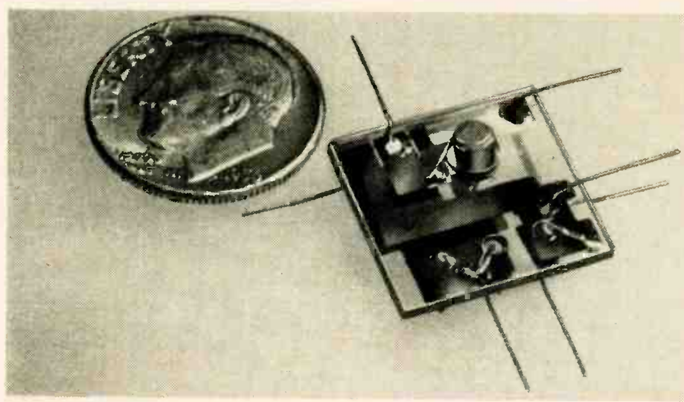
1	13	31
2	14	33
3	15	34
4	17	35
5	18	36
6	19	37
7	22	39
8	24	40
9	25	47
10	26	49
11	29	50
12	30	56

P-BC

NEWS BRIEFS *(Continued from page 8)*

The closed-system generation could be used on long space flights for such things as radio communication, light, heat, air conditioning and electrical propulsion. While MHD power generation may some day be applicable to other areas than space vehicle power—internal-combustion engine exhausts could be used after a certain amount of superheating—the technique will require considerable development and time before it may be used for stationary power generation.

MINIATURIZATION down to the molecular level has been achieved by research workers of the International Resistance Co. Going one step beyond the "printed" or engraved circuit, its elements are evaporated onto the board—called a "substrate"—in layers which can be reduced to a few molecules thick.



The glass substrate is drilled to provide holes for diodes and transistors, cleaned thoroughly by chemical or ultrasonic means and placed in a vacuum, where what IRC research scientists call a "relatively thick" (2,000 to 5,000 Angstrom units) conducting layer is deposited on it. A mask confines the deposit to desired areas.

A second mask is placed on the substrate, and another layer—this time a dielectric layer—is evaporated onto the surface. A third step deposits the resistors, and a final one puts on the "top plates" of capacitors. Of course, the unit has to be taken out of the vacuum chamber between each step, for fitting the masks. After all the evaporation–deposition operations, the active elements (transistors, etc.) are soldered into place and input and output leads connected.

It has been possible to deposit resistances with values up to 100,000 ohms, capacitances up to 1 μf per square inch and inductors up to 1 μh in .05 square inch.

A technique similar in some ways was recently developed by Bell Labs (October, 1959, page 6).

3 NEW TV STATIONS are programming:

KLYD-TV, Bakersfield, Calif.....17
KNDO-TV, Yakima, Wash..........23
WABG-TV, Greenwood, Miss....... 6

Two returnees have reactivated:

WFAM-TV, Lafayette, Ind.........18
WICC-TV, Bridgeport, Conn.......43

WFAM-TV, off the air for 6 months, resumed under new ownership and on a new channel. WICC-TV, which had closed down Aug. 12, 1959, for a month, didn't reopen until Nov. 7, 1959.

Two stations left the network, however:

KHTV, Portland, Ore..................27
WTOV-TV, Norfolk, Va..............27

WTOV-TV quit per agreement to merge with WVBC-TV, Hampton-Norfolk, Va., channel 13. Note that WVBC-TV changed over from channel 15. Also, KCCC-TV, Sacramento, Calif., channel 40, has a new call, KVUE.

Canada has upped its total by two:

CJCB-TV-1, Inverness, N.S..........6
CJSS-TV, Cornwall, Ont...............8

CJCB-TV-1 is a satellite of CJCB-TV, Sydney, N.S., channel 4.

The US roundup of operating stations is now 565, including 473 vhf and 92 uhf. The noncommercial figure of 43 remains the same. Canada's total has moved up to 58.

MACHINE READS 10 handwritten words, "zero" to "nine," as a first step toward machines for scanning ordinary handwriting. Words must be written on special surface. Believed to be the first machine ever built which will read handwritten script, it was developed by Leon Harmon of Bell Labs.

The machine encourages good handwriting. Writers must dot their i's if they expect to be understood, for example. They may not print or lift the stylus between letters.

RADIOPHYSICS AND SPACE RESEARCH CENTER of Cornell University will have charge of the world's largest and most powerful radar, construction of which will start soon in Puerto Rico (page 12, December, 1959).

The 1,000-foot radar dish will have only limited motion of its beam—about 20° in each direction—because of its size. It will have a tripod mounted on the dish 600 feet high to support the feed antenna. The radar will pulse 2.5 million watts at about 420 mc into space.

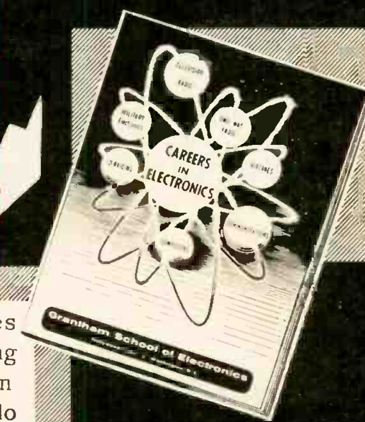
Venus, Mars, Mercury and the sun will be contacted with this installation, and it is hoped that Jupiter, 400,000,000 miles away, will also be reached.

(Continued on page 18)

Learn Electronics

PREPARE FOR YOUR F. C. C. LICENSE—YOUR TICKET TO A BETTER JOB AND HIGHER PAY!

This booklet FREE!



This free booklet gives details of our training and explains what an F.C.C. license can do for your future.

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 (residence or correspondence), we train you quickly and well—no previous training required. Even a beginner may qualify for his first class license in a relatively short time.

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.*

Upgrade Your Income with a First Class

F. C. C. LICENSE

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
Mario Bidese, 342 Alexander Avenue, Greensburg, Pa.	1st	12
Richard M. Wilhoit, 2104 Santa Paula, Las Vegas, Nev.	1st	12
Larry R. Perrine, 7 Normandy Place, Champaign, Ill.	1st	15
Emerson F. Lawson, 111 Excelsior Ave., Union, S.C.	1st	12
Marion Woolsey, 3246 Warwick, Kansas City, Mo.	1st	12
Harold W. Johnson, 5070 Hermosa Ave., Los Angeles, Calif.	1st	15
Arthur W. Hardy, 66 Dresser Ave., Great Barrington, Mass.	1st	12
Ralph Frederick Beisner, 2126 Grand, Joplin, Mo.	1st	12
N. B. Mills, II, 110 So. Race St., Statesville, N.C.	1st	12
Dean A. Darling, 403 S. Chase Ave., Columbus 4, Ohio	1st	12
Paul D. Bernard, 408 First Ave., N.E., Watertown, S.D.	1st	18
Gerald L. Chopp, 518 Aubudon Road, Kohler, Wisc.	1st	12

GRANTHAM SCHOOL OF ELECTRONICS

HOLLYWOOD CALIF.	1505 N. Western Ave. Hollywood, Calif.	(HO 7-7727)
SEATTLE WASH.	408 Marion Street Seattle, Wash.	(MA 2-7227)
KANSAS CITY MO.	3123 Gillham Road Kansas City, Mo.	(JE 1-6320)
WASHINGTON D. C.	821 - 19th Street, N. W. Washington, D. C.	(ST 3-3614)

MAIL COUPON TO SCHOOL NEAREST YOU

(Mail in envelope or paste on postal card)

To: GRANTHAM SCHOOL OF ELECTRONICS

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

Gentlemen:

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 04-A

DIFILM®

BLACK BEAUTY®
CAPACITORS
BEAT HEAT AND HUMIDITY

New DIFILM Black Beauty Capacitors lead the way in tubulars! The operating temperature range of these new capacitors goes up to 105 C (221 F) *without voltage derating.* Capacitance tolerance is held to ±10%.*

• The new dual dielectric used in DIFILM Capacitors combines the proven long life of paper capacitors with the effective moisture resistance of polyester plastic film capacitors . . . to give you performance that can't be beat.

• Here's the kind of performance you can expect from DIFILM: very high insulation resistance, low power factor, moderate capacitance change with temperature, excellent retrace under temperature cycling, and superior long-term stability . . . *all at regular prices!*

• This high performance is fully protected by HCX®, an exclusive Sprague hydrocarbon material which impregnates the windings, filling all voids and pinholes before it polymerizes. The result is a solid rock-hard capacitor section. These capacitors are further protected by an outer molding of humidity-resistant, non-flammable phenolic.

For complete technical information on DIFILM Black Beauty Capacitors, write for Bulletin M-759 to Sprague Products Company, 81 Marshall St., North Adams, Mass.

*From .001 μF up

The major capacitor improvements come from

SPRAGUE®

world's largest capacitor manufacturer

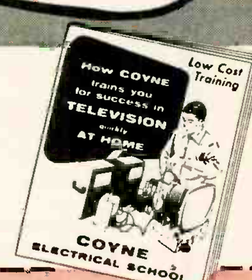
SPRAGUE RESEARCH IS CONSTANTLY PRODUCING NEW AND BETTER CAPACITORS FOR YOU

Giant opportunity field! Join the thousands Coyne Home Training is preparing for a successful future in TV—open the door to better pay jobs, *or* your own business! COYNE—a leading residential, practical school—oldest of its kind—established 1899—*is the institution behind this training.*

Here is **MODERN—QUALITY TELEVISION** Home Training designed to meet the rigid standards that have made Coyne famous. You get personal supervision of Coyne Staff who know TV and know how to teach. **Learn quickly and easily in spare time.** No previous experience or advanced education necessary.

SEND COUPON FOR FREE BOOK

Send coupon below for all-new fully-illustrated book and full details including **EASY PAYMENT PLAN. NO COST OR OBLIGATION—NO SALESMAN WILL CALL**



Modern, up-to-the-minute. Easy to follow, step-by-step instructions—fully illustrated with 2150 photos and diagrams. **UHF and COLOR-TV included.** So practical you can quickly earn extra money in TV-Radio Sales and Service. Not only Coyne Quality training, but costs *half* what you'd expect to pay because you pay only for training—no costly extras. Free life-time employment service.

B. W. Cooke, Jr.
President

COYNE
ELECTRICAL SCHOOL

Founded 1899

A TECHNICAL TRADE INSTITUTE OPERATED NOT FOR PROFIT
1501 West Congress Parkway, Dept. 10-H5, Chicago 7, Illinois

COYNE TELEVISION
HOME TRAINING DIVISION
1501 West Congress Parkway, Chicago 7, Illinois
Dept. 10-H5

Send FREE Book and details of your Television – Radio – Color TV Home Training offer.

Name ______________________

Address ______________________

City ______________ *State* ________

NEWS BRIEFS *(Continued from p. 14)*

Calendar of Events

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

ISA Instrument-Automation Conference and Exhibit, Feb. 2–4, Sam Houston Coliseum, Houston, Tex.

Winter Convention on Military Electronics, Feb. 3–5, Ambassador Hotel, Los Angeles, Calif.

Solid State Circuits Conference, Feb. 10–12, University of Pennsylvania, Philadelphia, Pa.

Cleveland Electronics Conference, Feb. 11–12, Engineering and Scientific Center, Cleveland, Ohio.

ERA National Convention, Feb. 11–13, Drake Hotel, Chicago, Ill.

Distributor - Representative - Manufacturer Conference, Feb. 18–21, El Mirador Hotel, Palm Springs, Calif.

International Electronic Parts Show, Feb. 19–23, Parc des Expositions, Porte de Versailles, Paris, France.

Scintillation Counter Symposium, Feb. 25–26, Washington, D. C.

Hi-Fi Shows

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.

ELECTRONIC HEARTBEAT timer (pacemaker) with no external wiring can be sewn into patient's chest near his heart because it has self-contained batteries. The circuitry is in a plastic envelope about 2½ inches in diameter, ⅝ inches thick. Presently used devices require external power and carry some danger of infection where wires enter body.

The timer supplies a stimulating pulse at regular intervals to keep the heart beating regularly, where otherwise it might beat dangerously out of time, slow down or stop entirely.

This heart timer will run for 5 years, has been tested on dogs for periods up to 100 days. Dr. Wm. Chardack, of the Veteran's Aministration, and electronic consultant Wilson Greatbatch of Buffalo, N. Y., developed the device.

Meanwhile, it was reported that RCA has developed a heart timer using a generator strapped around the patient's chest which induces power into a device sewn inside his chest cavity.

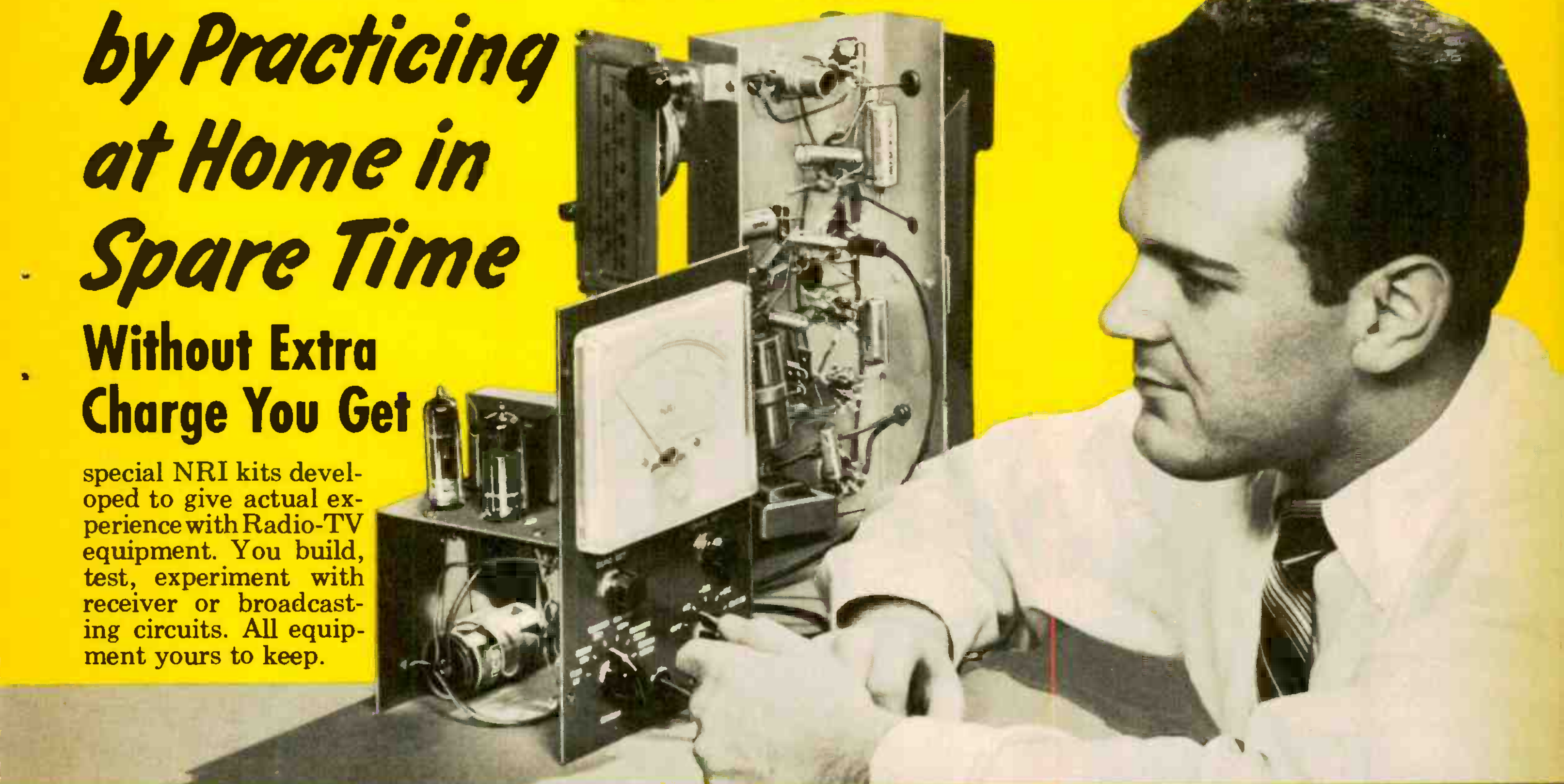
INSTANT MAIL BY FACSIMILE is the goal of a project for which the Post Office Department has awarded a development contract to IT&T. The company has already installed facsimile equipment in Los Angeles and in Washington, D. C., and is sending experimental transmissions using wire line.

Ultimately, it is believed, a special scanner will "read" the message through the envelope, transmit it via microwave (or coaxial cable) and rewrite it in a sealed envelope at the other end.

Cost of instant mail could be lower than 2 cents for a cross-country letter compared with present 7 cents for air mail. END

Learn Radio-TV Electronics

by Practicing at Home in Spare Time



Without Extra Charge You Get

special NRI kits developed to give actual experience with Radio-TV equipment. You build, test, experiment with receiver or broadcasting circuits. All equipment yours to keep.

Have High Pay, Prestige, Good Future as a Skilled Radio-TV Electronic Technician

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

Increasing Opportunities in Growing Field

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

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

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

Act Now—See What NRI Can Do for You

NRI has devoted over 40 years to developing simplified practical training methods. You train at home in spare time. Get practical experience, learn-by-doing.

NATIONAL RADIO INSTITUTE
Washington 16, D.C.

NRI Has Trained Thousands for Successful Careers in Radio-TV

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

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

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

➧ ➧ ➧ ➧ SEE OTHER SIDE ➧ ➧ ➧ ➧

Cut Out and Mail This Card—No Stamp Needed

Sample Lesson and Catalog Both Sent FREE

OLDEST & LARGEST HOME STUDY RADIO-TV SCHOOL
National Radio Institute
Dept. EF , Washington 16, D.C.

Please send me sample lesson of your Radio-Television Training and Catalog FREE. (No salesman will call.)

Name.. Age..........

Address..

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

ACCREDITED MEMBER NATIONAL HOME STUDY COUNCIL

Correspondence

PART TIMERS 20 TO 1?

Dear Editor:

In the Technicians News column of the September issue you quoted part of a NATESA publication article which said that part-timers were outnumbering regulars by 20 to 1.

I'll wager that in any large city where there are several trade schools you will find that there are some 60 to 100 part-timers entering into the "racket" every month!

It is the most natural thing in the world for recent students to be asked by neighbors to repair their TV receivers. (And washing-machine line cords, electric clocks, irons, toasters or what have you.)

If you were a little ol' lady living in Apt. 4-A, wouldn't you ask the big strong man living in 4-B to come over and move the piano before you would call up some furniture moving outfit and pay maybe $10 or $12 for the job?

Some of these TV associations complaining about the evils of spare-time servicing should check into the side activities of their own employees.

One would have to be awfully naive to believe that the prize technician of Joe Blows Shoppe is going to answer his grandma's frantic plea for technical assistance by telling her to call in a report to the shop when it opens Monday morning.

It has just occurred to me that most of the correspondence school ads in RADIO-ELECTRONICS depend for a large part of their appeal on the "make money in your spare time while you learn" angle.

Sooner or later you gentlemen at RADIO-ELECTRONICS are going to have to get off the fence and take *one* side or the other. *That* will be something to watch!

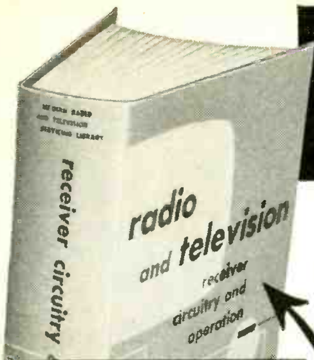
LEE LAMASCUS
Hollywood, Calif.

[We never have been on the fence. We have always been on the side of the honest, competent service technician, no matter whether he is part-time or full-time. What we are against is the dishonest, the incompetent and the chiseling operators, whether part-time or full-time. Honest part-timers offer less competition to the full-timer than the "$1-a-call" boys and the dishonest fringe.

The fact that we report what some service associations think about some part-timers doesn't necessarily mean

(*Continued on page* 24)

Here's the SPECIALIZED



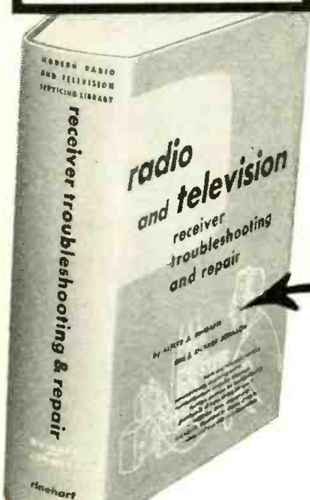
Let these 2 Ghirardi manuals teach you to
REPAIR ANY TELEVISION
OR RADIO RECEIVER ever made!

A. A. GHIRARDI

SAVE $1.25

Make your service library complete! Get *both* these famous Ghirardi books at a saving of $1.25 under the regular price. See MONEY - SAVING COMBINATION OFFER in coupon.

Let these two famous training books teach you to handle all types of AM, FM and TV service jobs by approved *professional* methods *—and watch your efficiency and earnings soar!* Almost 1500 pages and over 800 clear pictures and diagrams explain EVERY troubleshooting and repair operation as clearly as A-B-C. No needless mathematics. No involved theory. You get straight-from-the-shoulder training of the type that teaches you to do the best work in the shortest time. Each book is co-authored by A. A. Ghirardi whose radio-electronics training guides have, for more than 25 years, been more widely used for military, school and home study training than any other books of their types. Books are sold separately at prices indicated—or you save $1.25 by buying them both. Use coupon or order from Rinehart & Co., Inc., Dept. RE-10, 232 Madison Ave., New York 16, N. Y.



① RADIO & TV CIRCUITRY and OPERATION

Learn about circuits . . . and watch service headaches disappear

You can repair ANY radio, TV or other electronic equipment lots easier, faster and better when you're fully familiar with its circuits and know just why and how each one works . . . and that's exactly the kind of specialized training you get in Ghirardi's 669-page Radio & TV CIRCUITRY AND OPERATION training guide. First it gives a complete understanding of basic modern circuits and their variations. Finally it shows what troubles to look for and how to eliminate useless service testing and guesswork. Throughout, it gives you the above-average training that takes the "headaches" out of trouble-shooting—the kind that fits you for the best-paid servicing jobs. Contains 417 clear illustrations.

Sold separately for $6.75—or see MONEY-SAVING COMBINATION OFFER.

② RADIO & TV TROUBLESHOOTING and REPAIR

Complete training in modern service methods

Radio & TV TROUBLESHOOTING AND REPAIR is a complete 822-page guide to ***professional*** service methods . . . the kind that help you handle jobs faster, more profitably. For beginners, this giant book with its 417 clear illustrations is an easily understood course in locating troubles fast and fixing them ***right.*** For experienced servicemen, it is an ideal way to develop better methods and shortcuts; or to find fast answers to problems. You learn troubleshooting of all types from "static" tests to dynamic signal tracing methods. Step-by-step charts demonstrate exactly what to look for and how to look. A big television section is a down-to-earth guide to all types of TV service procedures. Read it 10 days at our risk!

Sold separately for $7.50 or save $1.25 on MONEY-SAVING COMBINATION OFFER.

Get More Work Out of Fewer Instruments!

Save time . . Save money . . Avoid buying instruments you don't really need!

BASIC ELECTRONIC TEST INSTRUMENTS
254 Pp. 171 Illus.
Price $4.95

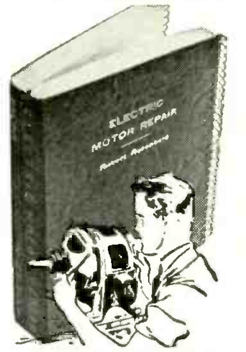
It pays to think twice before you buy new instruments — without first determining whether you really need them — or just how and where you'll actually use them!

BASIC ELECTRONIC TEST INSTRUMENTS is an instrument guide especially for servicemen, amateurs and experimenters. It explains modern instrument types and the advantages and limitations of each. It shows how to choose the instruments you really need; how to understand instrument readings and put them to practical use; how to work with fewer instruments, and how to put old instruments to new uses.

Over 60 instrument types discussed include everything from simple current and voltage meters to ohmmeters and V-O-M's; V-T voltmeters; power meters; impedance meters; capacitor checkers; inductance checkers; special-purpose bridges; oscilloscopes; R-F test oscillators; signal generators; audio test oscillators; R-F and A-F measuring devices; signal tracers; tube testers; grid-dip oscillators; TV sweep and marker generators; square wave generators; distortion meters and many others. It helps you work better—and saves you money.

Check BASIC ELECTRONIC TEST INSTRUMENTS in coupon for 10-day FREE examination

Now! FIX ANY ELECTRIC MOTOR!



TRAIN FOR BETTER PAY IN A FIELD THAT ISN'T CROWDED!

Handle ANY job from minor repairs to complete rewinding
560 pages— Over 900 how-to-do-it pictures

It pays to train for something different! ELECTRIC MOTOR REPAIR is a complete guide that helps you cash in on this vast, rapidly growing field. Shows step by step how to handle all repair jobs (including complete rewinding) on practically ANY AC or DC motor or generator in common use — from fractional horsepower to giant industrial motors. Special duo-spiral binding brings text and related how-to-do-it diagrams side by side so that you learn fast, easily and right. Every job is explained so clearly you can hardly fail to understand it. Over 125,000 copies in use in motor repair shops, schools, and for home study. Fully approved by repair specialists, unions and instructors.

It's the ideal book whether you want to train for a good-pay motor repair job or simply want to fix motors as a sideline or hobby!

Order ELECTRIC MOTOR REPAIR in coupon. Price only $6.95.

SHORT CUT TO TELEVISION REPAIRS

No. 1 No. 2

Pix-O-Fix TV Trouble Finder Guides
Only $2 for the two

Eliminate useless testing . . . Fix sets twice as fast

Just turn the dial of the handy, pocket-size Ghirardi & Middleton PIX-O-FIX TV Trouble Finder Guide. When the picture in the PIX-O-FIX window matches the screen image on the television set you're repairing . . . ***presto! . . . you've got your clue.*** PIX-O-FIX then shows the causes of the trouble. Next it indicates the exact receiver section in which the trouble has probably happened. Then it gives step by step repair instructions.

The two PIX-O-FIX units No. 1 and No. 2 cover 48 different television troubles . . . just about anything you're likely to be called on to fix. No. 1 identifies 24 of the most common troubles and gives 192 causes and 253 remedies for them. No. 2 covers 24 more advanced troubles not included in No. 1. Together, they are a comprehensive guide to quick "picture analysis" servicing of any TV set . . . ***AND THE PRICE IS ONLY $2.00 for the two.*** Money-back guarantee. ***Specify PIX-O-FIX in coupon.***

USE COUPON FOR *10-day Free Trial!*

CORRESPONDENCE *(Cont'd from p. 21)*

we agree. (And even the service organizations recognize that legitimate part-timers exist—see page 136, November, 1959, RADIO-ELECTRONICS.) After 51 years in this field, we are well aware that many of today's part-timers are tomorrow's full-timers, and that we have large numbers of both kinds of technicians among our readers.—*Editor*]

CREDIT WHERE CREDIT IS . . .

Dear Editor:

Congratulations on your new section on INDUSTRIAL ELECTRONICS. Articles of this sort should prove extremely valuable to your readers.

I was especially interested in "Printed Circuits Are Here to Stay," page 48 in your November 1959 issue. It is an excellent discussion and review of the printed- and packaged-circuit field.

However, there was one important omission. The article stated that the "National Bureau of Standards developed the printed circuit using a ceramic base." Though this is true, your author neglected to say that this work was done by the NBS cooperatively with Centralab. As a matter of fact, the proximity fuze mentioned was manufactured by us and all the original techniques for its manufacture were developed by the NBS and Centralab working as a team.

Our contributions to packaged circuits were noted in James P. Baxter's *Scientists Against Time*, in which he reviewed America's wartime scientific accomplishments, ". . . a highly ingenious system of manufacturing circuit components such as capacitors and resistors and the connections between them, by new techniques in the field of ceramics developed by Centralab, Div. of Globe-Union, permitting considerable saving in space."

FRANK L. APPLE
Centralab Div. of Globe-Union, Inc.
Milwaukee, Wis.

Dear Editor:

We of TELautograph Corp. were disappointed in errors contained in Mr. Aaron Nadell's article "Electronics Works on the Railroad" (November, 1959, page 46).

The Penn Station installation is one of the largest TELautograph installations. Our equipment plays a major part in the overall reservation system.

Specifically, the TELautograph equipment is leased to the Pennsylvania Railroad by our company and we, too, have servicemen who check this equipment each morning and evening. It is definitely *not* Western Union equipment nor is it maintained by their servicemen. We also spell our company name with a capital TEL.

The TELautograph Corp. was founded late in the 19th century by Elisha Gray and our stock has been traded on the New York exchange since 1906. We have service offices and representatives in 114 cities throughout the United States and all major market centers of the world. Our products include the

Telescriber, Teletypewriter and closed-circuit television. Through our subsidiaries, Hogan Faximile, Inc., and Teletronic Security Systems, Inc., we provide high-speed data facsimile and facsimile paper and government and commercial security systems.

Incidentally, Bremy's Electronics in Paterson, N. J., is a representative of the TELautograph Corp. His article also appears in the November issue of your magazine.

JOSEPH M. CRAWFORD

TELautograph Corp.
Los Angeles, Calif.

SAVING MAGAZINES?

Dear Editor:

On page 24 of your November issue Mr. Bemis suggested clipping RADIO-ELECTRONICS articles for storage and filing them in a loose-leaf notebook to save storage space. This method requires more than a little work and articles discarded today will often be of great interest years hence. For example, today I have absolutely no interest in hi-fi. Yet several years from now . . . who knows?

My space-saving method is to file RADIO-ELECTRONICS copies upright, book-fashion, in a canned food carton. Grocery stores are happy to provide the correct size: a carton for 24 No. 2½ cans. This holds just 4 years' issues neatly. To separate the years and keep the top from sagging, I insert dividers cut from other cartons. I file the January to November issues together and put the four December issues (with the annual indexes) in one end.

This way any copy can be found as easily as taking a book from a shelf. The magazines remain in good condition, unmutilated. Indexing is automatic. And you guessed it . . . there is much less work involved.

JOSEPH H. SUTTON

Kansas City, Mo.

GENERATING SPIRALS?

Dear Editor:

Readers of Mr. Jaski's "Better Yet, Use A Spiral" (November, 1959, page 88) should be warned that they may be disappointed in generating polar-coordinate patterns by modulating ahead of the deflection amplifiers, unless the scope used has very good, linear deflection amplifiers with identical phase shift. If the radial modulation frequencies are *lower* than the circle frequency, the sidebands produced may not be too far from the circle frequency to use the spiral for time measurement.

If one should wish to use it for some other purpose such as frequency comparison at high ratios or study of the actual waveshape of nonrecurrent transients on a much longer axis than the 5-inch X-axis, the radial modulation frequencies will be much higher than the circle frequency, and severe distortion will result.

If, for example, a 1,000-cycle circle is to be modulated at 50 kc to produce a sinusoidal cogwheel, each deflection amplifier must amplify 1,000 cycles, 49 kc and 51 kc. And this must occur identically in both amplifiers without generating any 2,000 cycles or 50 kc, as will happen if there is any nonlinearity.

The safest and easiest way to generate perfect patterns is to modulate in the last deflection stage, as most users of polar coordinates have done in the past. My old article, "Stroboscopic Interpolation," *Radio & Television News*, (Engineering Edition), January, 1954, contains full details of suppressor-modulated deflection amplifiers as well as details of a 1936 chronograph which used the spiral trace, and a bibliography of still earlier work with polar patterns.

One can easily add optional polar coordinates to any scope having identical X and Y push-pull output stages with suppressor grids accessible. One might also add them with no circuit changes at all, using a PPI radar tube directly interchangeable with one's CRT. The one I tried in 1944, a DuMont, had a terminal in the middle of the screen for polar deflection.

ALBERT H. TAYLOR

Read Island
British Columbia

END

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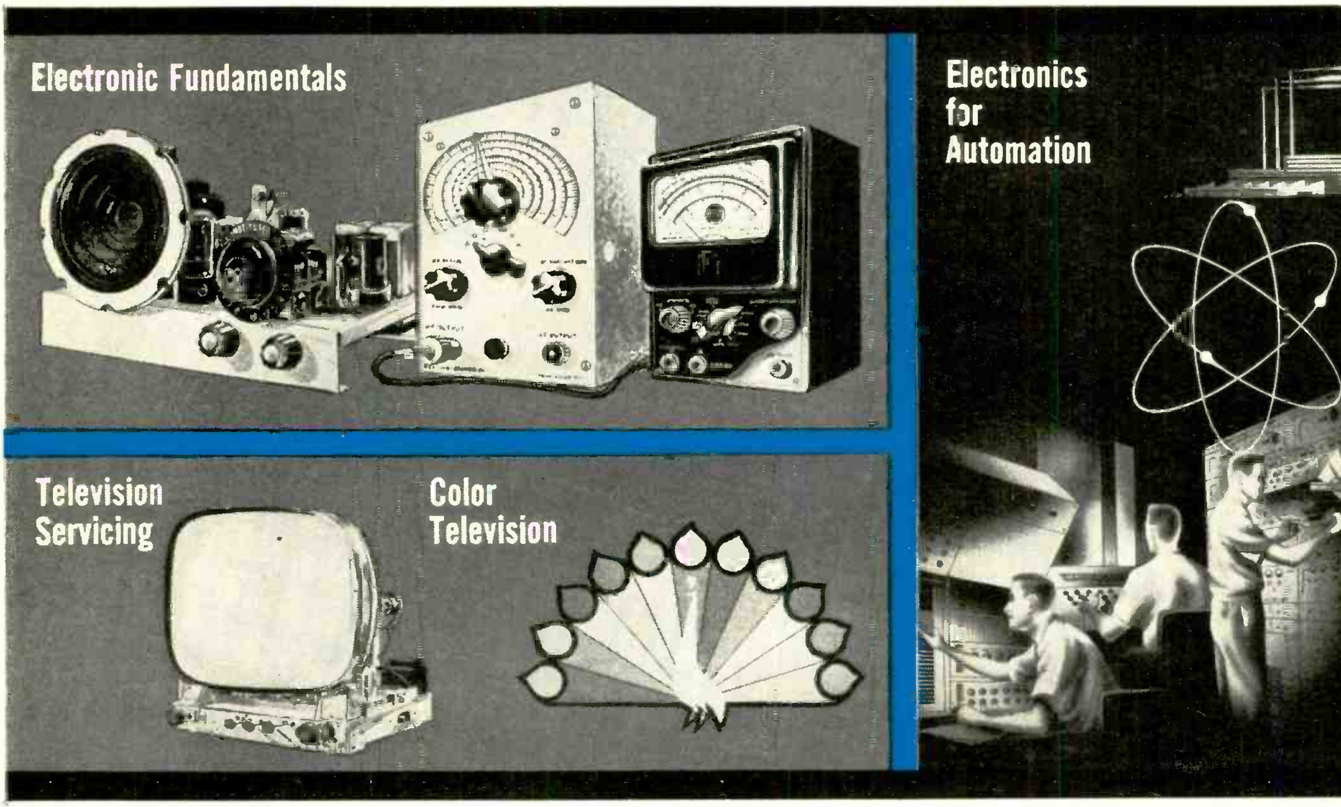

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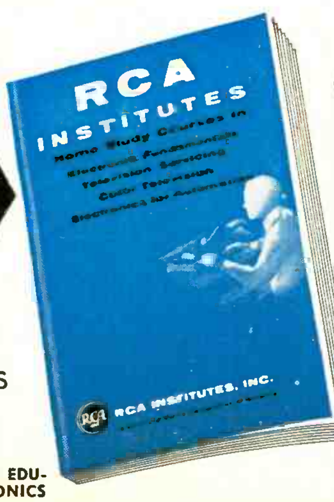

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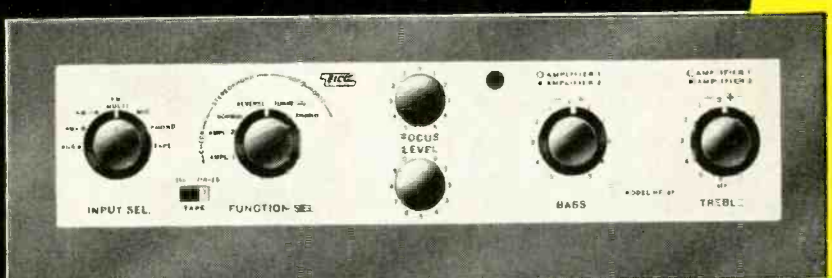
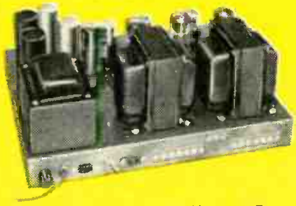
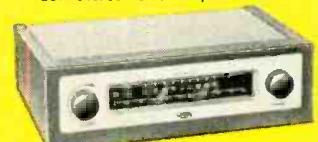


Stereo Amplifier-Preamplifier HF81

Stereo Preamplifier HF85

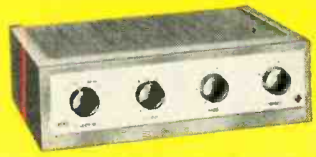


70W Stereo Power Amplifier HF87
28W Stereo Power Amplifier HF86



FM Tuner HFT90
AM Tuner HFT94
FM/AM Tuner HFT92

Stereo Integrated Amplifier AF4



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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.**

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AUTOMATION IN ELECTRONICS

. . . Without Automation, Electronics Could Not Exist . . .

TECHNICAL people are constantly astonished and nonplussed when they read the current polemics about automation and its supposed resulting unemployment.

To them it is clear that automation, with us since 1733, *creates more employment* in the long run. True, automation may at times cause dislocation in certain industries, but never for very long.

Let us take an outstanding example. In 1920, the American Telephone & Telegraph Co. had only manual operators, a total of 228,900 employees. There were 8,000,000 phones at that time. Then it turned to automation—the dial telephone system—eliminating nearly all hand-switchboard operators. Today, AT&T employs nearly 750,000 workers and we have over 70,000,000 phones! Such a quantity of phones could not be handled by manual operators—the phenomenal growth of the telephone industry has been made possible by electronics. But automation, instead of decreasing the number of employees, has vastly increased it. More skilled and specialized jobs have been opened up by electronics than were eliminated when electronic circuits and devices replaced operators.

A few years ago, the Corning Glass Co. with a small staff turned out hand-blown 20-inch television glass picture-tube shells for $75 apiece—*at a loss.* Then they built an automatic machine that turns out 21-inch tube shells for $9.89 each at a profit! On top of this, Corning now employs 2,000 people on TV picture-tube manufacturing—*people who have jobs that never existed before!*

It is incomprehensible that so many people fail to understand that automation means **new things** in nearly every instance. And new things mean **more work.**

Consider the following: We will mention only a single industry, radio electronics. In 1929, only 30 years ago, many of our radio receivers were still battery-operated. There were less than 11,000,000 radio sets in the United States then. In 1959, there were over 150,000,000. Most of the present-day radio tubes were unknown. Television was in the laboratory blueprint stage. Coast-to-coast broadcasting hookups were entirely via land lines. The coaxial cable still was in the future, as was microwave relay cross-country transmission. In 1929, there were no transistors, no light portable radios with concealed aerials, no pocket radios, no high fidelity, no stereo, no FM broadcasting, no magnetic recording tape, no germanium rectifiers, no proximity fuze, no radar, no guided missiles, no electronic instrument landing for airplanes, no handy-talkies, no practical two-way mobile radio, no radio astronomy, no electronic computers, no ultra-high-frequency transmissions, no atomic batteries, no solar batteries and none of several hundred other radio-electronic inventions commonplace today, but unknown a quarter-century ago.

In 1929, the radio-electronics industry was small and insignificant. Today it has achieved an annual turnover of almost $14,750,000,000! It employs over 1,000,000 people, *all* on jobs that did not exist 25 years ago.

Many of these radio-electronic items are now made by automation, with more being manufactured in this manner constantly.

Is it not elementary that only mass-produced articles—consequently only articles that are in constant demand—are turned out via automation?

An automation machine calls for a capital investment of from $50,000 to over $1,000,000. Would anyone in his right senses spend such sums if the end product to be automated did not already have a huge market?

What usually is not realized is that nearly every new and successful invention spreads out continuously, creating endless new branches like a living tree. Take the telephone, the automobile, the airplane, television — each has thousands of new facets, all creating new employment where none existed before.

Add to this our rapidly growing population that increases demand of most items constantly. Under such pressure even automation, at times, falls behind.

Automation in our present technological age is the one absolutely necessary link to allow us to expand indefinitely. Without automation, our industry would choke from constant bottlenecks. Without it, our rapid industrial growth would be impossible despite new inventions and new devices. Today our population numbers nearly 180,000,000. By 1975, there will be 200,000,000.

Full automation by that time will supply most of our needs and give us a shorter working day with far more leisure.

—H.G.

INDUSTRIAL ELECTRONICS

Setting up an ITV CAMERA

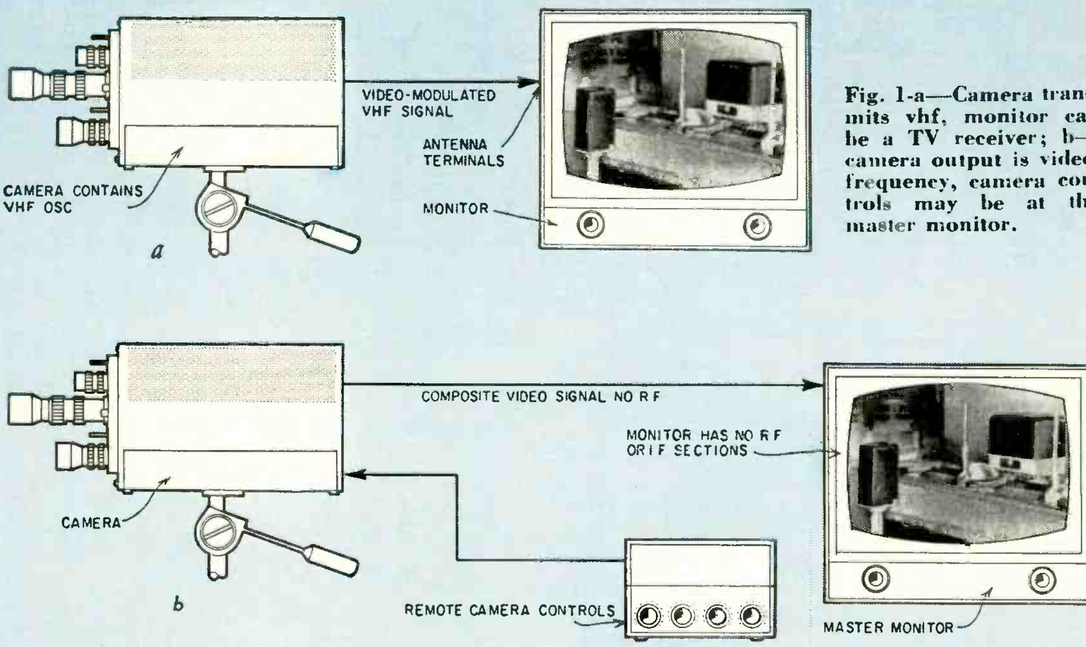


Fig. 1-a—Camera transmits vhf, monitor can be a TV receiver; b—camera output is video-frequency, camera controls may be at the master monitor.

By EDWARD M. NOLL

INDUSTRIAL television is the "seeing eye" of industrial electronics; many automatic operations depend on the remote viewing facilities of closed-circuit TV. A number of processes can be monitored from a single central control point with industrial television, and controlled from the same point with industrial electronic equipment.

New uses for closed-circuit TV systems are constantly appearing in commerce, education and business. It is doubly unfortunate that so few independent service organizations or technicians have displayed any initiative or confidence in this field. Neither industrial television nor industrial electronics has been pushed—or even welcomed—by the average technician. Yet installing and servicing industrial TV and electronic equipment is no more difficult than many regular service assignments, and certainly much simpler than most color TV receiver servicing.

An industrial TV setup must be properly installed and adjusted if the owner is to be happy with it—or even able to use it. Electronic controls, lighting and optical systems must be set precisely to insure good, reliable pictures on a long-term basis. Cameras must require a minimum of attention, and the entire system should be able to run unattended for long periods of time.

The first step in securing the best operating conditions is to adjust the pre-set controls of cameras and monitors. Correct camera adjustment is important in obtaining a high-quality picture and insuring the best life for the vidicon tube.

Two important considerations are positioning the camera and selecting an optical system suited to the duties expected. There must be enough field of view and depth of focus to include the necessary data in the picture. Lighting must be adequate to render a clear well-defined picture. Mounting positions and the intensity of the light are significant factors.

Monitor adjustment

The monitor is the first unit of an industrial television system that must be adjusted. The two most common types of closed-circuit TV systems are shown in Fig. 1. In the first one (Fig. 1-a), the monitor is a standard receiver. The television signal formed by the camera is used to modulate a high-frequency oscillator operating in the vhf television band. The vhf signal is then used as a carrier to convey the signal from the camera to the monitor. The signal is fed directly to the receiver's antenna terminals and the selector knob is set for the channel covered by the vhf oscillator.

The monitor for such an installation can be adjusted by using a signal from a standard television broadcast. Linearity and size adjustments can be made and the vertical and horizontal synchronization circuits aligned in the same manner that you would adjust a television broadcast receiver. If a standard TV broadcast cannot be received, use a bar or cross-hatch generator to tune up the monitor and viewers.

The monitor must be correctly tuned because it will be used as a standard when adjusting the camera. The camera tube requires horizontal and vertical deflection waveforms just as does the monitor. So camera linearity, size and

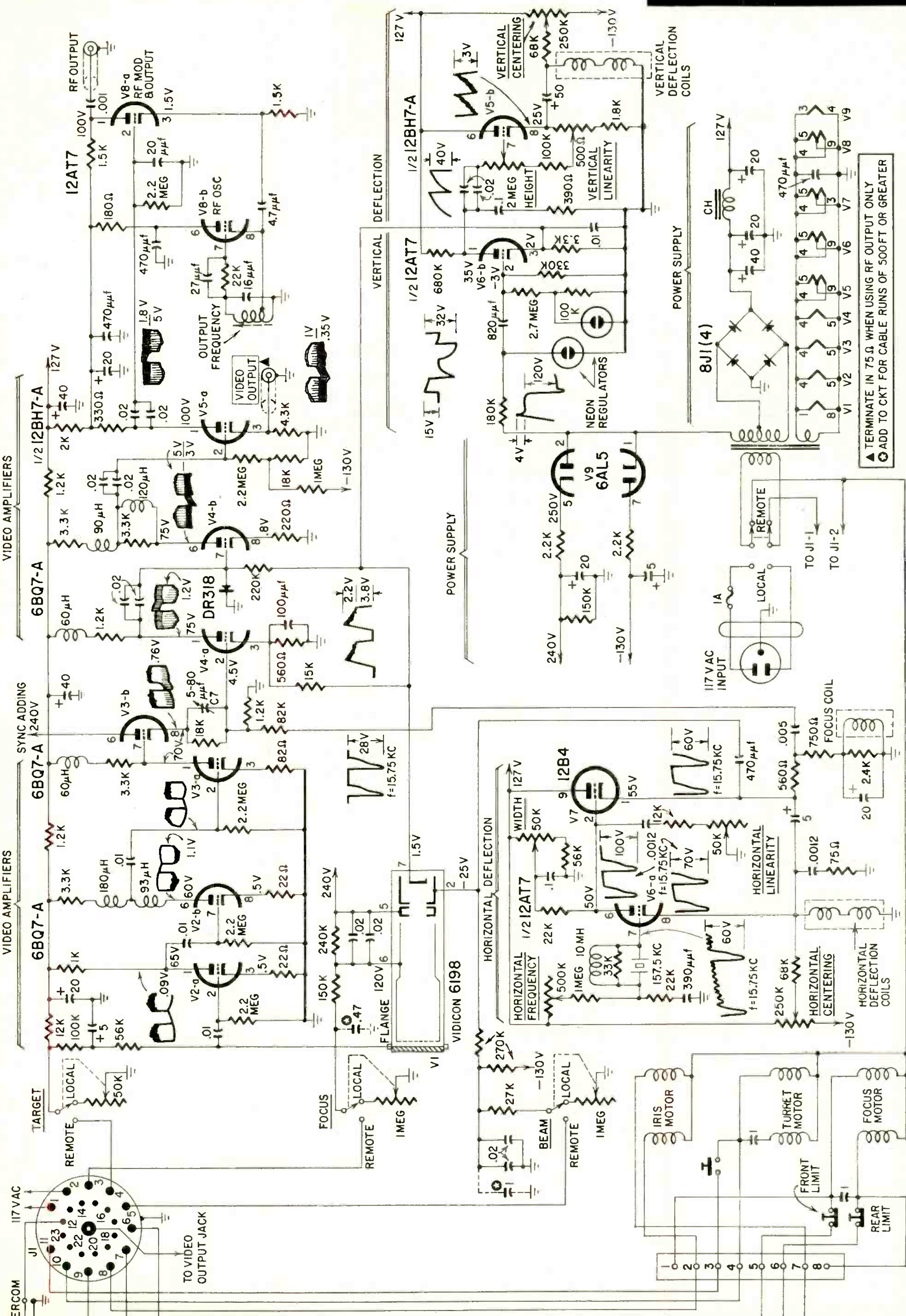


Fig. 2—Circuit of the General Precision Laboratory model PD-500 camera.

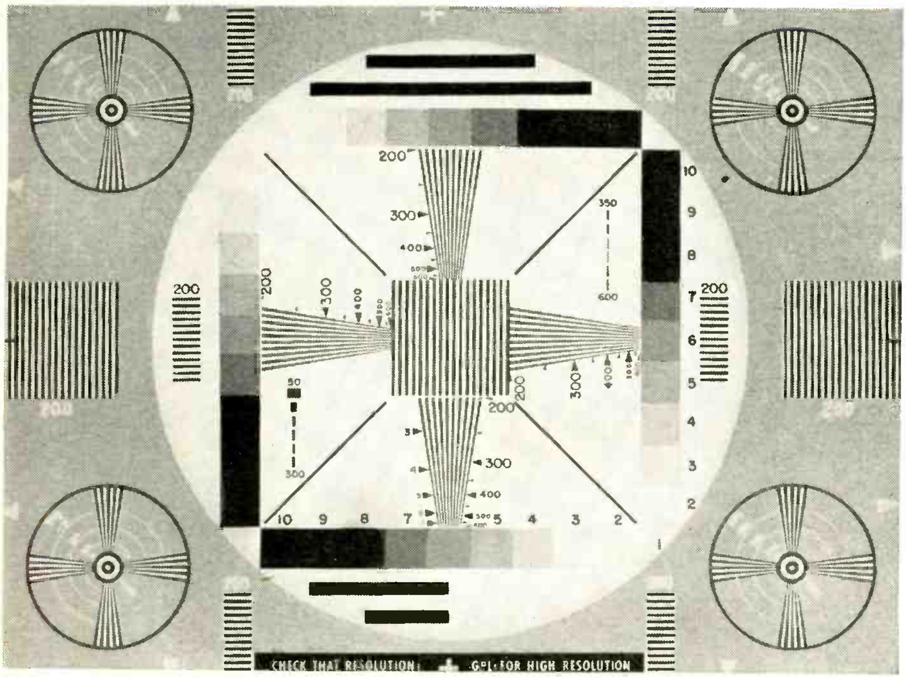


Fig. 3—Test chart used in adjusting the camera.

centering must also be adjusted. This can be done exactly only if some deflection standard is available. A correctly adjusted monitor can fill the bill.

The second arrangement (Fig. 1-b) is becoming an even more common type of industrial television installation. In it the camera controls are located at the master monitor. Thus they can be adjusted and the results observed at the master monitor. (However, there are preset camera controls that must be aligned too.) This arrangement permits mounting the camera in a fixed out-of-way or inaccessible position. It is generally much more convenient because the camera's operating characteristics can be adjusted by the person watching the picture on the master-monitor screen.

Most installations of this type do not use an rf carrier method. Instead, a composite video signal is sent over a coaxial cable to the master-monitor position. The monitor and viewers do not contain rf and if sections and the composite video signal is fed directly to the monitor's video amplifier and sync separator.

In such a system it is sometimes difficult to adjust monitor deflection correctly. The problem can be circumvented in two ways. One is to use a bar or cross-hatch generator very carefully, making certain of width and height adjustments.

The second method is to use a TV tuner and if section to receive a local television broadcast signal. The output of this tuner and if strip can then supply a composite television signal of proper amplitude to the antenna input of the master monitor. Now the television broadcast signal can be used in setting up the master monitor and viewer.

The monitor where the camera controls are located is called the master monitor or viewer. Additional monitors and viewers are called remote or slave viewers.

Camera preset adjustments

To provide as definite a procedure as possible for setting up a camera, let us consider the adjustments recommended for the General Precision Laboratory model PD-500 camera whose circuit is shown in Fig. 2. The procedures to be followed are typical for most industrial TV cameras. As cameras are shipped factory-aligned and adjusted, they can usually be put in operation and made to deliver a satisfactory picture by following the suggested operating procedure.

If picture defects appear after following the operating procedures carefully (including lens and lighting instructions), it may be necessary to adjust some of the preset controls. When camera tube or circuit replacements are made, some of the preset controls will probably need attention.

Operating procedure

1. Set the camera for local operation. Many TV cameras have facilities for either remote or local operation.

2. Set TARGET control at No. 3 on its scale (see photo at head of article). The TARGET control regulates the dc voltage applied to the signal electrode segment of the photoconductive target area.

3. Bring up the beam voltage slowly until a picture appears. The BEAM control regulates the negative bias supply to the control grid of the gun section of the vidicon camera tube.

4. Focus the picture carefully. It will rotate slightly as the adjustment is made and, if the camera is operating normally, the picture will come into focus when it is exactly upright. The ELEC FOCUS control regulates the dc voltage applied to the wall electrode of the vidicon camera tube. If the picture does not come into focus, check both the monitor focus and the optical focusing of the lens system.

5. If a picture did not appear when beam voltage was increased, move the TARGET control to the next highest setting, improving its sensitivity. Repeat steps 3, 4 and 5 until a picture does appear.

Proper settings of beam and target voltages are important. Generally, the minimum possible target voltage required to produce a good-quality picture should be used. Although increasing the target voltage does improve sensitivity, there is a greater tendency toward image retention or stickiness. (If the camera is panned or tilted or a new lens switched into position quickly, an impression of the previous scene will persist for a short time.) Also, with stickiness it is more difficult to differentiate a fast-moving object, as an impression of the motion will hang on in the reproduced picture.

Under certain circumstances, a high target voltage can produce image burn-in—an image of the scene being televised under improper operating conditions will make an impression in the target surface which will persist for a long period of time and, if very serious, for the life of the tube. It is always advisable to use as much light as feasible and the widest lens aperture that can provide the proper depth of field. In this way the TARGET control can be set to a minimum value.

The BEAM control influences the ability of the camera tube to resolve the brightest portions of the scene and produce a picture with a good contrast ratio. It is generally turned up until the bright portions or highlights of the scene can be well differentiated. A good operating procedure is to find the lowest target voltage that will permit the BEAM control to resolve or wipe clean the brightest areas of the scene.

Use only enough beam current to resolve the highlights. When the top of the picture flickers, it often indicates that the beam setting is too high and the beam current excessive. If the picture becomes twisted or distorted or begins to roll vertically, it is often an indication of hum being introduced because of too high a target or beam setting. Dark lines at the top of the picture often imply too high a target setting.

If a camera must be used to view both brightly illuminated and dull subjects, vary the target voltage only. Set the BEAM control for the brightest subject and leave it there. Now you can lower the target voltage for bright scenes and increase it for low ambient lighting conditions and dull subjects.

If remote operation is included, the same operating procedure should be followed, using the remote controls with the camera set on remote. To summarize, the target setting should be set to the lowest value that will render an adequate picture. The more lighting, the lower this setting can be. Beam setting in turn depends on target setting—a higher target setting requires a higher beam setting. The BEAM control too should be operated as low as possible and at a setting that will just resolve the brightest portions of the picture.

If lighting levels are very low (under 15 or 20 foot-candles), the target must be operated at near maximum. Under these conditions there will be a great tendency for the highlights to stick with scene motion and some bright flare may exist at the edges of the picture. On the other hand, if TARGET and BEAM controls are set too low, picture contrast is lowered. Although contrast can be corrected to some extent by increasing the overall video gain of the system, noise content is also increased. Therefore, beam and target settings should be high enough to render a noise-free picture.

If a camera is used frequently, it is generally advisable to let it operate continuously if light levels and subjects do not change radically. The life of the camera tube and other vacuum tubes in the unit is usually longer because there is no frequent heating and cooling of the tube electrodes and no voltage surges due to turning equipment on or off.

Scanning adjustments

An important consideration in the operation of the vidicon camera tube is to make certain that the useful area of the target surface is scanned. When the target surface is not scanned fully, a permanent impression of the smaller raster section is burned into the vidicon target. Consequently, when normal scanning is restored, a burnt-in impression of the smaller area will appear in the reproduced picture. Furthermore, if the complete area is not scanned, full resolution cannot be realized from the vidicon camera tube. When the target surface is being scanned fully, the actual corners of the target barely appear in the picture on the monitor or can be made to appear with only a very slight adjustment of the vertical and horizontal centering controls at the rear of the camera.

A test chart such as the one in Fig. 3 is generally used when adjusting vidicon scanning. Such a chart not only provides a check of scanning, but also resolution, contrast and focus. For a general check of scanning linearity, check the trueness of the large center circle and the four corner circles. More specifically, the vertical sweep linearity can be judged by comparing the spacing of the short horizontal bars at both top and bottom of the chart with those of the middle bars. Horizontal linearity can be checked in a similar manner. Just compare the vertical bar spacing at each side with the center bar spacing. A true aspect ratio will not only reproduce the center circle faithfully, but the pattern formed by the gray scale will produce a perfect square as well.

To use the chart most effectively, a linear and properly adjusted monitor is needed. The chart, according to the instructions included with the camera, should be positioned at a prescribed distance from the camera with the proper lens in position and the camera directed toward the chart perpendicular and dead center. Then the camera can be set to use the full area of the target surface.

Scanning adjustment procedure:

▶ With the 1-inch lens in position, the test pattern provided should be mounted 14 inches from the end of the lens. Now proper scanning will exactly cover the whole chart. If the 2-inch lens is used, the chart should be mounted 28 inches from the lens edge. Be certain that the camera is positioned so its axis is lined up with the center of the chart. The optical focus should be adjusted for 14 inches or 28 inches, as required.

▶ Adjust the VERTICAL LINEARITY and HEIGHT controls for a full-size and linear picture vertically. The VERTICAL LINEARITY and HEIGHT controls are both in the vertical output stage.

▶ The WIDTH, HORIZONTAL LINEARITY and HORIZONTAL FREQUENCY controls interact and sometimes influence proper focus. If there appears to be a complete misadjustment, all three controls should be set to their mid-positions. Adjust the HORIZONTAL FREQUENCY control for proper lock-in of the picture on the monitor screen. Next adjust the WIDTH and HORIZONTAL LINEARITY controls for a full-size and linear picture in the horizontal direction. Then readjust horizontal frequency and focus for the best possible picture. The horizontal controls are in the camera's two-stage horizontal deflection pulse generator, tubes V6-a and V7.

Some interaction between adjustments should be expected because of the multiple functions of the horizontal and vertical deflection waveform generators. In these two stages all the necessary waveforms and pulses for the television system are formed. For example, the horizontal deflection system generates two other pulses in addition to the deflection waveform required by the horizontal deflection coils. Horizontal blanking pulses are formed as well as horizontal sync-blanking pulses that are added to the video information and conveyed to the monitor. At each monitor these pulses blank the picture tube and synchronize the horizontal deflection system. The vertical deflection generator performs the same function in terms of vertical deflection, blanking and sync-blanking.

▶ The centering controls should be adjusted to just pull the edges of the target out of the picture as viewed on the monitor. If this cannot be done, it sometimes indicates that a shield or iron wire wrapping has become permanently magnetized.

▶ If a tilted picture appears on the monitor screen, orient the camera's deflection yoke until the picture is straight.

High-peaker and cable compensation

The high-peaker stage of the camera's video amplifier compensates for the loss of highs at the output of the camera tube. The high-peaker has a rising gain characteristic with frequency. A control generally associated with this stage permits a more precise control over the bandwidth characteristic of the television system. Hence it is possible to make corrections for other frequency disturbances, both high and low, with the control facilities of a high-peaker. Usually the high-peaker is adjusted to get a picture with maximum possible resolution without the appearance of echoes or repeats in the picture information. These transients show up as vertical repeats behind abrupt changes in scene brightness.

In the GPL PD-500 camera, capacitor C7 and tube V3-b compensate for the influence of cable length between camera and viewer. The capacitor is adjusted for minimum streaking and smear in the reproduced picture.

The quality of picture in a closed-circuit system is always surprising, considering the few stages and simplicity of the units employed. In difficult television pickup locations, don't expect reproduction comparable to that of a television broadcast station. Remember, television studios are illuminated by batteries of lights and the television signal is developed and corrected in elaborate amplifier and control systems. To obtain a good-quality picture in industrial television application, the camera must be adjusted carefully and diligent attention must be given to proper lighting, lens arrangement and mounting position. END

"I think I'll get a decade resistor kit. That means it's guaranteed for 10 years, doesn't it?"

Pulsed electric currents discourage undesirable fish — save valuable ones

Electronics Goes Fishing...

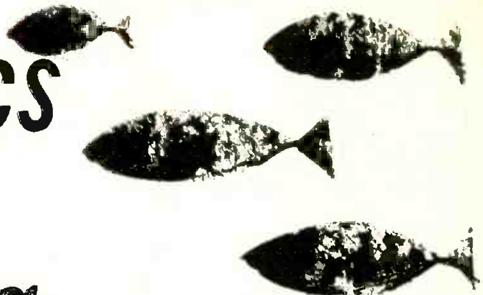


Fig. 1—The shark repeller gives dangerous fish the desire to go elsewhere for lunch.

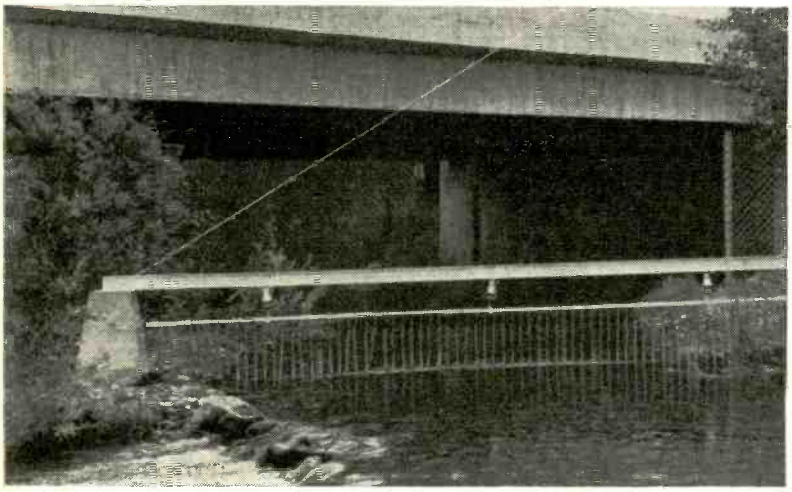


Fig. 2—Electrode system of an electronic fish screen at the intake for an irrigation district.

Fig. 3—These two metal plates were immersed in salt water for 6 months. Lower specimen has heavy crust of corrosion and algae. Upper specimen, used as a negative electrode in pulsed-current setup has only a uniform grayish coating which prevents corrosion.

By S. M. MILANOWSKI

WITH the right electronic equipment, you can not only catch fish but you can be sure of getting the types and sizes you want. Also, you can avoid or prevent the needless destruction of valuable marine life by killing or rendering harmless the more voracious species, such as sharks.

It's mainly a matter of knowing how and where to use high-voltage current which is pulsed somewhat like the output of a radar transmitter.

The shark repeller

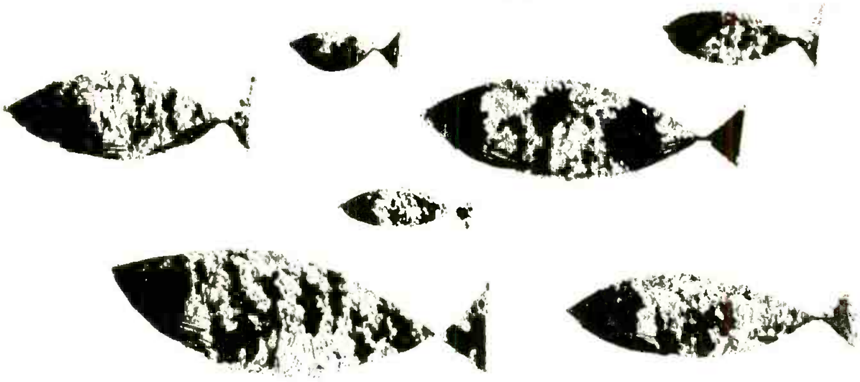
A recent, yet relatively simple, example of electronic fish-control equipment is the shark repeller shown in Fig. 1. Designed for use by skin divers and people aboard survival rafts at sea, it repels any dangerous species of marine life that may be encountered by giving the fish a series of 500-volt shocks—each similar to the jolt you get after sliding across the seat of a car and touching a metal part. These shocks probably couldn't kill anything larger than a microbe, but they give unimaginative creatures like sharks and moray eels a sudden desire to go elsewhere for lunch.

Power for the shark repeller comes from a battery-powered unit (strapped to the back of the diver in Fig. 1) with a trigger type switch which is manually depressed. A person using the device with reasonable care will receive none of the high-voltage output because the equipment is well insulated and has a probe which is literally an antenna that produces an elliptical zone of electrified water well away from the operator's body.

Electronic fish screens

Fundamentally, the shark repeller is a miniature version of an electronic fish screen.

Fig. 2 shows the cast-iron electrode system of an electronic fish screen designed to keep fish away from the intakes of an irrigation district and a municipal reservoir. An ordinary metal barrier or "trash rack" couldn't serve the purpose of these screens, because it



would soon be clogged up with fish that tried to swim through it. The electrodes could of course be charged with raw ac or dc, but this would literally create a stink by killing fish—and perhaps a few humans.

Because the 1,000-volt output of the electrodes is pulsed very slowly, an invisible zone of electrified water is briefly and repeatedly produced in front of each intake. This zone ranges from 10 to 20 feet from the electrodes and is parallel to the flow of water (since fish ordinarily travel lengthwise with water currents and should receive optimal shocks in this position). Of course, the further from the electrodes the weaker the field.

Small fish, having the smallest surface areas, can swim closer to the electrodes than large fish, without experiencing discomfort. However, any fish that comes too close receives a jolt strong enough to make him turn away from the electrodes.

Selective barriers

As various species of fish have differing reactions to pulsed current, electronic equipment can be used for other purposes. For instance, let's consider the case of the sea lamprey and the trout.

As the reader may recall, the sea lamprey is a bloodthirsty killer which invaded the Great Lakes region a few years ago and virtually annihilated trout which had previously brought commercial fishermen an estimated $8,000,000 a year. (In Lake Michigan alone, the catch dropped from more than 5,500,000 pounds in 1946 to a mere 402 pounds in 1953.) Consequently, researchers decided to try eradicating sea lampreys in the Great Lakes with an electronic technique that had been used successfully in fish hatcheries.

The equipment produces pulses at a rate which allows fast-swimming trout to dart through the electronic-screen area while the current is off, and yet makes life painful for slow-moving lampreys, when the two species head toward their spawning grounds. This worked out better than anybody expected because lampreys whose mating instincts are aroused ignore the pain caused by the pulsed current until they are electrocuted.

A simple relay circuit controls the 1,000-volt pulses fed to the electrodes. Circuits of this type may use 3–600 watts of power to deliver 500–1,000-volt pulses at a rate of usually less than 10 per second—depending on the conductivity of the water, the area to be electrified and the species of fish being dealt with.

The control circuit usually uses two relays. One controls the 1,000-volt output while the other controls the thyratron that keys the output relay. The thyratron control relay is placed in the grid circuit and is set up so that when it is energized the thyratron fires, closing the pulsing relay. To assure a short pulse the grid relay has two sets of contacts—one set normally open, the other normally closed—so arranged the open contacts close before the closed contacts open. When this relay is activated, the normally open contacts close, firing the thyratron. The normally closed contacts then open, cutting off the thyratron and the 1,000-volt pulse.

Other uses

The low-cost metal electrodes do not undergo electrolysis when charged with pulsed current and if their polarity is reversed occasionally, they usually acquire protective coatings which actually prevent corrosion.

This occurs because the high-voltage current flowing between electrodes electrifies minerals suspended in water and deposits them on negatively charged metal surfaces. Because such deposits take place more rapidly in salt water than in fresh, naval officials and commercial shipowners have been trying to find out whether pulsed current can be used to keep the hulls of seagoing vessels from corroding and then accumulating large quantities of algae and barnacles (see Fig. 3).

By greatly increasing the weight of a ship, algae and barnacles reduce operating efficiency to a point where the vessel must be drydocked (so its hull can be cleaned and refinished) every year or two. If electronic equipment can be used to maintain a protective finish on a metal hull as it does on the metal electrodes for a fish screen, the cost of operating naval and commercial ships may be lowered many millions of dollars annually.

It has also been suggested that a refinement of the pulsed-current concept might make it practical to recover valuable minerals—such as gold and silver—which are known to be suspended in ocean water. This would necessitate the use of electrical or magnetic plates, each of which could collect a given mineral in accordance with the electromagnetic properties of the desired material in an electrified condition. END

Cutting, punching, imprinting, and embossing are vital parts of many industries and the electronic controls that keep these devices working accurately can become a profitable source of income for the aggressive independent service shop

PHOTOELECTRIC REGISTER CONTROLS ...how they work

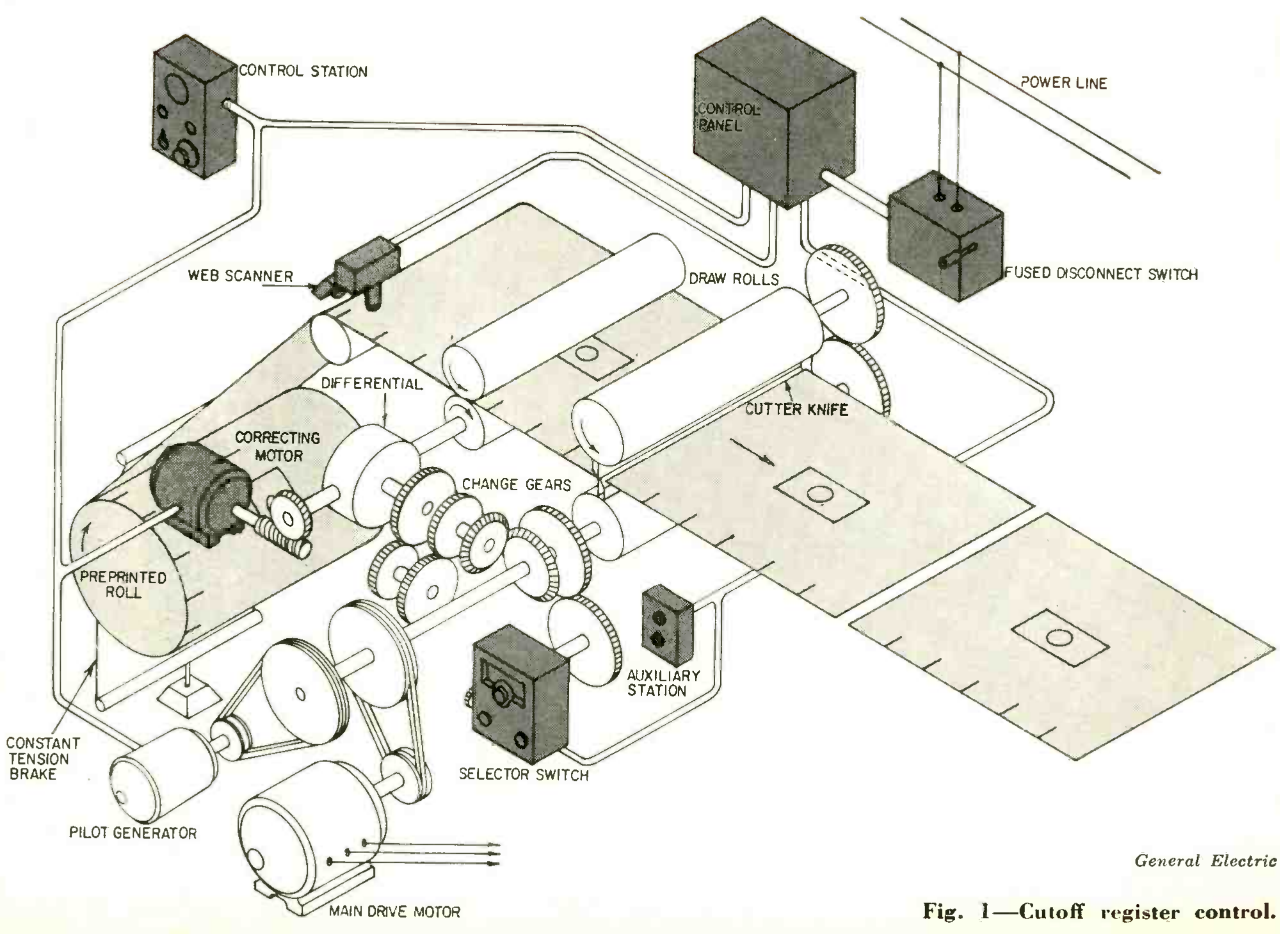
By ALLAN LYTEL

WHEREVER rolls of material are cut to sheet size, imprinted, punched or embossed—whether in a steel mill, a paper plant or a printing house—photoelectric controls make sure the cuts, printing, holes or embossing come out in the right place.

Wherever a continuous strip of material (or *web*) is wound into a roll, photoelectric controls help keep the roll's edges smooth and even. These electronic devices can be and are kept in good working order by electronic technicians. Any technician can repair or maintain one of these systems if he knows how it works. Let's examine some of the types that are in use.

A correction type of register control made by G-E is shown in Fig. 1. It is used on a cutting machine and requires a roll of paper (or other material) preprinted with register marks that trigger the web scanner controlling the cutter knife. Each cut produces a sheet of paper of the proper length. The system has built-in correction to compensate for errors in the machine or changes in the roll or web caused by stretching or shrinking.

This may seem foolishly complex but there is more to the cutting than you might think. Suppose the machine were cutting pages from a preprinted web—a seemingly uncritical operation. What difference does an error of .01 inch in



General Electric

Fig. 1—Cutoff register control.

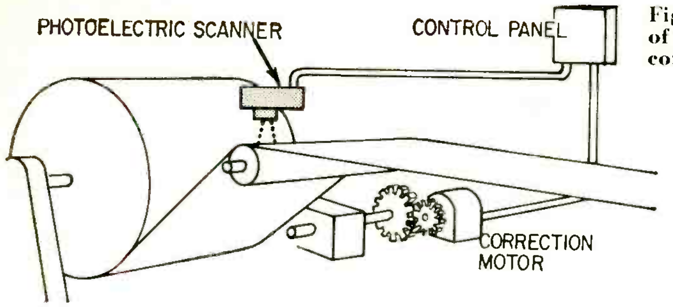


Fig. 2—Basic operation of G-E side register control systems.

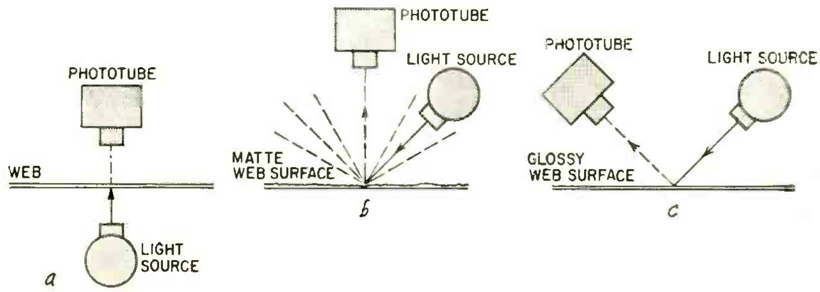


Fig. 3—Three light-source and phototube-pickup arrangements; a—transmitted light scanning; b—diffuse reflected light scanning; c—specular reflected light scannning.

a 3-foot length of paper make? None, if you are cutting only a couple of sheets. But when many thousands of pieces are cut, and the error is cumulative, you have a 1-inch error after 100 pages and an error of 10 inches after only 1,000 pieces. Before you know it you are cutting the page in the middle instead of at the end.

The error control system does four things:

- The web scanner detects the relative position of the register marks.
- The selector switch detects the relative position of the cutter blade.
- The control panel circuitry compares these positions to determine their relationship.
- The correcting motor adjusts for any difference between the actual and the proper cutting position.

Side register controls

In operations such as paper printing or slitting, you end up with improper printing and wasted materials if the web moves sideways. Some system for keeping the paper in line is needed.

Such a system is shown in Fig. 2. The edges of the web are "seen" by a photoelectric tube which controls the web's side-to-side movement. The controls can be at the beginning of the process (where the web enters the machine), at the end of the process (where the web leaves it) or at some intermediate point.

To control sideways motion, a web scanner is needed. Such scanners fall into two groups—static and dynamic. The static scanner "watches" the web's edge and produces a steady signal to indicate the position of the web at all times. A dynamic scanner produces a signal only when a register mark passes the light beam. Dynamic scanners are commonly used as cutoff register controls to cut material to proper lengths.

Light can be transmitted through the web, as in Fig. 3-a, or reflected in a diffused manner, as in Fig. 3-b, where the surface is rough, or scanning can be specular as in Fig. 3-c.

The light source includes a lens system to focus the light on the desired position. The phototube is set to pick up the desired light according to the type of scanning. Phototubes are made with several color sensitivities, but the most important two for register controls are the red-sensitive S-1 and the

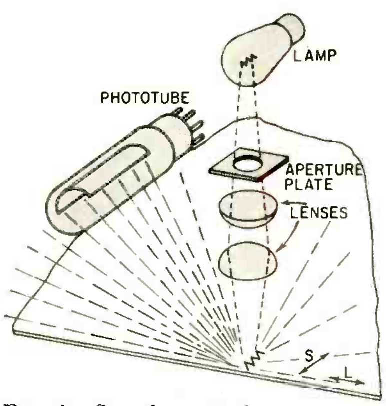


Fig. 4—Simple optical system for small photoelectric web scanners.

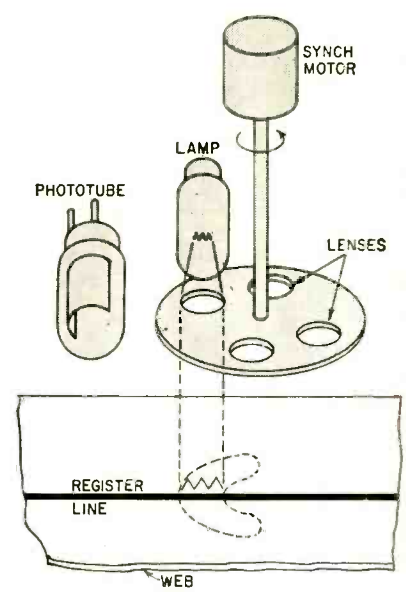


Fig. 5—Rotary lens web scanner.

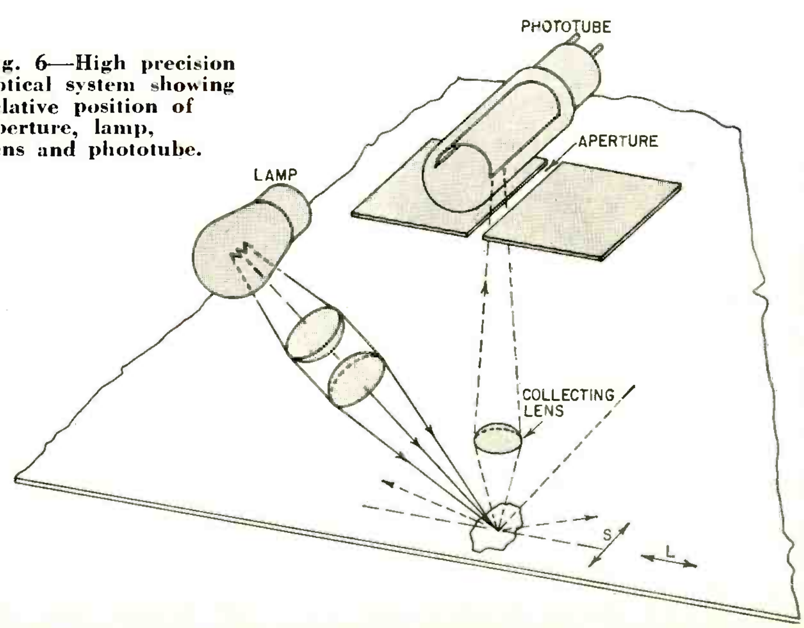


Fig. 6—High precision optical system showing relative position of aperture, lamp, lens and phototube.

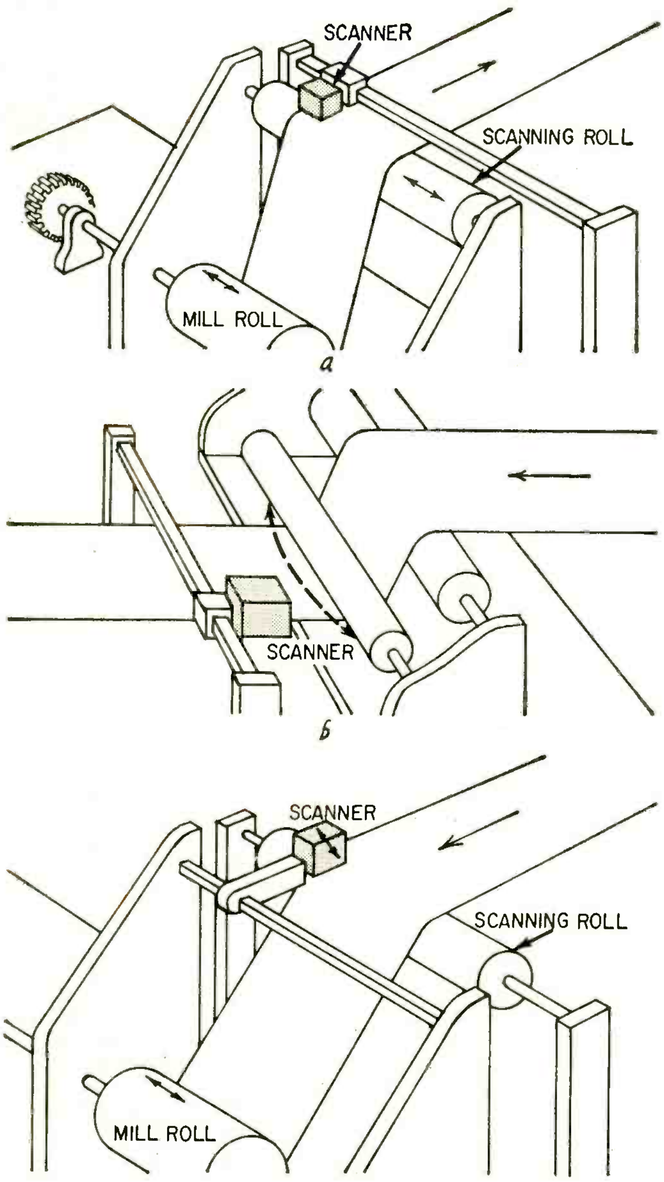


Fig. 7—Three kinds of side register controls: a—pay-off—for guiding a web entering a processing machine; b—mid-line—for guiding a web in the middle of a processing line; c—wind-up—for guiding a web at the exit end of a processing machine.

blue-sensitive S-4. These types include the red-sensitive 930, 868/PJ23 and the blue-sensitive IP39, 934 and 441. The preferred, most sensitive types are the IP40, 927, 918 and 927 (red) and 5581, 5583 and IP37 (blue).

The simple optical system used in the General Electric 3S7515-PS102 is shown in Fig. 4. The phototube is placed as close to the web as possible. As the web moves, scanning can be either sidewise (S) or lengthwise (L).

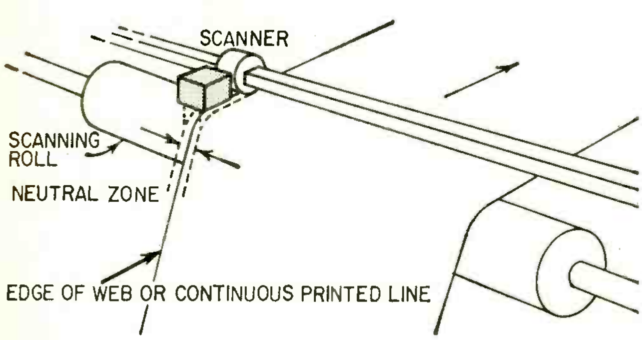
In the more complex system of Fig. 5, a rotary lens system does the scanning. A spot image from the light source is swept across the register line. The pulse from the phototube is phase-compared with the driving signal for the synchronous motor. The difference, if any, indicates the amount of misregister and is fed back as a correction signal. This is used in the General Electric CR7515-P201.

A high-precision system is shown in Fig. 6. A lens system forms a very bright spot of light which a collecting lens system directs to the tube. A variable aperture controls the light falling on the phototube. A position on the web can be detected to within .001 inch and stray light cannot affect this system. It is used in General Electric type CR7515-P202.

There are three ways to use side register controls. They are shown in Fig. 7. A "payoff" control is used when a web enters a machine (Fig. 7-a), a "mid-line" control in the middle of a process (Fig. 7-b) and a "windup" control at the end of a process (Fig. 7-c).

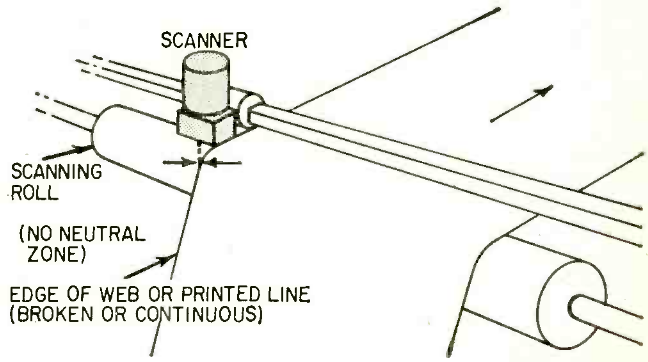
There are also two *types* of controls: Two-point and proportional. A two-point side register controls the web scanner (3S7515-PS102) discussed earlier. Where the rate of side motion of the web is moderate this system is effective. The edge of the web is normally used as an indication for the phototube, but a printed line will also serve. The control is an on–off system which provides adjustment only when the error exceeds preset limits. There is no control as long as the web is in the neutral zone (Fig. 8).

A proportional control (Fig. 9) has no neutral zone. Instead, it uses the



General Electric

Fig. 8—Two-point side register control system.



General Electric

Fig. 9—Proportional side control system.

CR7515-P201 rotary lens scanner. Correction rates go up to 100 inches per minute with an accuracy up to ±.010 inch of web displacement. The control can follow the edge of a web or printed lines, which can be solid, broken, black or colored.

The two-position control has a small differential over which it operates. The differential is defined as the difference between the upper and lower limits. Midway between them is the point to which the control is set. In a proportional control, the sped of the correction is proportional to the amount of error.

Side register control use vacuum-tube circuits which are related to radio. The circuit in Fig. 10 is a simplified drawing of one type of side register control. Because it must respond to slow changes in web motion from side to side, the tubes are direct-coupled. At some position, as in the original adjustment, the web register is correct. Then the light falling on phototube V1 is balanced by R5 and R14 so there is equal output from V5 and V6 and the correction motor does not move.

If the web moves to one side, more light falls on V1 and current increases, creating a greater voltage across R1, which increases the positive voltage on V2's grid. A voltage divider (R3, R4, R5) across the regulated supply voltage provides several reference potentials. R5 is used to vary V2's cathode voltage.

When V2's grid becomes more positive, the tube conducts more, lowering its plate voltage, and, since V2 is direct-coupled to V3, its grid voltage goes down. R2 sets the amount of this change. V3 and V4 form a phase-inversion circuit: as V3's grid goes less positive, its plate current drops. This increases the plate voltage which makes V5's grid more positive, increasing V5's plate current.

At the same time, the lowered cathode current (and resulting cathode voltage) through R6 also affects V4. This tube has a constant positive grid voltage, obtained from the voltage divider, so the lowered cathode voltage increases the plate current. This lowers V4's plate voltage and V6's grid voltage, decreasing V6's plate current.

Now V5 and V6 are out of phase. Each one's plate current becomes a source of driving power for the correction motor through a generator system. There is more current through forward winding F and less through reverse winding R, and the correction motor goes forward to correct for the original error of web motion. We get reverse action when less light hits the phototube (an error in the opposite sense) and the correction motor reverses and goes in the other direction.

CR7515-S118 side register control

This side register control equipment uses a continuous line or edge of a moving web of material to maintain the lateral position of the web. The photoelectric scanning head detects deviations of the material from its "on-center" position under the scanning head. One of two telephone type relays on the control panel, depending on the direction of lateral deviation, is triggered by the scanner signal. Whenever the material is in register (on center), both relays are de-energized (Fig. 11). If the material moves to one side, more light reaches the phototube and one of the relays (2CR) closes. This relay stays closed until the deviation is corrected. If the material moves the other way, the amount of light decreases and the other relay (1CR) operates. These relays control the reversing motor starter which, in turn, controls the power to the correction motor. The correction motor drives the mechanism to correct the error in lateral register which has been detected.

This two-point side register control is *not* a continuous correction device. It requires a definite lateral variation of the web from the on-center position before any correction is made. Since the web must always be under the scanner, it is a continuous sampling device. The control is set so the referenced edge or line moves through the center of a light beam or spot. With the material in its centered position, a fixed amount of light reaches phototube V1. With the BALANCE control adjusted to match the phototube signal, both relays (1CR, 2CR) are open.

In the balanced condition, both sides of V2 conduct, and both of V4's grids are so biased that the plate currents in both halves of the tube are equal, at some small current which does not energize either relay.

If the phototube receives more light because of a lateral deviation of the material, it passes more current. The current flows through resistor 1R or other sensitivity resistor, making one of V2's grids more postive. This increases V2's plate current. Current also flows through resistor 9R which raises the cathode voltage on the other half of V2. This lowers the grid voltage, and turns off the other half of the tube. The current in one half of V2 increases, while decreasing in the other half by approximately the same amount. Thus, with an increase in light to the phototube, the voltage at V4-a's grid decreases, due to an increased drop, while the voltage at V4-b's grid increases by an equal amount.

When V4-b's grid goes sufficiently positive, that section of V4 conducts enough current to energize relay 2CR. Meanwhile, V4-a's grid has gone negative and that section of V4 does not conduct and relay 1CR remains dropped out.

When the contacts of relay 2CR close, the correction-control devices move the material in a direction to correct the deviation.

As the correct position is approached,

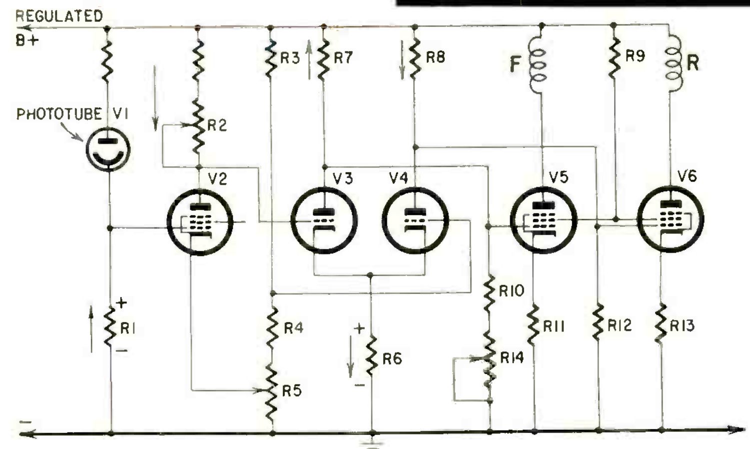


Fig. 10—Circuit of side register control CR7505-S119.

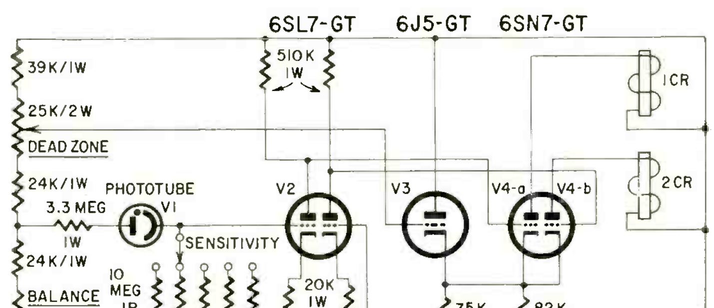


Fig. 11—Partial schematic of G-E type CR7515-S118 side register control.

the light reaching the phototube decreases, V2's grids are again at the same potential and the potentials on V4's grids are matched. V4-b's plate current decreases to its balance value, and relay 2CR drops out.

A decrease in light reaching the phototube, because of a deviation in the opposite direction, runs the control system in reverse. Relay 1CR is energized, the correction is made, the material returns to the in-register position once again, and relay 1CR drops out.

V3 is a cathode follower that keeps V3's and V4's cathodes at several volts positive with respect to V3's grid. With the control in the balanced condition, the voltage on V3's and V4's cathodes determines the bias voltage on V4. Thus the voltage on the cathodes determines the width of the zone (called "dead zone") in which neither relay is energized. By increasing the voltage on V3's grid (increasing the dead zone setting), V3 conducts more, the bias on V4 is increased, and the dead-zone size increases. An increase in the dead-zone size decreases the control's accuracy and the systems tendency to hunt. This adjustment should be set to give the highest accuracy possible without hunting.

So far we have examined side-register photoelectric controls designed to keep the web straight during a continuing industrial process. Next month, we will take a close look at cut off controls that insure cutting a roll of material into exact-size sheets. We will also see what servicing techniques work best for these devices. TO BE CONTINUED

WHALING BY ELECTROCUTION

The Russian whaling ship *Slava* has been equipped with a unique system to kill whales almost instantaneously. The cable linking the ship to the harpoon is not the ordinary type, but is an electrical conductor. When a whale is harpooned, a powerful electric discharge is sent through the cable to kill the whale painlessly.

The reason given for the adoption of this very humanitarian device is that it does away with the long struggle between harpooning and killing the whale, a struggle that could last hours.

TV Tech to MILITARY TECHNICIAN

By EDWIN N. KAUFMAN

At one time or another every TV technician has thought about getting out of the TV service field. One alternate to TV service is work in related aircraft, missile, computer or other types of military electronics.

In investigating job opportunities, commercial electronics should be rated secondary, as overworked and underpaid in comparison to most military electronic jobs. Maximum technician's pay for military electronics (in California) ranges from $3.25 to $3.80 per hour. All overtime is time and a half. It is my understanding that there are many similar openings in Florida as well as other Eastern states at the same pay scale.

Newcomers to the military electronics field are usually offered somewhere between $2.35 and $2.80 per hour. Within 2 to 5 years, depending upon ability, the maximum (present) salary can be reached. The technician with exceptional ability can be promoted to junior engineer, with a future salary limited only by ability.

The advantages of being in business for yourself are well known. The advantage of being a technician in military electronics is (usually) a 40-hour week with a very pleasant Saturday and Sunday off for personal pleasure.

Working conditions vary with the company (all punch timecards), but free life insurance and medical coverage (family additional) is usual. There may or may not be a union. A research or developmental electronics technician usually has the best working conditions. Some companies have both types of positions open while others may have only one.

The newcomer is not in a position to quibble over his first job offer. After doing some work in the field, he may wish to change positions to better himself.

Any military job may require the company to file an application with the Government for your security clearance. The company will keep you on nonclassified work until your clearance is granted.

As in TV service, many types of people (engineers) will be encountered. Most engineers are courteous individuals, happy to explain and aid their technicians in adapting to their jobs. But there are some engineers who can make life difficult. The best thing to do with these is to keep your temper, stay civil and, if the situation is unbearable, ask your superior for a transfer rather than quitting.

Types of work range over the entire electronic spectrum, including everything from the general electronics field to specialized work in radar, computers, etc. The actual jobs can range from missiles, aircraft, communications, instrumentation, ground support, to any of a hundred similar groups. All will prove interesting. The title of a company often has little to do with the electronics work being done.

Although some firms will hire any TV technician, many will not because of his complete lack of know-how outside of the TV field. There are three subjects that can help the technician. He should study one or more of them, preferably in an accredited night school. A correspondence school is also good. In order of importance, subjects are transistors, radar and computers. Further study on instrumentation and measurement techniques could also prove useful. If night or correspondence courses cannot be arranged, home study using the books listed at the end of the article should be satisfactory.

To apply for an electronics position, send a letter to the personnel manager of the company that you are interested in, requesting an application. Mention that you will submit a resume with the completed application. The resume should mention your school education, technical education and any other items of interest, such as an FCC license.

The best of luck to you— END

Recommended Books for Home Study

TRANSISTORS

Leonard M. Krugman, *Fundamentals of Transistors*, John F. Rider. $2.70.

Rufus P. Turner, *Transistors, Theory and Practice*, Gernsback Library. $2.95.

Richard F. Shea, *Transistor Audio Amplifiers*, Wiley. $6.

RADAR

Simon Ramo, *Introduction to Microwaves*, McGraw-Hill. $3.

Radar Electronic Fundamentals NAVSHIPS 900,016. (Order from Superintendent of Documents, US Printing Office, Washington 25, D. C.) $1.25.

COMPUTERS

M. H. Aronson, *The Computer Handbook*, $2.

Digital Techniques for Computation and Control. $6. (Order both from Instruments Publishing Co., 845 Ridge Ave., Pittsburgh 12, Pa.)

TV TUNER with a GUIDED GRID

Tiny TV tuner uses new kind of vacuum tube. Features better performance

By E. D. LUCAS, JR.

LIKE space vehicle electronics, TV tuners are being shrunk as drastically as Alice was pygmied on her way to Wonderland. And it becomes wonderful indeed when you look at the conventional-size Standard Coil vhf tuner and contrast it with the new Guided-Grid model. Examining them side by side (see photos), you see that the miniature turret fills only about a quarter the volume of the earlier tuner. Yet the tiny newcomer features superior performance, and can be used for uhf reception with appropriate coil strips. Also, service technicians will probably judge it easier to work on because of its functional design—its dust cover is easily removed and the printed circuit board is mounted above the turret.

It is only natural that the Guided Grid miniature turret should prove popular, with the current trend toward portable TV sets and consistently flatter chassis. Front ends are tending toward flatness like the silhouettes of the highest-paid Vogue models.

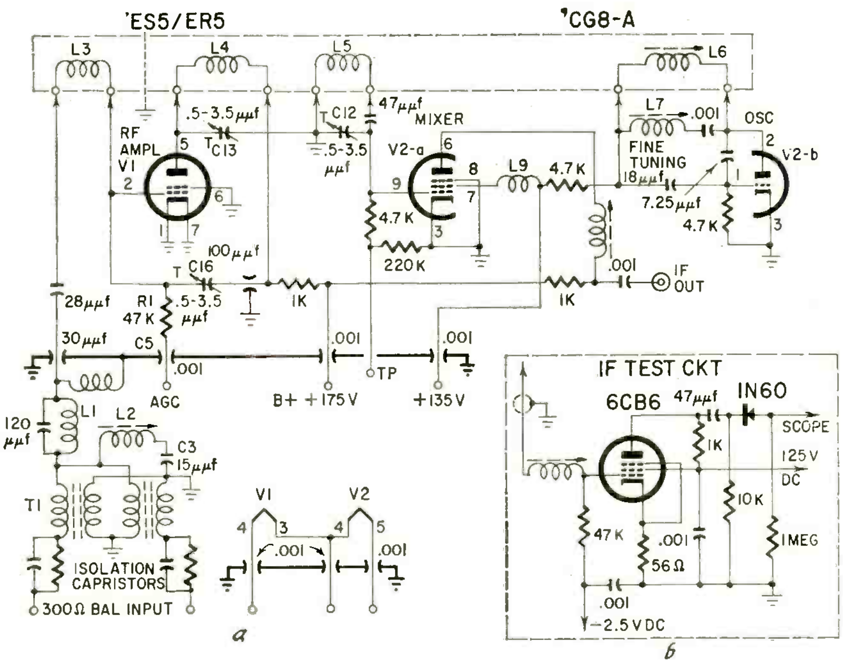


Fig. 1-a—Circuit of the Standard Coil vhf-uhf tuner; b—test circuit replaces if strip.

Circuit description

Examining the schematic in Fig. 1-a, we see a vhf antenna input assembly made up of two isolation capristors (printed-circuit resistor-capacitor parallel networks), a balun (T1) to transform the input impedance from a 300-ohm balanced impedance to approximately 75 ohms, and two traps. The variable inductance in one of these traps (L2) can be adjusted in the field, while the other trap (L1), is factory-aligned. Both are tuned to the intermediate frequency to afford additional if rejection.

An outstanding electronic feature of the tuner is the rf amplifier tube, the 'ER5 or 'ES5, in an improved version of the neutralized triode or Neutrode circuit. This tube was developed as a result of the cooperative effort of Robert C. A. Eland, director of research of Standard Coil Products, and two major tube manufacturers. Included in the tube are additional elements added to pin 6, as shown in Fig. 2. These elements are what the inventor calls the Guided Grid, and they act as shield plates which draw no current. They reduce the plate-to-grid capacitance, thus raising the plate impedance. They also reduce radiation, as compared with that of the 'BN4 type previously used in the Neutrode circuits. With the higher plate impedance, the circuit does not damp the inductance of coil L4 so much. As a result, the tuner's gain is considerably higher, and its signal-to-noise ratio is improved.

As before, the circuit is neutralized by adjusting trimmer C16. To adjust C16 properly, agc voltage must be supplied through feed-through capacitor C5 and resistor R1, with just enough agc level to cut off the tube. A signal is then impressed on the antenna terminals, and the tuner's output is observed through a suitable detector. C16 is then adjusted for minimum response. Capacitors C13 and C12 permit ready compensation for variations in capacitance that may occur when tubes are changed.

The amplified rf signal goes from L4 to L5, two mutually coupled coils, with L5 the grid coil of the mixer (the pentode section of the 'CG8-A). If you

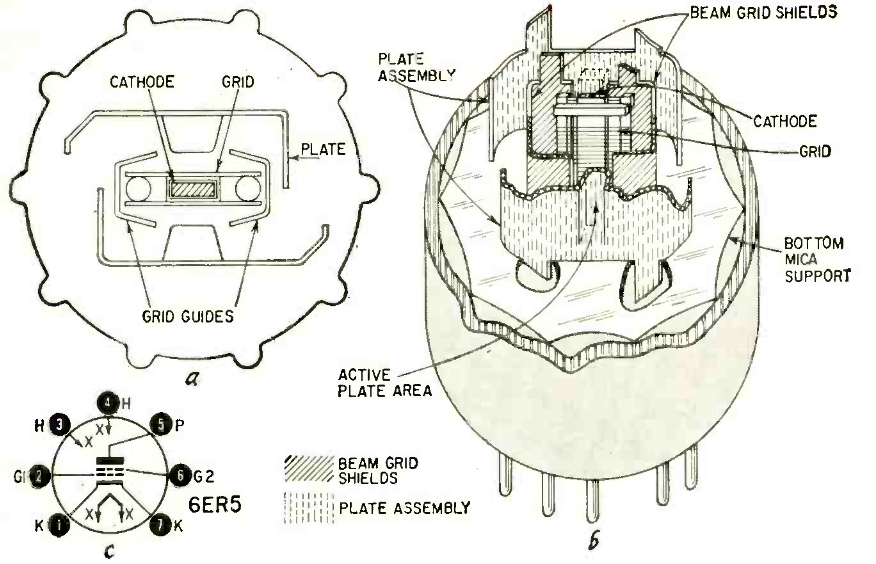


Fig. 2—Cutaway diagram shows construction of the Guided-Grid tube.

want to look at the bandpass characteristics of the tuner up to and including L5, connect a scope to the test point marked TP.

In the mixer, L9 has been added in the screen grid circuit to provide some controlled regeneration and to prevent what would otherwise be a loss of gain over the vhf channels. The local oscillator circuit (the triode section of the 'CG8-A) is conventional. L6 is the tunable oscillator coil and L7 represents the variable inductance of the fine tuning. The manual fine-tuning control moves a slug in and out of a coil wound on a ceramic core.

As shown in Fig 1, the tuner's if output is what may be called low-side capacitance coupled to the input of the first if amplifier stage (which is not part of the tuner, of course).

Gain measurement

To measure the tuner's gain, a reference signal is applied directly to the grid of the if tube in the test circuit (Fig. 1-b) or the first if tube in an if strip. This reference is at a frequency within the if passband, and its voltage is usually about 0.1 volt. A detector, either at the end or in the middle of this if strip, or at the test circuit's output drives an indicating meter. The indication on the meter connected to the detector is then noted, as well as the specific level of the signal fed to the grid of the first if stage.

A signal on the channel frequency is then applied to the antenna terminals and its level is adjusted for the same reading on the meter connected to the if detector. The ratio between the two signals, namely the reference signal and that impressed on the tuner's antenna input, gives you the tuner's gain. The if test circuit shown in Fig. 1-b can be used in lieu of a complete if amplifier and its detector or an auxiliary detector. The test circuit is preferred as it avoids the chance of error that might be introduced by a misaligned if strip.

There are two points at which the bandpass characteristics of the new tuner may be observed. One is at the test point (TP)—it shows the bandpass of the rf amplifier and grid coil of the mixer. The other is at the output of the if test circuit—it indicates both rf response and the unit's if bandpass. Signals are applied from a sweep generator centered on the selected channel frequency. You can observe bandpass on an oscilloscope synchronized to the generator's sweep rate.

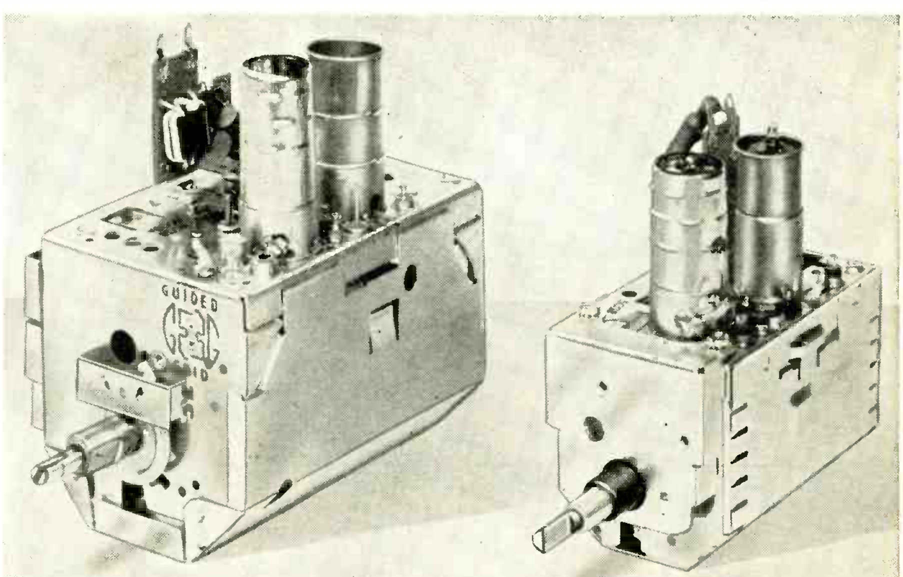
Noise factor is normally measured only at the factory. For this test, a noise diode is usually used to generate a uniform noise voltage over all desired TV frequencies. The tuner is operated with a stable if amplifier, and its output is connected to a meter that can read the residual noise content of the signal produced at the second detector. This if amplifier is so adjusted that its gain may be reduced by 3 db without deteriorating its bandpass characteristics. This can be done with a pad or a bias control. A signal from the noise generator introduced at the antenna input, is now fed through the tuner. With the if stage gain reduced by 3 db, the noise level from the noise diode is increased until the original residual noise reference is reached. The reading on the meter at the detector shows the noise factor.

It might be mentioned that the new miniature turret tuner operates well within the limits established by the FCC for vhf oscillator radiation. When uhf coil strips are used, the tuner is still well within the limits for uhf oscillator radiation.

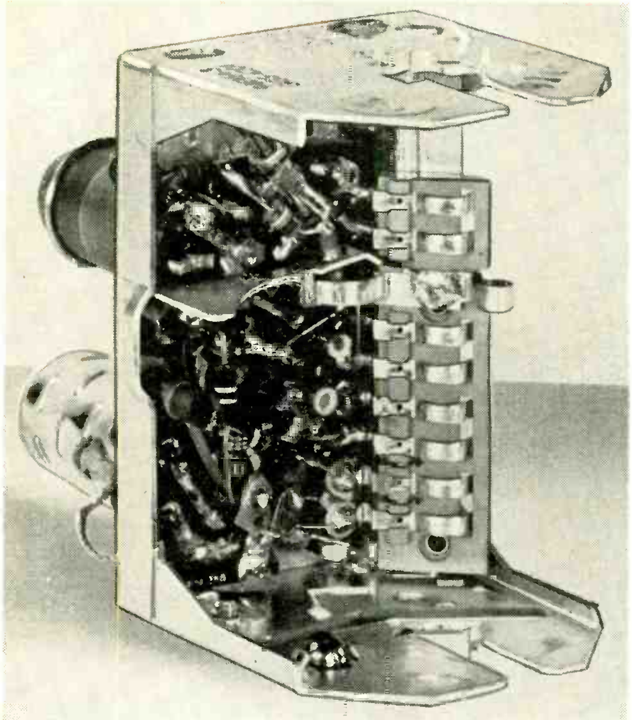
Mechanical features

The Guided Grid tuner appeals to service technicians because of several mechanical improvements. The dust cover is easily removed—merely press the springy slotted sections on each side of the cover. There is a ball detent for positive contact of coil strips on the turrets with the stator contacts. The strength of the coil boards is the same as in the big turret. Contacts are preloaded. Standard Coil uses an automated life-test machine, and the company's engineers state that the new tuner's operation is satisfactory for at least 50,000 cycles of turret rotation. A cycle is one complete rotation of the turret in one direction, and then an equal rotation in the opposite direction.

Component replacement works the same as with the larger earlier tuners; clip out defective units and solder in conventional parts. Practically all parts associated with the rf amplifier, mixer and oscillator, except for the antenna input assembly and the coils on the coil board, are either mounted on, or part



Miniature TV-tuner with Guided-Grid Neutrode circuit is on the right. It outperforms previous standard-sized version.



Bottom view of the Guided-Grid tuner with cover and turret removed to show the tuner's printed circuit board.

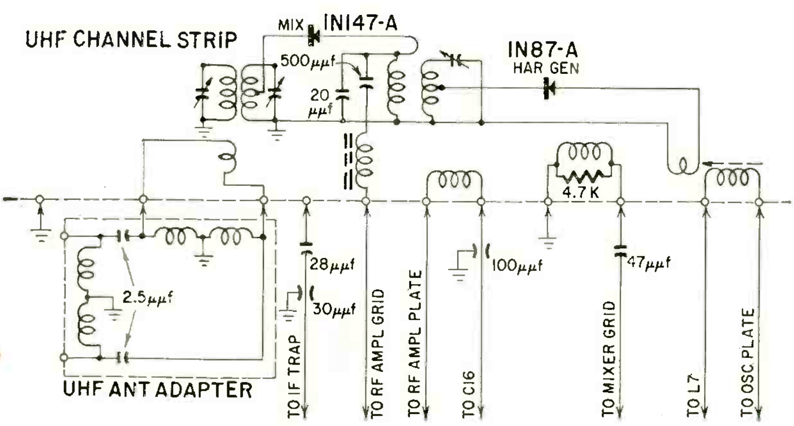


Fig. 3—A simplified circuit of a uhf tuner coil strip.

of, the printed-circuit board, which is installed between the turret and the tube sockets.

Uhf operation

The new tuner accommodates as many as four uhf strips in place of vhf coils. Each uhf strip may have two vhf strips on either side of it on the turret. The uhf strip is placed in the tuner in the same way as vhf boards, except that when a uhf strip is inserted the two vhf boards (one on either side) must first be removed and then reinserted after the uhf board is in place.

When you insert a uhf board in one of these tuners for the first time, you must make sure that the tuner is equipped with a uhf antenna adapter. This assembly is inserted through a hole at the rear of the tuner, adjacent to the vhf antenna input assembly. When the adapter is installed, it connects to the last two contacts on the uhf board as well as an additional contact for grounding which projects over the end of the board and is part of the metal base of the uhf strip.

As shown in Fig. 3, a simplified schematic of a uhf channel strip, this unit utilizes double preselection. The rf uhf signal is converted to the if frequency in the mixer crystal, a 1N147-A, which is also excited by the proper local oscillator voltage from the harmonic selector tank. This selector is excited by a harmonic generating crystal, a 1N87-A, which picks up its fundamental voltage from the vhf oscillator. This oscillator voltage is carried to the harmonic crystal by a link coupling to the oscillator coil.

The mixer crystal's output, as noted, is an if signal which appears across the first capacitor of a pi network. The output capacitor of this network is the input capacitance of the 6ES5 amplifier in the tuner, which now acts as a high-gain if amplifier.

Noise figures in the order of 11 db have been obtained with this uhf strip design, although Standard Coil does not claim this as average performance in production runs. The uhf strips are tuned to a specific frequency. The manufacturer recommends, however, that when one is inserted in a tuner for the first time the technician should touch up the oscillator adjustment, which is reached through the normal adjustment hole.

To sum it up

Performance of the Standard Coil miniature Guided Grid turret tuner is superior to that of larger conventional units. One important reason is the Guided-Grid tube used in the Neutrode rf amplifier stage, in which two shields are placed between the triode's grid and plate. These shield plates reduce the plate-to-grid capacitance, raising the plate impedance and the gain of the tube, while radiation is reduced and signal-to-noise ratio is improved.

Mechanical features of the new tiny unit also include several improvements, including a cover that slips on or off easily, without tools.

The vhf oscillator is very stable, and local oscillator radiation is within FCC limits.

The new miniature vhf tuner can be used to provide reception of as many as four uhf channels by adding an antenna assembly and four appropriate uhf strips in place of vhf strips.

The author acknowledges the very material assistance of Ralph Stubbe, assistant director of research, Standard Coil Products Co., Inc., in the preparation of this article. END

SOUND TAKEOFF

A Magnavox CT-214B needed a new tuner. This set is a split-sound unit with a 21.25-mc sound if. The sound takeoff is right at the tuner. I chose a Standard Coil TV-2232 cascode. Unfortunately, my distributor had the tuner but not the sound-takeoff coil.

Determined to have sound, I examined the schematic for this set and noticed a cathode trap tuned to 21.25 mc in the fourth video if. I figured all I had to do was throw a few turns around it, run a lead to the first sound if grid and sit back and listen. Completing the job, I turned on the set but could get only the faintest trace of audio.

After countless weird sound-takeoff circuits failed, my wife (and technical adviser) suggested, "Why don't you check the tubes?" I grunted, "It's not the tubes." And when her back was turned, I started to replace them. The if and limiter tubes checked good but when I reached for the discriminator, it fell out of its socket. Somehow it had worked loose and was not making good contact.

Plugging the tube in brought the sound thundering through. My original circuit worked and my wife was proud of me and, secretly, of herself.—*Robert D. Schloemer*

1960 TV DESIGN TRENDS

Part II—Circuits, remote controls, and new tubes in the 1960 receivers

By WAYNE LEMONS

LAST month we took a general look at the new lines of television receivers with particular concentration on picture tubes, single-rod antennas, printed circuits and modules.

This month we will go into somewhat more detail, starting with some of the more interesting circuits, remote-control units and this year's crop of new tubes.

Motorola Keyed Agc

An interesting innovation in keyed agc circuits is found in the Motorola TS-556 chassis (Fig. 1). Although at first glance we might think it a more or less normal circuit, the inclusion of a negative horizontal pulse from the flyback to grid 3 of the 3BU8 is unusual. The pulse is used to neutralize or balance the keyer. Without it, a certain amount of the positive pulse appearing on the plate of the keyer will leak to the grid through the tube's capacitance. Though not a serious consideration generally, it could be a factor under marginal conditions. By applying a negative pulse through a very small (2.7-$\mu\mu$f) capacitor, this feedthrough effect is cancelled and circuit operation refined.

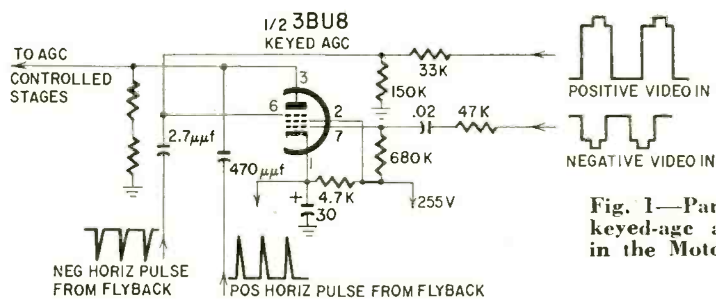


Fig. 1—Partial circuit of the keyed-agc and noise limiter in the Motorola TS-556.

Also new is the use of a Hartley oscillator and reactance tube as a horizontal oscillator and control. A triode–pentode type tube (5U8 or 5EA8, see Fig. 2) is used. The grid leak for the oscillator is a 2.7-megohm resistor and, instead of being returned to ground, is connected to the plate of the oscillator tube. According to Motorola, this method enhances the ability of the tube to start oscillating. The dual diode portion of a 6CN7 is used in a conventional phase-detector circuit.

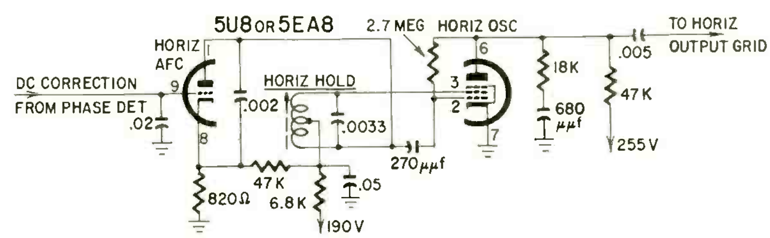


Fig. 2—Reactance tube and horizontal oscillator in the Motorola TS-556 chassis.

Incidentally, the Motorola printed-circuit board will be easier to make repairs on this year. Long leads on modules, resistors, and capacitors simplify disconnecting and replacing defective units.

G-E Horizontal Retrace Blanking

When definition is as good as it is in many new sets, horizontal retrace blanking is advantageous. This blanking is especially useful in eliminating the snaky white line that occurs when no picture is being transmitted. This effect seems to be especially annoying to some customers. The snaky line can appear in the picture if contrast and brightness are at a critical level or if the fine tuning control is slightly misadjusted.

G-E feeds a positive spike, in their U4 chassis, from the horizontal flyback to the cathode of the picture tube, as shown in Fig. 3. It cuts the tube off during horizontal retrace. Of course, this is not the first time that horizontal retrace blanking has been used. It is essential in the design of color sets. Most companies have at one time or another had some form of it. We include the G-E circuit because it seems

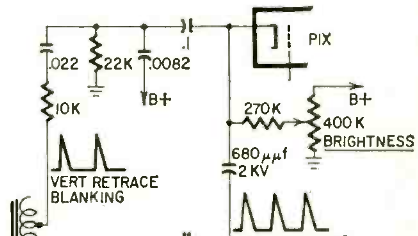
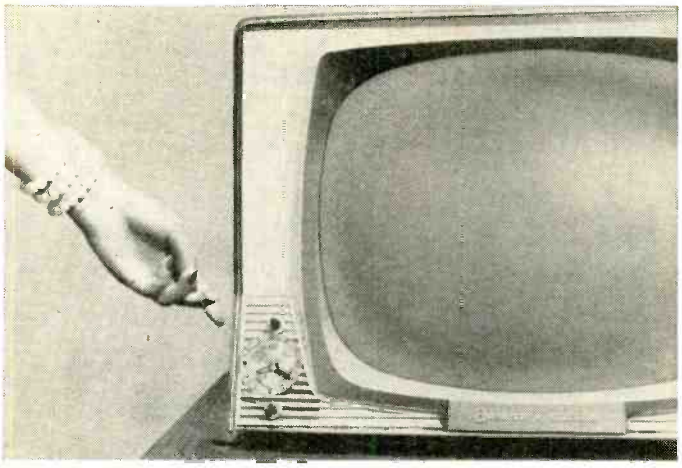
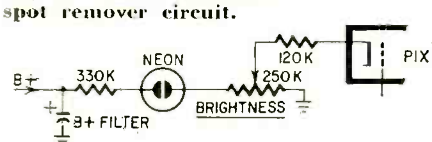


Fig. 3—Horizontal and vertical retrace blanking used in the G-E U4 chassis.



Sylvania 17-inch portable has automatic on–off timer for convenience of late-show viewers which turns set on or off at preset time.

Fig. 4—Zenith automatic spot remover circuit.



one of the simplest approaches.

Zenith Automatic Spot Remover

Fig. 4 shows how a neon bulb is used in some Zenith models to help eliminate the spot on the picture tube when the set is turned off. The neon acts as a switch to keep the charge remaining on the B-plus filter capacitor from being applied to the picture-tube cathode. This makes the tube conduct more and discharge the high-voltage capacitors more quickly when the set is turned off. It has somewhat the same effect as advancing the brightness control.

Clarity and Synchrophase Circuits

RCA is using a couple of new circuits in this year's line. One is a clarity (picture-quality) control found on their deluxe sets. A five-position switch, it connects capacitors in the cathode or plate circuit of the video amplifier to peak or depeak the video response. In this way, the amount of detail on the TV screen can be adjusted.

The other new circuit is the synchrophase system of controlling the horizontal oscillator. This system uses an oscillator and control-tube circuit that is practically the same as that used in the synchroguide. However, it incorporates a balanced-discriminator type of circuit in which a dc correction voltage is formed across the diode load resistors. As in the synchroguide, the phase of incoming horizontal pulses is compared with the phase of the horizontal oscillator. Any difference sets up a dc control voltage that corrects the frequency and phase of horizontal oscillator until they match those of the incoming sync pulses.

Checking selenium phase detectors

Philco recommends that the forward resistance measured on the 10,000-ohm scale of a 20,000-ohms-per-volt meter should not exceed 6,000 ohms.

The back resistance of the diodes should be a minimum of 2 megohms. The forward resistance ratio of the two diodes should be less than 2 to 1. For instance, if one diode reads 4,000 ohms forward resistance and the other reads 1,000 (ratio 4 to 1), the unit should be replaced even though both diodes have less than the maximum allowable of 6,000 ohms. On Philco's the center conductor of the phase comparer is the common negative.

New tubes

Dampers: *6DA4, 6DE4, 12AF3.*

The 'DA4 and 'DE4 are similar to the 6AX4 and have the same pin connections. The 'AF3 is a nine-pin noval-base tube with the cathode connection made to a cap on top of the tube similar to the older 6V3.

Vertical output and oscillator: *6DR7, 13DR7, 6AE7.*

These are dual triodes but with dissimilar sections. One section is used as the oscillator, the other as the output.

Vertical output: *6DB5, 6DT5, 6EM5, 7EY6.*

These are all pentodes used by various manufacturers for the vertical output stage, especially in 110° chassis.

Audio output: *6CA5, 8BQ5, 12DE5.* **Triode-pentode:** *6EB8, 8EB8, 5EA8, 6EA8.*

The 'EB8 is similar to the 'AW8 series. The 'EA8 is similar and interchangeable with the 'U8 series (5U8, 6U8).

Horizontal output: *6EX6, 12GC6.*

Both these tubes have pin connections identical to the 6CD6. Used by Motorola.

Ratio detector and first audio: *6FM8.*

Used by G-E. Similar to 6T8.

Rectifier: *5V3.*

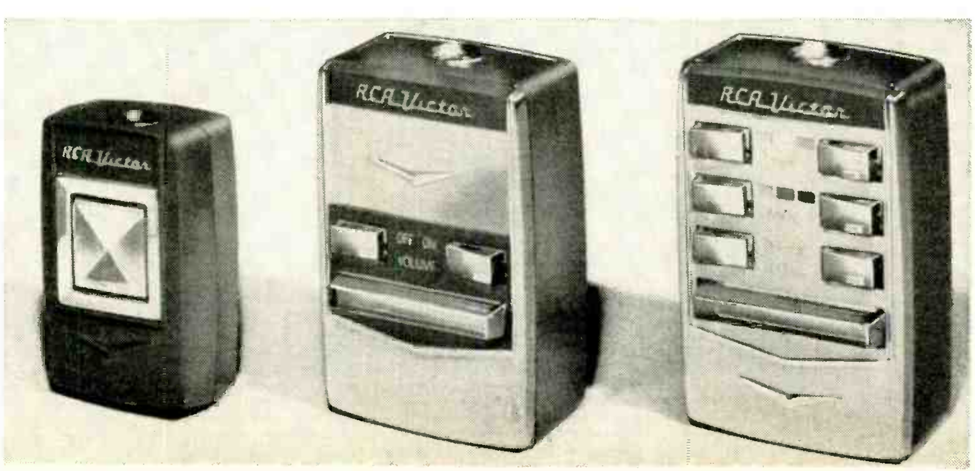
Used by Admiral in some models. Has pin connections identical to 5U4, but **should not be replaced by a 5U4 or 5U4-GB.** Maximum dc output of 5U4-GB is 275 ma at 450 volts. DC output of 5V3 is rated at 350 ma maximum at 450 volts. Instead of the 5V3 in some runs of Admirals, a 5U4 and a 5Y3 are used in parallel.

Remotes

Remote controls will apparently have their biggest year if the manufacturer is any judge. Except for one or two major companies, remote units, almost universally the wireless type, are being offered to the consumer. This includes remotes for portables too!

Zenith and Admiral (Space Command and Son-R) have mechanical nonelectronic remote units, while most other manufacturers, including RCA's 7-function color-set remote, use transistor remotes.

All use frequencies in the range of 40 kc, for two or three reasons. First, 40 kc is not harmonically related to



Three new RCA Wireless Wizard TV remote controls. On the left is 3-function unit for monochrome sets. Next is 5-function unit. At extreme right is new 7-function unit for color TV receivers.

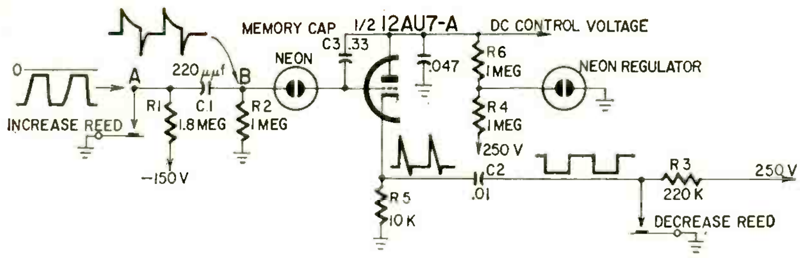


Fig. 5—Partial circuit of Magnavox remote control showing memory section

the horizontal frequency (that could cause spurious triggering), being between the second and third harmonics. Second, it is easy to develop stable signals by either mechanical or electrical means without using expensive materials or crystals. Third, selective circuits are easily designed for use in the remote receiver.

Most transistor units use only a CW signal, or sometimes pulsed CW, to actuate the remote receiver. However, Magnavox uses a tone-modulated CW signal that actuates vibrating reed switches that respond only to particular tones. Using these and a unique "memory" circuit, completely variable control —both up and down—of brightness, sound, and of channel change is the result.

Fig. 5 is a simplified schematic of the memory circuit. When the "increase" button on the remote unit is depressed, the "increase reed" in the remote receiver is excited at the tone-modulated rate and alternately grounds and ungrounds the negative supply through resistor R1. This produces at point A an almost square wave that is differentiated by C1 and R2, putting a positive spike wave form at point B. The positive spikes fire the neon glow tube and the pulses start to charge capacitor C3 in a positive direction. A more positive voltage on the grid causes the tube to conduct more heavily and the voltage drop across R6 to increase. This is the same as saying the dc control or plate voltage is lowered.

You will note that there is no grid return in the triode circuit except through the neon and that the neon is nonconducting unless ignited. This means that whatever charge is placed on C3 has no leakage path, so it will remain for an indefinite period of time. When the "increase" button is pushed then, the brightness (or volume, depending on which circuit) will increase as the button is depressed and will be "memorized" by capacitor C3, thus holding the brightness at that specified value until either the increase or decrease button is depressed again. The time constant of this circuit is several hundred hours, more than ample for normal viewing periods. The "decrease" reed interrupts the negative side of a positive circuit through resistor R3. The square pulse is differentiated by C2 and R5. The negative spike on the cathode makes the triode draw grid current and the charge on C3 is gradually reduced. This, in turn, increases the dc control voltage and lowers the brightness. The 12AU7-A memory tube is operated at reduced heater and plate voltages, which results in very low grid current in the tube itself.

Transistor sets

Only Philco is marketing a transistor set. It is a portable with a 2-inch picture tube with the image magnified about seven times. A special rechargeable 7.5-volt battery powers the set, which may also be operated from the ac line. A full circuit description of this first transistor set to be marketed can be found in the August, 1959, issue of RADIO-ELECTRONICS.

Other companies have shown transistor TV receivers, but none have announced plans for marketing.

Clocks

In catering to the late viewers, several companies are including clock mechanisms for some models in the 1960 line. Most of these units simply turn the set on or off at a given time. RCA, however, has a complete programmer. Setting levers for time and channel, the set owner can schedule an entire day of programs in advance. At the chosen time, the set will automatically turn itself on, select the proper channel and then turn itself off at the end of the program or move to another channel, etc. Possibly the big advantage in these convenience features is that that the set is more complicated and, from a technician's standpoint, probably will mean more service calls.

Summary

There have been no real major changes in either black-and-white or color in the actual electronic circuits. The 23-inch tube and the service accessibility are no doubt the big news for us technicians. There are more speakers in many models. Remotes, clocks and novel cabinet stylings are trends you'll be seeing a lot of in 1960.

Printed boards seem destined to stay with us, mainly, we believe, because they are less expensive to manufacture rather than because of better performance. Printed boards have been improved greatly but whether this will get them completely out of the doghouse with technicians is yet to be seen. It is almost certain that some of the animosity will disappear as technicians grow to trust them more. All in all, it should be an interesting year to watch. How will the public take to the 23-inch tube, color, printed boards, hand-wired sets, remotes, clocks, unusual cabinet designs? Only time and sales figures can tell. END

NEXT MONTH

One-Control Multimeter

One range-setting switch is all that is needed in this new multimeter. Not only is zero-setting eliminated, but the circuit is so designed that maximum current in the low-ohms position is limited to 500 μamp. Measures up to 750 volts dc and ac, has three current ranges to 150 ma and a VU scale.

Balancing Motors by Electronics

If the motor armature does not run absolutely true, a phonograph may be noisy or a small appliance have a short life. Rotors today are balanced by electronics, and the balancer is an important piece of industrial electronic equipment. This article tells how they work and how to operate them.

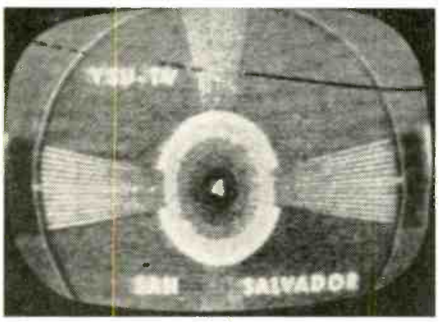
Electronic Voltage Regulator for Your Car

A four-transistor circuit overcomes most of the disadvantages of electromechanical types of regulators. Because of the high amplification of the transistor circuit, regulation is very close. Life and reliability of the unit is limited only by the quality of the components used.

fm tv dx in 1959

By ROBERT B. COOPER, Jr.

IN the past year, 760 dx enthusiasts interested in long-range television and FM reception have contributed material and dx reports to this column. Just by stacking these reports alongside one another, separated into the months of the year, it is easy to see



Test pattern of YSU-TV, channel 4, San Salvador, El Salvador, as seen by dxer Don Ruhland in Holly Hill, Fla. Distance—1,100 miles.

the potential for June and July. The chart shows the two most apparent facts. In a month-by-month comparison for the period November, 1958–October, 1959, the number of reporters (using official TV Dx Column logging sheets only) is compared with the number of dx loggings for each monthly period. And the total number of dx loggings is further broken down to depict the number of E-skip loggings (shaded area) versus the total number of dx loggings for the month. It was a very busy year for dxers, and a year involving a mountain of listing and other paper work for your editor.

The chart shows several facts most experienced dxers know well. At least half of the dx logged during the year was of the sporadic-E variety. This is probably traceable to the fact that many dxers "dx" only during the summertime Es season, and neglect periods of the fall, winter and spring when ground wave, MS (meteor scatter), and other forms of dx run rampant. The number of skip loggings rises to a peak in the summer months of June and July. The range from the high of 1501 Es loggings in June of '59 to the low point of but 4 in March, '59 shows that the frequency and duration of E-skip reception varies greatly in a short period of time.

Unlike TV dxers, the FM set found more interest in chasing long-haul ground wave (also known as trops) signals than the Es type of signals. Many dxers found to their surprise FM signals often pop in from stations 400–600 miles distant, when no signs of dx are apparent on TV dx channels. And such types of openings often affect only one or two FM stations—lasting with good fidelity for 15 to 30 minutes before disappearing. Propagation scientists still have to explain this phenomenon and this year's dx reports will be a great help in their studies.

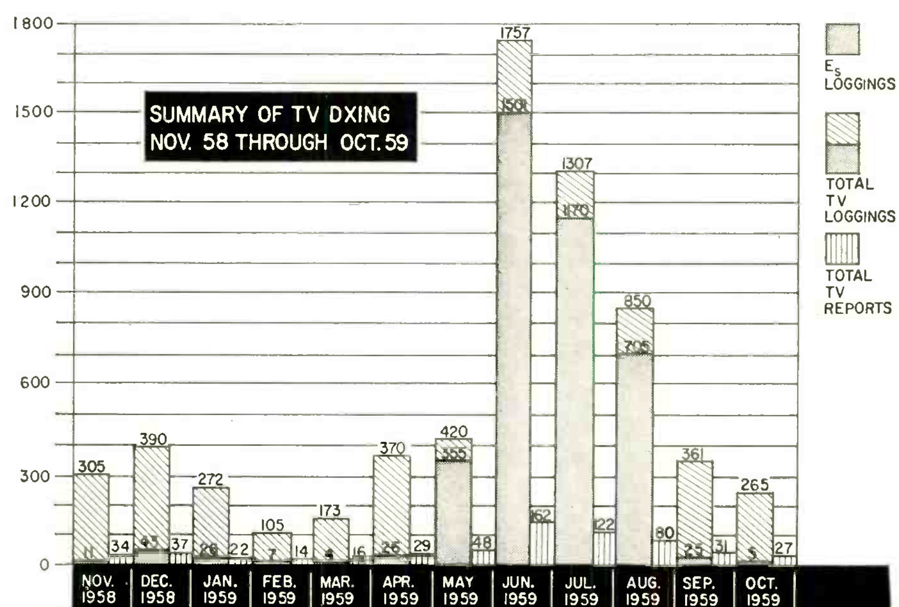
Unusual and rare reception

Studying the reports of the dxers on the peninsula of Florida for this past summer, one fact becomes quite apparent. Reception across the Gulf from stations in Mexico, Puerto Rico and many other Caribbean countries was on the increase this year. Still many stations in this area operating with good-size power and antennas which should have been logged, were not. Their unusual operating hours may not have coincided with the hours of the dx openings to the mainland USA. Or perhaps dxers have regained a habit common in 1952 and '53—writing off every unidentified Spanish-speaking station from the south as another Cuban transmitter.

Whatever the cause of these trends, we do know alert dxers did see new stations in new countries—El Salvador is one. Dxer Donald Ruland, Holly Hill, Fla., is an excellent case in point. Dxer Ruland nabbed YSU-TV, channel 4, operating from San Salvador, El Salvador (see photo).

September unusual also

September is by tradition not much of a month for E skip and this year was only a small exception. Two unusual E-skip openings did occur in September—the first on Sept. 6, the second on the 27th. The Sept. 6 opening was unusual for such a late season period because of the scope it covered and the strength of the opening. Skip began around noon EST over the Midatlantic coastal states and drifted slowly westward during the remainder of the day, hanging on as late as 0200 EST on the 27th. The area affected by skip was mostly north of a line drawn from Norfolk, Va., to San Francisco, Calif. The 27th of September produced a mild flurry of Es over the Southern states, from Southern California east to Florida and all along the Gulf coast. But as weak as it was in the USA, the skip effects appeared to extend far to the south of the USA, well into the Caribbean and perhaps even to the northern coast of South America. Dxers in South America report reception of Mexico City stations around 2000 EST. Dxers in the states of New Mexico, Arizona and Texas logged Mexico City reception during



the same period. There is a good chance skip lined up on both ends—only time and the shuffling of reports will tell.

FM reports up!

This was the first full year for FM dx reporting, and although the number of enthusiasts is still less that 250 reporting-wise, the hobby is catching on rapidly. Many more enthusiasts undoubtedly exist—if they could be reached and gathered together into one reporting group (a function of the new magazine *TV-FM Dxing Horizons* to be explained below).

Nearly 500 FM-band dx reports were turned into this office during the 12-month period—many from dxers only beginning the hunt for FM DX stations. In the totals listing, it would be only fair to point out that less than 10% of the active FM dxers ever bothered to mention their totals—thus the sparse listing.

Many of those who are regular readers of this column have known no other editor of the TV-FM dx section, but my connection with this project dates back only to the summer of 1956. RADIO-ELECTRONICS began this series of dx articles in the summer of 1950, following a series of reports made to the magazine by the rapidly growing TV service industry of the late 40's and early 50's. In the decade that has passed, this annual collection of reports from dxers in every state and 37 countries has found its way to the desks of scientists and engineers for detailed analysis, year after year. TV dx observations by RADIO-ELECTRONICS observers have served many useful purposes, and our column has united dxers into a very loose cooperative group. Now it is my unhappy duty to inform the dxing clan that this column is to be discontinued.

In the decade of reporting and dxing, the following this hobby has acquired has grown into the thousands. Speaking as a fellow dxer, RADIO-ELECTRONICS magazine, through its support and work with this column, is to be congratulated for its work helping this hobby grow. Now, however, a time has come when the hobby must either sink or swim—stand on its own merits or fall by the wayside. It is time for every dxer in every corner of the world to join forces with every other dxer for the benefit of the hobby, by supporting a magazine for the hobby exclusively!! Such a magazine is already a reality, and if you do not receive your copy by Jan. 6, 1960, a copy is waiting for you at 820 Tully Road, Modesto, Calif. Drop a postcard for your free copy.

Either activity this year has been unusual, or we have handled it in greater detail than usual, for I find no room in this installment for the usual ratings of TV–FM dx viewers and listeners. Next month we will describe some of the most interesting feats, and list the Over 50 Dx Club as usual, as well as tell a little more about *TV-FM Dxing Horizons.*

TO BE CONTINUED

TV Service CLINIC

conducted by

JACK DARR

COMMUNITY antenna systems are used in many sections of the country. While this is commonly thought of as a feature of life in rural districts far from the TV transmitters, it is also common in metropolitan areas, where many dwellers in large hotels, apartment houses, etc., are served by community systems, because of the impossibility of erecting individual antennas for each tenant.

These systems can create some unusual service problems, probably more virulent in the rural areas, but annoying in all. The reason for the difficulty in the fringe areas is that the technicians are accustomed to working on sets using very small signals. Their thinking is more or less oriented toward obtaining *more* and *more* gain in the TV sets. That trouble can be caused by *too much signal* sometimes escapes them!

The average TV set can deliver good pictures over a very wide range of input signals—from about 50 μv up to several hundred. Signal levels in most cable systems seem to be in the order of 400 to 600 μv for each channel. This should be sufficient to give clear pictures on even the older TV sets.

If correctly installed, the system offers signals on several channels and, by proper use of controls, keep each signal within the same range of amplitude. The better systems are set up as shown in Fig. 1. The incoming signal is picked up by suitable antennas and passed through separate single-channel amplifiers. These have gains ranging up to 25 or 30 db, and each uses a very close-set agc circuit to hold the amplifier's gain to a tight tolerance. Gains of the amplifiers are adjusted to give approximately the same output on each channel.

For small-town systems, where the signals must be transmitted over several miles of cable, the high-band stations are amplified more than the low-band ones. This is necessary because of the greater attenuation of coaxial cable at the higher frequencies. Equalizing amplifiers, with response curves peaked to favor the high bands, are used at intervals along the cable system. For very long runs, the signals are sometimes run through a complete set of single-channel amplifiers just before they enter the distribution system. Filters separate the different signals, and they are fed to individual amplifiers, boosted, controlled, their amplitudes adjusted, and then sent into the broad-band amplifiers of the distribution network.

For apartment-house systems, this is not necessary because of the comparatively short runs of cable, although it is possible to use additional amplification if local conditions require it. The final aim of each system should be to deliver signals on each available channel, at approximately the same level, to each set on the network.

Tuners on the average TV set, while adequate, are not noted for their selectivity! This is a "Law of Nature"—if we expect the tuner to respond to a band of frequencies 6 mc wide, we can't expect the poor thing to drop off sharply on either side of this band. So if we have two very strong adjacent channels, we can run into some interference. To avoid this as much as possible, the signals are separated in the community antenna network. By using frequency changers, possible adjacent channels are converted to another channel, so that there is always at least one empty channel between each pair. This allows us to use a much higher signal level in the system without interference.

Unfortunately, many technicians are prone to blame the cable for unfamiliar troubles—sync clipping, hum, distortion, color-burst attenuation, etc. While it is possible for some trouble to originate in the system, it is usually of a nature which makes itself immediately obvious.

Hum bars can be caused by leakage in tubes or by power supply defects, in the cable amplifiers. This should be immediately obvious since the trouble is on all channels. In metropolitan areas, substituting a pair of rabbit ears for the cable connection should show this up quickly. Checking another nearby receiver for duplicate symptoms is just as quick.

Sync clipping on the cable itself is another favorite. Actual experience has shown that this *rarely happens!* The signal in the cable is rf. For sufficient compression, the signal would have to be almost detected by the defective amplifier! Because of the high level of signal on the cable, even very slightly gassy if and rf amplifiers, or slightly weak tubes in the agc circuits can cause sync clipping. This is often unintentionally caused by the user himself! Especially if the set happens to have a local–distance switch. If this switch is accidentally set to distance, the high signal level will cause a perfectly normal overloading of the if's.

Attenuation of the color burst is always possible, but is seldom encountered. This is the reason: the amplifiers used in community antenna systems have a tremendous bandwidth, ranging from about 50 up to 220 mc, to cover all the vhf channels. The response curves of these amplifiers are fairly flat with only minor peaks here and there. For the amplifiers to clip the color burst, this curve would have to drop off *very steeply* at only certain frequencies! It is possible, but quite unlikely! If any defect in the amplifier causes this trouble, it would always be accompanied by other unmistakable symptoms of improper operation—hum bars, snow, etc.

Actual cable troubles can be readily identified with a standard field-strength meter and the TV set itself. The field-strength meter will tell you whether there is enough signal to make a picture and the TV screen will give all the information necessary as to its quality. One possibility of trouble in cable systems is adjacent-channel interference, despite the one-channel guard band. If the signal level in the system is too high, windshield-wiper interference and venetian blinds will appear on most or all sets. This can be reduced only by cutting the gain of the amplifiers until the interference is eliminated.

In the outdoor systems in smaller towns, troubles are often found after a heavy rain, especially on long runs of cable. If the polyethylene foam-filled type of coaxial cable is used and the junction boxes are not properly sealed, moisture will enter the cable itself. This increases the attenuation tremendously, especially on the high channels, and will result in snowy pictures. If the highs seem weaker than the lows, check the tuner tubes first, then call the cable office!

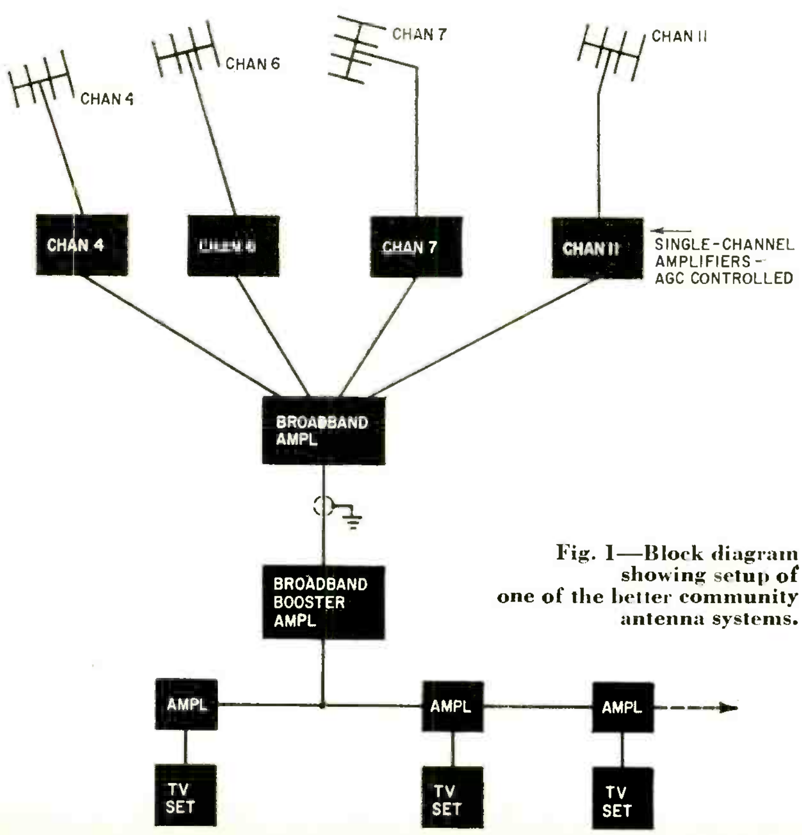


Fig. 1—Block diagram showing setup of one of the better community antenna systems.

Dc restorer

I am one who believes that all TV sets should have a dc restorer circuit. I have a Capehart model 1C213M in which I would like to add such a restorer. Can you give me a circuit for this, using a crystal diode?—R. W., Tacoma, Wash.

Many designers hesitate to use dc restorers in monochrome sets because they feel that component drift could cause objectionable shift in tube operating points. This is summed up in the statement that viewers usually do not complain about loss in picture quality! The cost factor is also important.

Fig. 2 shows a circuit using a 1N34-A diode for a grid-driven dc restorer that can easily be added to your set. The 100,000-ohm resistor in series with the diode reduces the load on the video signal. This passes the 15,750-cycle sync pulses, working into the input capacitance of the diode. Thus, it gives a low-pass filter action where needed. The higher video frequencies are not affected: the restorer operates only on low video frequencies, such as will be found in creating large grey areas of the picture.

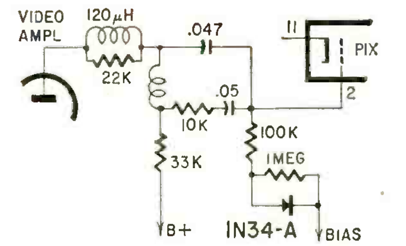


Fig. 2—Simple dc restorer circuit uses a 1N34-A diode. Select diodes with back resistance of at least 750,000 ohms.

Two questions

I have a Philco F4628 which rolls when connected to our cable system. In the shop it works OK. Another set did not roll on the cable. Can you tell me what is causing this? I also have a Capehart CX33 which has a pull in the top 2 inches of the picture.—L. T. V., Montesano, Wash.

Your trouble with the rolling is caused by sync clipping, probably from the high-level signals of the cable. This can be caused by defective tubes in any one of several stages. Most of this, in this chassis, seems to be caused by the video if amplifier tubes. Test them carefully, especially the first and second stages, and you'll find them slightly gassy. Gas currents flowing in the grid circuits buck out the agc bias, letting the stage overload and clip sync. This can also happen in any of the agc-controlled stages, of course. If this does not cure it, check the sync separator tubes for low plate voltage.

The pulling trouble in the Capehart is probably caused by a substandard electrolytic. The output capacitor (last one in the filter circuit) is the most likely suspect here. Run a complete readjustment procedure on the horizontal oscillator—short out the ringing coil, adjust the hold control for best picture, remove the short and adjust the ringing coil for stationary picture. If shunting the old electrolytics with new ones does not cure the trouble, take the old units completely out of the circuit, one at a time, replacing with new ones.

Power transformer out

A Silvertone TV set (chassis number 110-449-1) has a burnt-out power transformer and I cannot find any information on a replacement. I would like to modify this set to use selenium rectifiers if possible. I am overseas, and unable to get any information about the set here.—H. H. B., APO 864, New York, N. Y.

A replacement transformer for this

set is a Triad R-35A or R-35BC. This has a 370-volt center-tapped winding for the plate voltage, two rectifier heater windings and two 6.3-volt heater windings. This set uses a 5U4 and a 6X5 as rectifiers and the low-voltage supply is rather complicated. I don't believe the conversion to a dry-rectifier power supply would be practical. Unless the power supply were completely redesigned, using a voltage-tripler circuit, probably the set's performance would no longer be satisfactory.

Insufficient height

A Crosley G17TOMH TV had a bad vertical output transformer and I replaced it with the recommended type, a Thordarson 26S55. Now, the picture is only about 2 inches high, and I can't get any more height. I have tied the ends of the windings to make an autotransformer out of it. As it says, the green and black wires.—H. H. N., Hatfield, Ark.

You're going to hate me when I tell you the answer! This is not an uncommon trouble. The output transformer you mention is *already* an autotransformer! If you were using an output transformer with two separate windings, your procedure would be exactly right. However, by tying two taps of the winding together, you have lowered the Q of the transformer to

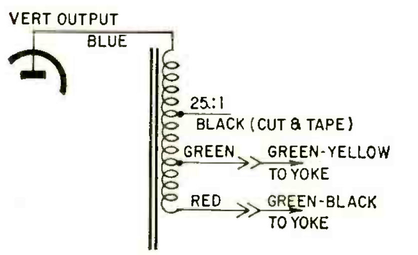


Fig. 3—Correct connection for a Thordarson 26S55 replacement vertical output transformer in a Crosley G17TOMH TV receiver.

the point where you cannot get enough deflection, and your height is bad. This set uses a 50-to-1 ratio in the output transformer. Cut the black wire loose, and tape the end of it. This will give you the correct ratio. The correct connections are shown in Fig. 3.

Retrace eliminator

Could you give me a circuit for adding a retrace eliminator to a TV receiver with a cathode drive to the picture tube?—D. R. W., Towson, Md.

A vertical retrace eliminator can be added to any TV set not using one. Theoretically, it is simple. A sharp vertical spike is fed to either the cathode or grid of the CRT, so it will cut the tube off during vertical retrace.

You can make up an R-C network, as shown in Fig. 4, or get one of the regular PC networks made for the purpose. Sprague makes these in two forms, RS-1 and RS-2. The required vertical-frequency pulse can be picked

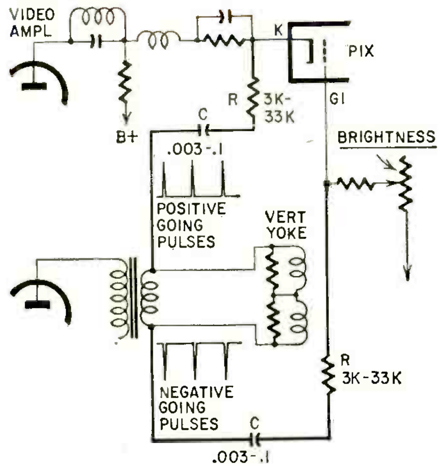


Fig. 4—R-C network adds retrace elimination to a Transvision WRS-3.

up around the vertical output transformer, usually on the secondary or yoke connections. The R-C network serves to couple the pulse to the CRT, and also to differentiate the pulse into a sharp spike.

The pulse need not be fed into the signal element of the CRT: if the signal is fed into the cathode, the blanking pulse can be fed to the grid, and vice versa. Of course this requires a change in polarity. A positive-going pulse on the cathode or a negative-going pulse on the grid will cause the CRT to be cut off.

Dim raster

A Sentinel 1U-1101-T has a very dim raster at about 50% of brightness level. This stays the same throughout the range of the brightness control. The dc voltage from chassis to CRT cathode goes from 0 to 85. There are also retrace lines on the screen.—L. C., Chattanooga, Tenn.

From the symptoms you describe, the most likely possibility is a dead picture tube. The lack of brightness, the retrace lines and the lack of control when the brightness control is varied, all point to this conclusion. Your dc voltage is going well down into the range where the tube should light up if it were OK.

Pix tube breakdown?

I installed a new CRT in a Muntz 17B6. It worked perfectly for about 3 weeks. Suddenly, a snowy picture, chassis hot, a severe corona discharge along the high-voltage lead support. I installed a 500-μμf filter capacitor and killed most of the discharge, but some still appears on the cable support. To get good brightness, the ion trap is located between 3 and 4 o'clock from the rear, tight against the socket. If the picture drops out of sync, the buzzing and arcing surges with it. With brightness turned down, the buzz is severe; at viewing levels it's moderate, and at maximum brightness it almost goes away.—L.A.W., Baltimore, Md.

The steps you have taken so far are right. Now, keep on! The root of your trouble is a corona discharge from the high-voltage lead. The 21EP4 you used does not have an external conductive coating, so you were correct in installing the high-voltage filter capacitor. You might try inserting a well-insulated 1-megohm resistor in series with the high-voltage lead, at or near the high-voltage rectifier socket. Clean off the side of the CRT near the ultor button and spray with Krylon acrylic compound or paint with some good corona dope. (*After* the high-voltage lead is connected, of course!) If the insulation on the lead has deteriorated replace it with a new lead, keeping it as short as possible. It might be advisable to remove the metal lead holder and replace it with a strip of fiber.

The exceedingly high voltages developed around the high-voltage system are the basic cause of the sync trouble.

No high voltage

A Hallicrafters 730 has been brought in with a replacement flyback and a no-high-voltage complaint. I restored the high voltage, but now have a vertical white line down the center of the screen.—C. R. T., Dallas, Tex.

Your report does not state the type of flyback used, but it appears that the core is saturating on peak current flow. This can be corrected by increasing the air gap in the core (which also reduces width). I assume that you have tried backing off on the drive. Another approach is to reduce the 6BQ6's screen voltage to lower the peak current flow. There is a possibility of mismatch between the transformer and yoke, although this is less likely than the other points noted. As a last resort, a heavier flyback will be necessary.

Sync buzz

An AMC chassis has a bad sync buzz. Any suggestions as to the cause?—P. F. M., Brooklyn, N. Y.

Sync buzz can be traced to one of the following causes:

- Ratio-detector charging capacitor (usually a low-voltage electrolytic)—leaky or changed value.
- Ratio-detector transformer — mistuned or defective. Check with a sweep generator and scope.
- Video amplifier overloading—low plate voltage or incorrect grid bias. Screen voltage may be low.
- If amplifier overloading—faulty agc action or misalignment.
- Open bypass capacitors or other defects in if amplifier—regeneration. Check with sweep generator and scope.
- Audio section picking up vertical sweep buzz. If so, tone of buzz changes when vertical hold control is turned through its range.
- Audio section picking up blanking buzz from picture-tube fields. If so, buzz disappears when the picture-tube screen is dark.
- Check filter and large bypass capacitors in the receiver, to make sure that the vertical sweep circuit is not cross-talking into the signal channels or audio channel. END

DESIGN YOUR OWN PREAMP

AUDIO—HIGH FIDELITY

By NORMAN H. CROWHURST*

Part I—Losser and feedback equalizer circuits

ANY preamp has to have phono-equalization to compensate for the recording characteristic so the response of the program material reproduced is flat. Equalization usually has two parts, bass and treble, and generally is arranged with a number of settings so it can be adjusted to conform to recording characteristics.

As the design procedure is similar for any equalization characteristic, we shall show the procedures for one particular characteristic and the reader can apply the same method to produce a complete set of equalizers for the preamplifier he chooses to build. As the RIAA curve is the one most used these days, we shall design each equalizer to produce this characteristic. The resultant response curve is shown in Fig. 1.

Analyzing the curve

The curve is made up of two parts, shown separately in Fig. 2. The low-frequency part is a step or shelf response that produces an ultimate change in level of 20 db. The critical design frequencies are at 50 and 500 cycles, which means the response at 500 cycles is about 3 db up from the ultimate lower level and at 50 cycles about 3 db down from the ultimate higher level.

The other component of the response is the high-frequency rolloff which gives a loss of 3 db at 2,120 cycles and a 6-db-per-octave rolloff from that point on.

Such a combined characteristic can be built into a preamp in a number of ways. The equalization may be carried out at the same point or it may be distributed between two different points—one for the low frequency and the other for the high frequency. It can be a direct equalization circuit connected between stages or a feedback type.

The latter principle is illustrated in Fig. 3. However, as we shall see in designing the feedback type, it is not always quite as simple as this idealized presentation might make it appear, although the actual circuit might be even simpler than one might think.

Direct method

Taking the simplest approach—putting the equalization between two stages in the amplifier—we will assume that the preceding stage is a 12AX7, using a 100,000-ohm plate coupling resistor. First, we have to introduce a 20-db attenuation to give the 1,000-cycle reference point, because of the 20-db so-called boost we have to provide for the bass.

We *could* do this by shunting the interstage point with a resistance one-ninth the source resistance presented by the tube. Taking the plate resistance of the 12AX7 as 80,000 ohms, the source resistance is 80,000 ohms in parallel with the 100,000-ohm coupling resistor, or about 45,000 ohms. Dividing this by 9 gives 5,000 ohms. This means a 5,000-ohm load resistor could be used in the grid circuit of the following stage.

It also means that the 12AX7 will be

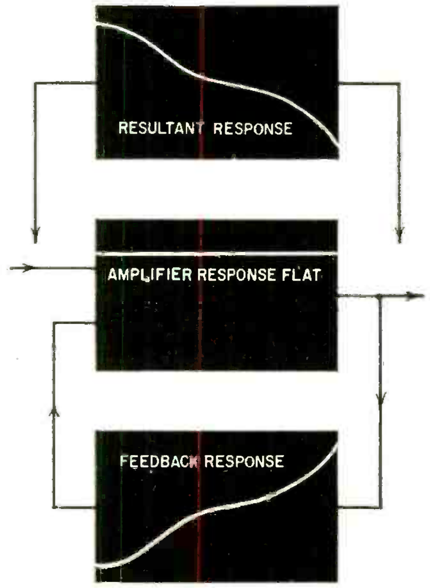


Fig. 3—Basic principle in design of feedback equalizers: Make the feedback response exactly the reverse of the equalization curve.

*Author: *High-Fidelity Circuit Design* (Gernsback Library).

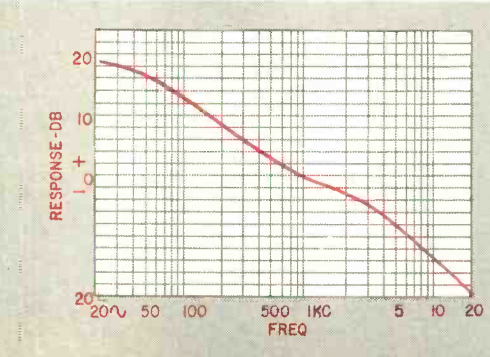


Fig. 1 (left)—The RIAA equalization characteristic.

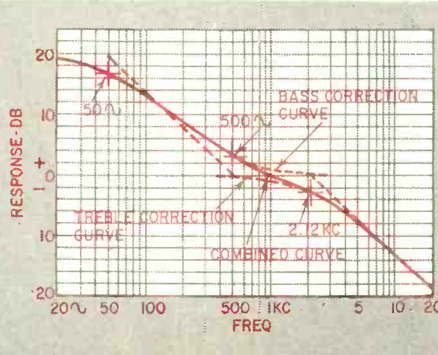


Fig. 2 (right)—The curve of Fig. 1 repeated to show how it consists of two elements, and the design frequencies for those elements.

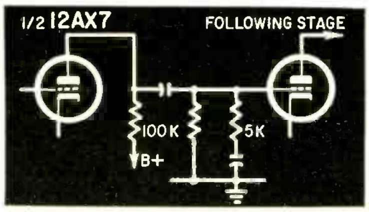


Fig. 4—The start of a design following a 12AX7 input stage. It is not completed because the 5,000-ohm load on the 12AX7 would cause an unacceptable amount of distortion.

operating with a plate load in the region of 5,000 ohms. This represents an almost vertical load line for the 12AX7, which means considerable curvature and distortion in the mid-range frequencies, since the attenuation provides the load in the 1,000-cycle region. This circuit is shown in Fig. 4, but all values are not shown because the circuit is impractical.

To protect the 12AX7 against this kind of distortion, we should provide a series resistance, as shown in Fig. 5. A value of 220,000 ohms is suggested. This will make a total source resistance of 220,000 plus 45,000, or 265,000 ohms. From the viewpoint of the shunting effect of the so-called bass boost, the grid-return resistor, which can be 820,000 ohms, is also in parallel. This brings the resultant to about 200,000 ohms. We can now provide a terminating resistance of one-ninth of 200,000 ohms, or 22,000 ohms which will produce an attenuation of 20 db.

This loads the 12AX7 with the 100,000-ohm coupling resistor in parallel with 220,000 plus 22,000, or 242,000 ohms, a resultant of about 70,000 ohms, which is quite satisfactory for a 12AX7 operating at low level.

To produce a 20-db step or shelf circuit, the capacitor in series with the 22,000-ohm resistor should have a 22,000-ohm reactance at 500 cycles, or 220,000 ohms at 50 cycles. Consulting a reactance chart shows that a .015-μf capacitor will do the job.

All we have to do now is provide a rolloff at 2,120 cycles. This can be done by putting a shunt capacitance on the grid of the second stage. What we need to know is the effective resistance which the capacitance will be shunting at this frequency. Looking back, toward the plate of the 12AX7 there is the 265,000-ohm source, and then, in parallel with this, there is 22,000 and 820,000, a resultant of about 20,000 ohms. So the capacitance should have a reactance of 20,000 ohms at 2,120 cycles. A .0039-μf capacitor comes closest and since it is in the 5% range, the accuracy should be quite good.

However, it may be necessary to use a slightly smaller value because of the input capacitance of the following stage, which will contribute to this. Probably a .0033-μf capacitor will give about the right response.

Thus Fig. 5 represents a circuit that will give the RIAA curve. By providing other values, which can be switched in as alternatives to the ones shown, the circuit can give a variety of other equalization curves that may be desired.

Pentode

If, as in Fig. 6, the preceding stage is a pentode, such as a 6AU6, the intervening resistor to protect the linearity of the 12AX7 is not necessary. As the coupling point is going to be shunted down to a lower resistance in the middle frequencies, a high value coupling resistor can be used. For example, 1 megohm with a correspondingly high screen-feed resistor, about 2.7 megohms, will work here.

Under these conditions, the tube will have a transconductance of between 2 and 2.5 ma a volt and its plate resistance will be in the region of 1 megohm. This means the source resistance can be taken as the two 1-megohm resistances in parallel, or 0.5 megohm. Using a 1-megohm grid-return resistor, which is about the highest value practical, the total circuit resistance at this point drops to 330,000 ohms. Dividing this by 9 means that the shunt resistor in the grid of the following stage, operative at 1,000 cycles, should be about 36,000 ohms. The bass-boost capacitor should have a 36,000-ohm reactance at 500 cycles, or 360,000 ohms at 50 cycles. A value of .009 μf will do.

The effective parallel resistance at this point is now 33,000 ohms, so we can get high rolloff by using a capacitance whose reactance is 33,000 ohms at 2,120 cycles. A value of .0022 μf would seem to work here, except for the circuit's natural capacitance. Probably .0018 μf will give the right response.

In each of these circuits there is no grid return unless an additional resistor is used to bypass the bass-boost capacitor. The part of the calculation that brings this in is often overlooked. This can invalidate the calculation. Choosing a suitable value is not easy. If the grid-return resistance is too high for the following stage, the circuit will need redesigning. Where the circuit seems to need an unusually high value, it may be possible to use grid-current biasing in the design, or at least it can be based on partial grid-current biasing.

For example, if the recommended value for grid-current biasing, with the cathode returned directly to ground, is 10 megohms in the grid circuit, and you use a 2.7-megohm return, it will provide about one-third of the necessary bias. The other two-thirds should be provided by cathode biasing. If the normal cathode resistor should be 1,000 ohms, an actual resistor of 680 ohms will give the remaining two-thirds.

Check working levels

From the data just given we can calculate the approximate gain of the 6AU6 pentode at 1,000 cycles. With an assumed transconductance of 2 ma per volt, which is the best figure we can find, the plate-load resistance is effectively 1 megohm in parallel with 35,000 ohms, or about 34,000 ohms. This will yield a gain of about 68, which is satisfactory if the pentode is being relied upon to give high gain for satisfactory input noise level.

In applying the triode circuit, it should be remembered that there is an attenuation at mid-frequency. This will bring the signal level down that much closer to the noise level. If the input stage's gain is only a little more than the attenuation, the signal level at the grid of the second tube will be not much higher than the signal level at the grid of the first tube. Thus, if noise is a problem in the first stage, it will still be a problem in the second stage.

In this example, the 12AX7 has a 70,000-ohm working load, giving a gain of about 47. Then the 220,000 with the 22,000 and 820,000 ohms in parallel cuts this by a factor of $\frac{241.5}{21.5}$, or 11.2, leaving a net gain of 47/11.2, or 4.2, about 12.5 db, for the first stage at 1,000 cycles. More gain would be better so it is best to use two stages before attempting this kind of equalization.

The only exception to this is the high-end rolloff. If desired, it can be placed in an early circuit as it will help minimize noise by restricting the noise bandwidth. We can even put the high end rolloff ahead of the first stage. In fact, with magnetic pickups, where the pickup's impedance contains considerable inductance, it is often possible to get the high-end rolloff merely by terminating the pickup with a suitable resistance. This is a simple way to get the high-end rolloff, but it may deteriorate the signal-to-noise ratio, if too low a resistance is required to achieve the objective, because it will load down the output from the pickup at the middle frequencies.

This depends on the relative resistance and inductance in the pickup. If the resistance required to give the rolloff at the correct place is appreciably

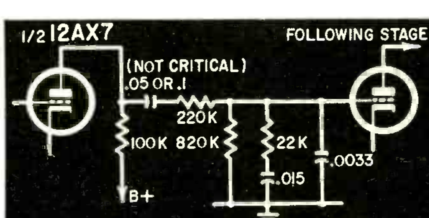


Fig. 5—A satisfactory design for a straight-forward equalizer circuit following a 12AX7 stage.

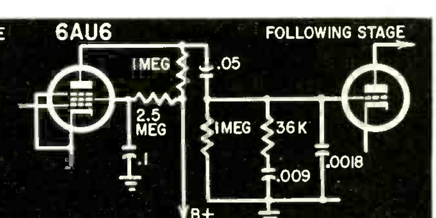


Fig. 6—A satisfactory design for an equalizer to follow a 6AU6 input stage.

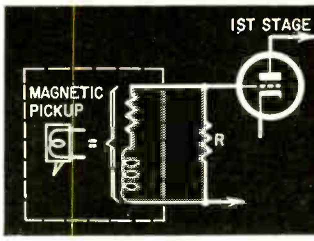


Fig. 7—For some magnetic pickups this arrangement will give the treble or high-end equalization.

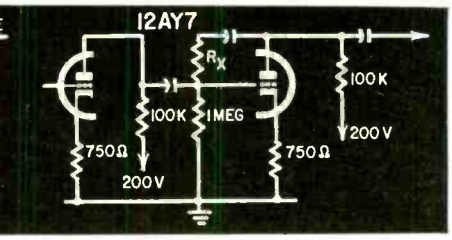
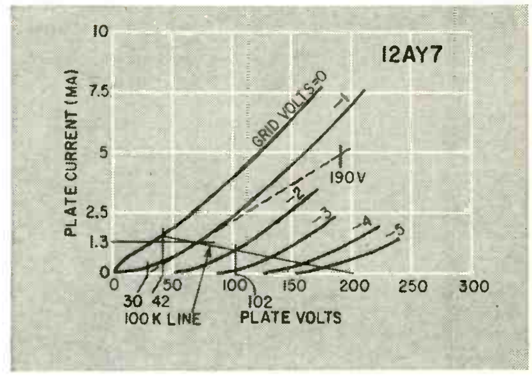


Fig. 8—A first try for a simple feedback equalizer using the two halves of a 12AY7.

Fig. 9—The tube characteristics of a 12AY7 showing how the design parameters discussed in the text are obtained.



larger than the pickup's, the method shown in Fig. 7 is quite acceptable.

Feedback circuits

The other type of equalizer uses feedback. The principal reason for going over to feedback type equalization is to minimize distortion. One method uses feedback over only one stage, directly from plate to grid.

It is not advisable to do so over the input stage, because the arrangement is dependent for the exact response on the source resistance from which the circuit operates. To assist in this, the source resistance presented by the preceding stage should be controlled. It may be advisable to insert a series feed resistor to linearize this source resistance to some extent.

Fig. 8 shows a tentative arrangement with a 12AY7 as the input and equalization stages. Fig. 9 shows the characteristics for a 12AY7 tube using a 100,000-ohm load line from a 200-volt plate supply. A bias of −1 volt gives a plate current of 1.3 ma. This means a 750-ohm bias resistor should be used.

Drawing a tangent to the −1-volt curve where it crosses the 100,000-ohm load line, the plate resistance figures out to 32,000 ohms. This can be figured from the fact that the tangent passes through 30 volts 0 ma and 190 volts 5 ma—a change of 160 volts for 5 ma. This represents a resistance of 160/.005, or 32,000 ohms. The coupling resistor in parallel with this produces a resultant resistance of $\frac{32,000 \times 100,000}{32,000 + 100,000}$, or 24,000 ohms. To get a good gain figure, use 1 megohm for the following grid resistor.

To find the gain, the 100,000-ohm load line cuts the 0 grid voltage curve at 42 volts and the −2-volt curve at 102 volts—a change of 60 volts for 2 volts in. This represents a gain of exactly 30. Working from a source resistance of 24,000 ohms into a load of 1 megohm, this will divide the gain by a factor of 1.024, leaving a gain of about 29.

To obtain a 20-db boost we need 20 db of feedback over the second stage. This means that a feedback voltage 9 times the normal grid voltage must be fed back from the plate to the grid. As the plate voltage is 29 times the normal grid voltage, this means that the voltage fed back must be 9/29 or 1/3.2 times the plate voltage.

The ac resistance reflected in the grid circuit is 1 megohm in parallel with 24,000 ohms, or about 23,500 ohms. So the resistor to feed back from the second plate will have to be 2.2 times this, or about 50,000 ohms.

Now we see the difficulty in designing this type of circuit. To get a gain of 29, we have assumed a grid resistor load of 1 megohm, but we also need a feedback resistor in the region of 50,000 ohms to get enough feedback, which will load down the tube's gain. We shall no longer get a working gain of 29. To get enough feedback we shall in fact need a lower resistance than 50,000 ohms, which means the gain will be even further reduced.

Assuming we can get 20-db feedback with this circuit, it is obvious that the load line will be of such low resistance as to run into the curvature of the tube considerably, and this will cause distortion. True, the feedback will help minimize the distortion, but the best it can do is bring the final distortion back to approximately its original figure.

An alternative approach is to raise the effective grid circuit resistance. This will also, as mentioned earlier, help minimize any nonlinearity caused by the variation in plate resistance of the first stage. Assume that we use a 1-megohm resistor for the following grid and a 1-megohm resistor for the feedback as shown in Fig. 10. This will reduce the gain of the stage to about 28.

So we still have a factor of 3.1 step-down to meet. This means that the grid-circuit resistance must look like 1/2.1 times the 1-megohm series feed resistor. This figures to 475,000 ohms. We already have a 1-megohm grid resistor, which means that the source resistance must look like about 900,000 ohms. As the preceding stage has an actual source resistance of only 24,000 ohms, a series resistor of about 820,000 ohms (using a standard value) will probably come near enough to achieving the desired overall characteristic.

To give a 3-db boost at 500 cycles, the feedback capacitor should have a reactance of 1.475 megohms. This needs to be 220 μμf. We now encounter two difficulties:

▶ For the high end, a bypass capacitor across the 1-megohm feedback resistor will give high loss, but can produce only about a 10-db step (by going to 100% feedback) instead of a full 6-db-per-octave rolloff.

▶ Also, the parallel-fed feedback reduces the effective resistance in the grid of the second tube from the viewpoint of attenuating the signal from the plate of the first tube. It will reduce the effective resistance by a factor in the

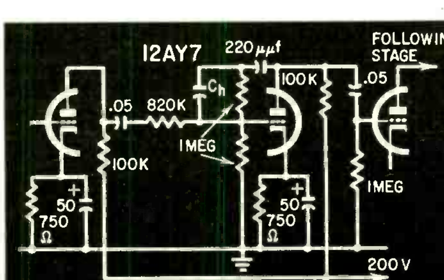


Fig. 10 (left) — Almost satisfactory design using two halves of 12AY7 with feedback over second one.

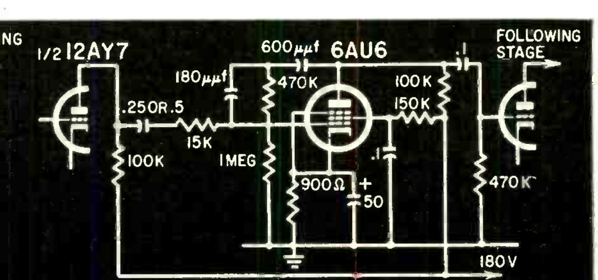
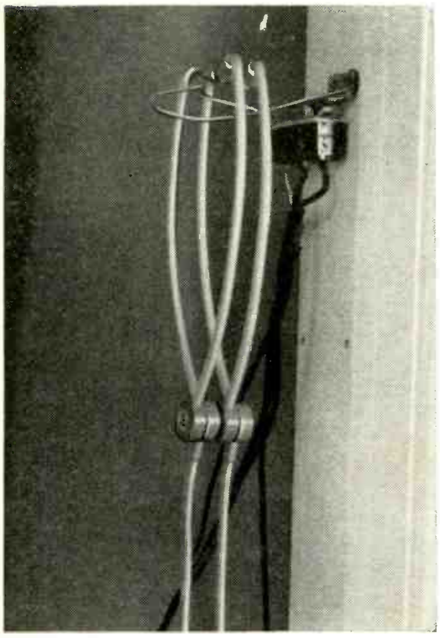


Fig. 11 (right) — Using 6AU6 for feedback stage makes design of this type relatively easy.

HEADPHONES FOR TV

By WILLIAM B. RASMUSSEN



MOST of us keep the television and hi-fi sets in the same room. We don't want to, but in small apartments there is little choice. Often, we want to use both units at the same time. The only practical way of doing so is to attach headphones to one or the other. The logical choice is to add headphones to the TV receiver since the viewers remain comparatively stationary and the audio range is rather narrow. Since the childrens' TV programs are the ones that conflict most often, the phone system is designed so that they will use it willingly

A child-approved system is shown. It is semi-automatic—the user has only to lift the phones from their hooks to silence the speaker in the set and switch audio output to the phones. Replacing the headphones restores normal operation. The photograph shows the circuits. The phones hang on a hook that rests against a snap-action switch. This spdt unit is wired with its normally open contacts to the speaker and the normally closed side to the phones. Naturally, you would position the bracket as close to the viewing area as practical. In some positions, wiring to the switch can be concealed, in others it cannot.

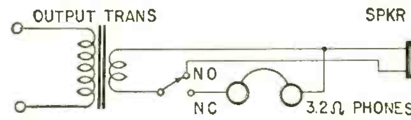


Fig. 1

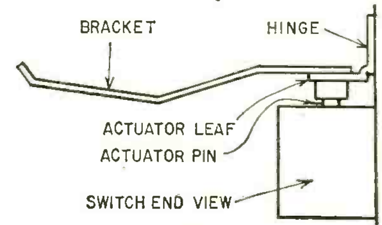


Fig. 2

The wiring for this setup is shown in Fig. 1 and details of the switch arrangements in Fig. 2.

Such systems are so simple that there is no good reason why TV sound should be allowed to disturb nonviewers. END

DESIGN YOUR OWN PREAMP (Continued)

region of 20 to 1, bringing the actual 1-megohm grid resistor down to an effective 50,000 ohms. Fed through an 820,000-ohm resistor, this represents a loss of about 16 to 1, so that the effective gain from the grid of the first tube to the grid of the second tube is now cut back to about 1.8 at 1,000 cycles, and noise is liable to be a trouble in the equalization circuit as well as the input circuit.

To overcome these two problems for this kind of equalization, it is best to use a tube which has plenty of gain, such as a 6AU6. It can still follow an appropriate triode input stage. Using a 6AU6 with a plate voltage of 180, and taking the figures quoted in the "Resistance-coupled Amplifier Section" of RCA tube manual, a 100,000-ohm plate coupling resistor with a following 220,000-ohm grid resistor, a 150,000-ohm screen-feed resistor and a 900-ohm cathode resistor, gives a voltage gain of 116. Instead of using 220,000 ohms for the following grid resistor, we can use 470,000 ohms for the grid resistor and 470,000 ohms for the feedback, as shown in Fig. 11, which will still give the same gain.

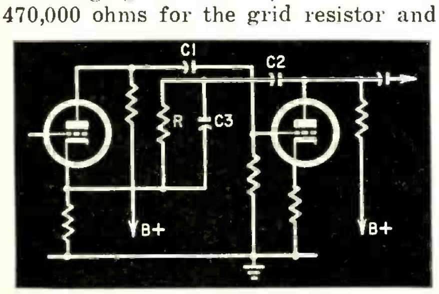


Fig. 12—Showing the method of using feedback over two stages.

So we need a feedback voltage that is the plate voltage divided by 116/9, or 13. Thus the grid-circuit resistance should be approximately 1/12 of 470,000, or about 39,000 ohms. This is much nearer the results we would like. If the preceding stage presents a 24,000-ohm source resistance we can pad it out with a 15,000-ohm resistor and have a 39,000-ohm source resistance.

The correct capacitor for a 3-db reduction in feedback at 500 cycles must have a reactance of 510,000 ohms at 500 cycles. A 600-$\mu\mu$f capacitor works here.

To avoid interfering with the lower end of the response, the reactance of the coupling capacitor from the previous stage should be low compared with 39,000 ohms at 50 cycles. A 0.1-μf capacitor gives 32,000 ohms at 50 cycles, so a 0.25- or, if possible, a 0.5-μf capacitor should be used. If not, the lower end of the equalization characteristic will not be held, because the bottom end of the feedback network will not be maintained at 39,000 ohms.

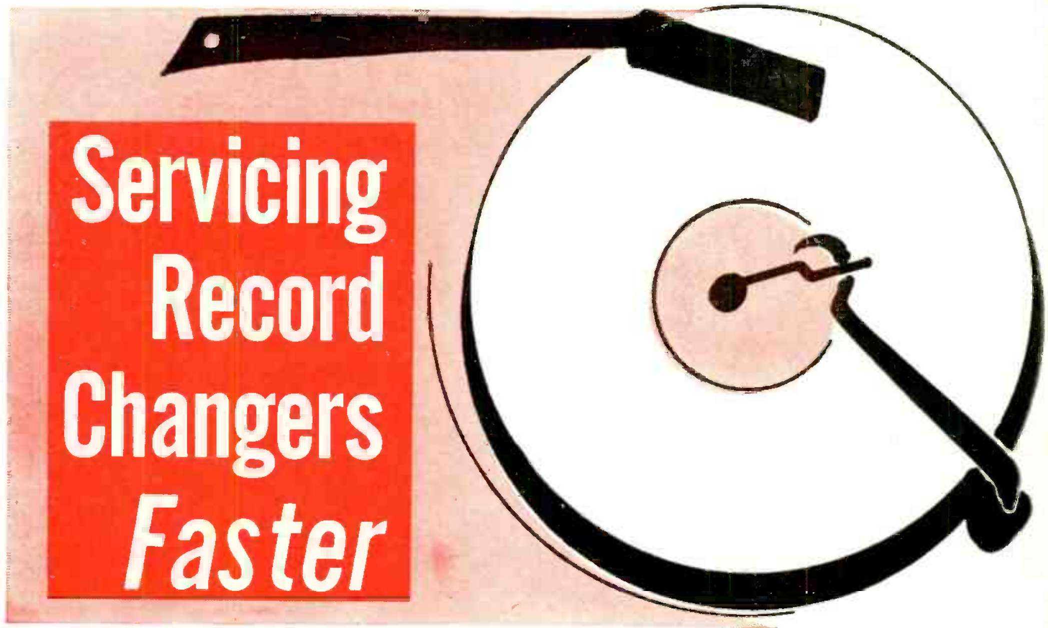
To take care of the high end, a capacitor is needed to bypass the 470,000-ohm resistor with a reactance of 470,000 ohms at 2,160 cycles. This requires about 150 $\mu\mu$f. However, it may prove to need a little larger value than this, on account of the effective grid input and stray wiring capacitances. Probably a 180-$\mu\mu$f capacitance will be satisfactory in this position to offset these losses.

There are of course many possibilities in the design of feedback type equalization circuits. We could use a high-mu triode such as the 12AX7, employing a similar approach. The points to watch for have been discussed earlier. The advantage of feedback over only one stage is that the possibilities of interaction in the feedback are minimized and the calculations are much simpler.

To get enough gain to make the feedback easily obtainable without too many problems with circuit values, feedback over two stages, as shown in Fig. 12, could be used. The difficulty here is that there is considerably more to the design calculations involved in obtaining the correct frequency response. A future article will cover feedback equalizers in more detail.

To get a simple design which maintains its response with reasonable accuracy when tube parameters fluctuate, stick with the simpler circuit. I feel the straightforward equalizer circuit between stages is by far the best, because change in gain of a tube does not in any way affect equalization. With feedback equalizers the change in the tube's gain is bound to modify the equalization, whichever circuit is employed. By watching that the loads provided for the tube do not go into the region where the tubes cause distortion due to curvature, the straightforward equalizer does not produce appreciable distortion, and the argument of improved quality for the feedback type no longer applies. END

Record changers aren't so tough —if you know what to look for



Servicing Record Changers Faster

By P. SHENEMAN

ALL automatic record changers are mechanically different, but some service problems are common to all. A technician who has some mechanical ability, a stroboscope and a lot of patience can solve most of them—often right in the customer's home.

The first common fault is caused by a speed change within a single revolution of the turntable and is called wow. This change in speed produces a wavering tonal effect which is much more pronounced on a 33⅓-rpm disc than on its 78-rpm brother.

A stroboscope placed on the turntable will display a pattern that systematically advances and retreats. (A heavy turntable acts as a flywheel and tends to damp out and smooth such speed changes, especially at the higher record speed.)

When wow is the problem, check for:

- Center hole in records too large.
- Warped records.
- Bent idler wheel.
- Tire on idler wheel out of round.
- Bent pulley shaft.
- Warped turntable.
- Defective turntable bearings.
- Pulley(s) not seated correctly.
- Motor not balanced.
- Bent motor mounting plate.
- Bent motor armature.
- Defective motor bearings.

Change in musical pitch

A changer can play a single record at the correct musical pitch, yet have the pitch become lower as additional records are placed on it. With a full stack of records on the turntable, the last record may be as much as a half a tone flat. This change in pitch may be unnoticed by some, but to others it is very annoying.

To locate this trouble, check turntable speed with a stroboscope when one or several records are on the turntable and when the turntable is fully loaded.

When change in musical pitch is the problem, check for:

- Motor overheating caused by poor ventilation, bad bearings or shorted windings.
- Lack of friction in the turntable driving mechanism.

Slow turntable

Another common problem is the turntable that runs slow. A stroboscope placed on such a turntable will produce a pattern that seems to crawl backward. Like most speed-regulation troubles in record changers, it will be most noticeable on long-playing records.

When slow turntable speed is the problem, check for:

- A pulley binding on its shaft.

  Because of condensation, rust often forms on the pulley shaft. This acts as a parasitic drag and can slow the turntable down by several rpm. To check, remove the pulley by pressing upward at its base with a screwdriver. If the shaft is rusted, sand with very fine emery cloth and lubricate.
- Motor armature bearings that need lubrication.
- Too strong a tension spring on idler wheel.

  The original spring may have been replaced with one with more tension or shortened.
- Worn turntable bearings.
- Low line voltage.
- Defective motor.

Stalls, won't complete change cycle

This is by far the most common trouble. While the record is playing, the phono motor has to oppose only the force of the needle in the record groove and the friction of the tone-arm support. During the change cycle, the motor must provide enough torque to operate all the mechanical parts needed to complete the change cycle. In most rim-drive turntables, the torque is applied by friction. Any loss in friction results in failure of the change cycle.

If the turntable stalls and won't complete the change cycle, check for:

- Grease or oil on turntable rim.
- Grease or oil on idler wheel or pulleys.
- Worn pulley(s), too small in circumference.
- Pulley(s) not seated on pulley shaft.

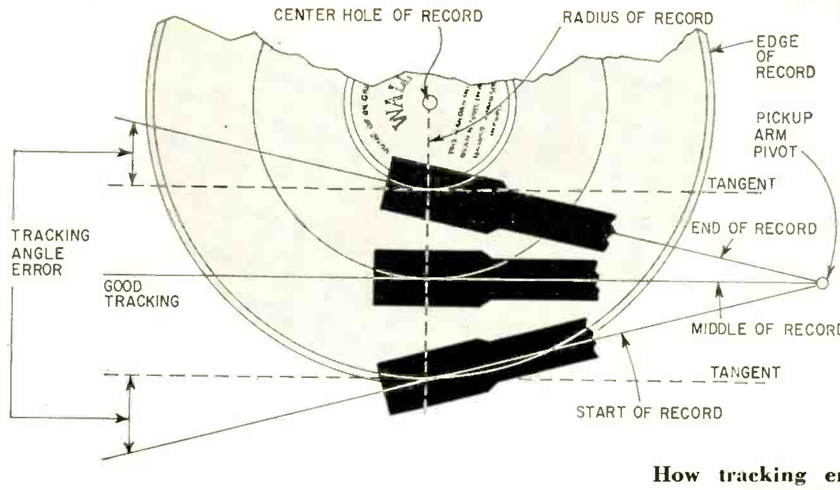
  Often when pulleys are removed for cleaning or replacement, too much lubricant is placed on the shaft. When the pulley is replaced, air is trapped between the shaft and the pulley hub. The trapped air prevents the pulley from seating firmly. The pulley should be pressed until it snaps into the seating ring.
- Pulleys or idler-wheel rubber impregnated with dirt.

  When dirt is in the pores of the rubber, the pulley has a glossy appearance. To remove the gloss, hold fine sandpaper lightly against the pulley while it is turning. Motors using drive belts to turn the pulleys can have friction restored by turning the belts inside out.
- Weak motor.
- Weak idler wheel spring.

Tracking-error distortion

Correct positioning of the pickup arm and cartridge is essential to minimize tracking-error distortion. Tracking error is the deviation from tangency of the needle in the record grooves as the stylus moves across the record. [For more detailed information on this subject see "Record Tracking," by Norman Crowhurst, (October, 1957, page 40) and "The Record Skips," by Charles W. Farrington, (April, 1959, page 61).]

Since record changers use a relatively short pickup arm, tracking error is much greater in record changers than in single-record turntables. In addition to tracking error, compensation must be designed into the pickup arm to



How tracking error is measured

allow for the change in tangency of the stylus to the record relative to the size of the stack of records. Ideally, the stylus should be perpendicular to the record. This condition is satisfied when a single record is on the turntable. However, as more and more records are placed on the turntable, the stylus assumes an angle to the record. This consideration is a major factor in pickup arm design.

If tracking-error distortion is the problem, check:

- Pickup-arm mounting.

  The arm should mount in its pivots without binding or excessive play.

- Stylus replacement.

  The length and angle of offset of the pickup arm was designed by the manufacturer in conjunction with a certain stylus design. Using a different replacement stylus often increases tracking-error distortion. Also true of a cartridge in which stylus position differs from original.

- Vertical tracking force.

  Vertical tracking force is the pressure the stylus exerts in the record groove. The average is 5 to 9 grams. This tracking force is adjusted by spring tension or a counterbalance. For accurate tracking force, the weight should be adjusted with scales made for this purpose.

- Worn or dirty stylus.

  A worn stylus produces distorted sound and causes excessive wear. Dust and dirt that have collected on the stylus can attenuate the sound pickup and, in severe cases, prevent any pickup at all.

- Loose cartridge.

  A loose cartridge can increase tracking error and cause distortion.

Rumble

Low-frequency noise produced by mechanical vibrations of the phonograph motor is called rumble. Since the pickup arm in an automatic record changer is part of the changing mechanism, these mechanical vibrations can be picked up by the arm and sometimes modulate the recorded signals.

When rumble is the problem, check for:

- Worn motor mounts.
- Motor mounts that have lost their elasticity.
- Poor changer mountings.

  The changer is designed to rest on springs and should not rest on any part of the cabinet.

- Old idler wheel.

  If the rubber tire on the idler wheel is old and hard, noise will be transferred to the tone arm and cartridge via the turntable.

- Bent armature shaft of motor.
- Motor out of balance.
- Worn turntable bearings.

Stylus replacement

The assortment of styli runs from the steel stylus, good for a few plays, to the diamond, good for 10,000 or more plays. However, life cannot be judged by the number of times a record has been played. The record's condition is a predominant factor in stylus life. Even more than the number of plays, worn or dirty records, incorrect vertical tracking force and binding of the tone-arm mechanism, all shorten stylus life.

When needle replacement is necessary, check:

- Record condition. Discard worn records.
- Correct stylus pressure (vertical tracking force). Too light a pressure causes skidding. Too heavy a pressure speeds both stylus and record wear.

Trip–reject cycle

Tripping, generally referred to as rejecting, is the mechanical action which results in applying power to the record-changing mechanism. In most record changers, this is done by the lateral motion of the tone arm caused by the stylus riding in the concentric groove in the center of the record.

Generally, tripping problems can be separated into three distinct conditions:

1. Won't trip.
2. Trip is activated and change cycle begins but is not completed.
3. Trips continuously.

If the changer won't trip, check:

- Pickup-arm follower.

  The pickup-arm follower follows the pickup-arm movement to activate the trip mechanism. The pickup-arm follower may be caught in a position where it cannot activate the trip mechanism, may be bent so it misses the trip mechanism, or may not be following the tone arm.

- Follower may not have enough friction to activate the trip mechanism.

  The pickup-arm follower as a rule is not connected to the pickup arm directly, but usually follows the movement of the pickup arm because of friction between the follower and pickup-arm mounting arrangement. Friction is generally applied by a coil or arched spring. However, sometimes it might be done by cork or fiber washers between the follower and pickup-arm mounting arrangement.

  In many changers, friction can be increased by an adjustment which compresses the spring. With changers using cork or fiber washers, lack of friction can be caused by smooth washers or grease or oil on washer surfaces. Cleaning will often restore the original operation.

- Trip mechanism binding.

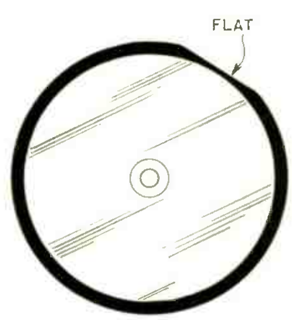
  The trip mechanism may be jammed, broken or binding, so the pressure from the pickup-arm follower cannot activate it.

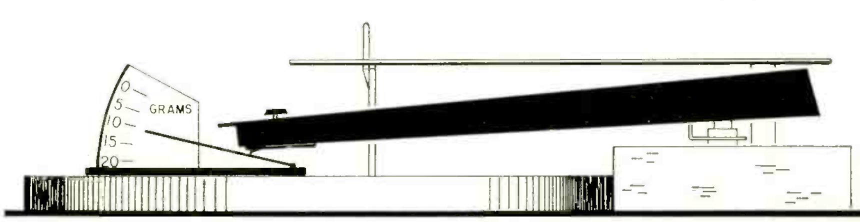
If the changer trips and starts the change cycle but the change cycle is not completed check:

- Binding in the record-changing mechanism.

  The changer may have been

A flat on an idler wheel can cause wow.





How to measure stylus pressure.

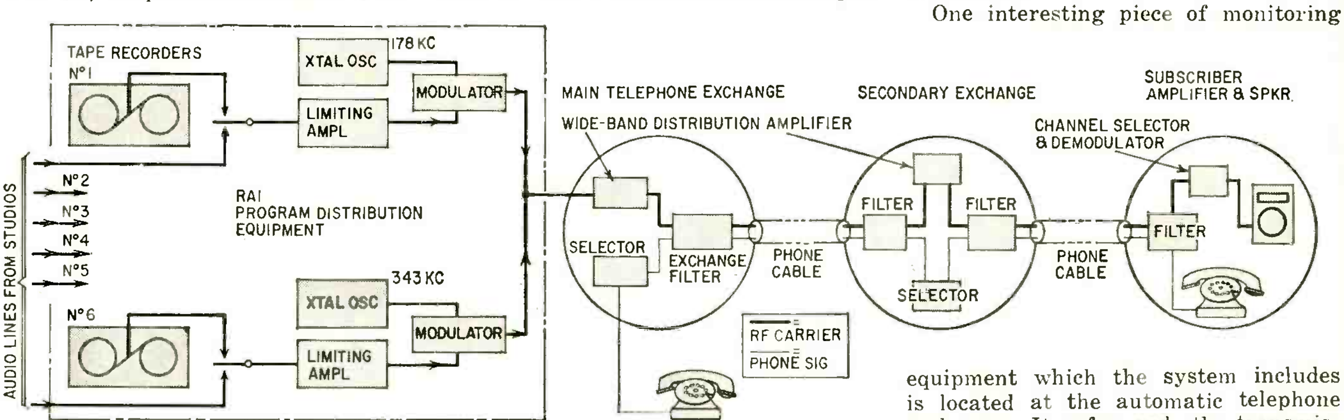
WIRED BROADCASTS IN ITALY

FOUR principal cities in Italy now have a high-quality wired music service available to home subscribers via carrier-current transmission over telephone lines. The Italian Broadcasting System (RAI) has been providing a choice of up to six programs over this wired-broadcast service since December, 1958, in Rome, Naples and Turin. (Milan was added later.)

The carrier frequencies are from 178 to 343 kc, amplitude-modulated with audio up to 15 kc. There are guard bands 3 kc wide between each of six channels. Five channels provide a choice of varied musical fare, similar in many ways to the First, Second, Third, etc., programs of the BBC in England. The sixth channel is reserved for special events such as international festivals and will ultimately be used for multiplexed stereo.

Programs originate in the RAI Studio Centers, usually from special long-playing tape machines. The audio for each channel is fed into a limiting amplifier. Outputs of each of these limiting amplifiers goes to a modulator. The outputs of the six modulators are then fed into a wide-band mixer–amplifier which amplifies all the modulated rf in its passband, 150 to 400 kc. The mixed carriers travel over leased telephone lines to power amplifiers in automatic telephone exchanges, then out to subscribers over the regular phone lines.

The subscriber's equipment may be merely a filter network to separate the normal telephone signals from the carrier programs, if he has a long-wave receiver which can select frequencies between 178 and 343 kc. But as there are no long-wave broadcast stations in Italy, few Italian receivers cover these frequencies and one additional piece of equipment is usually required. It is a small 6-channel selection and demodulation unit.



One interesting piece of monitoring equipment which the system includes is located at the automatic telephone exchanges. It safeguards the transmissions by indicating loss of any carrier and by continuously measuring the amount of crosstalk. It does this by monitoring 455 kc. Since two of the channels (178 and 275 kc) have a sum frequency of 453 and two others (211 and 244 kc) have a sum frequency of 455 kc, any increase in crosstalk between the stations in either of these pairs will produce a proportional output at 455 kc. The crosstalk threshold is kept below 50 db at all times. END

SERVICING RECORD CHANGERS FASTER *(Continued)*

dropped or worked on by its owner so that a part or parts of the mechanism are damaged.

- Loss of friction between the motor and turntable.

If the changer trips continuously, check:

- Pressure applied to the trip mechanism from the pickup-arm follower.
  Very little pressure is needed to trip the change mechanism. Too much pressure may be the result of incorrect adjustment of the friction between the pickup arm and follower. Excessive friction also can be the result of corrosion, rust and the accumulation of dirt.
- Trip mechanism itself.
  It may be jammed in a position permitting constant tripping.

Record drop

There are several systems for making a record changer drop the next disc. Zenith uses an ejector finger that swings out from a flush position in the spindle and rotates 180° to drop the record. In the VM and many other changers, an ejector lever, normally flush with the spindle, moves forward to drop the record. With many Philco changers, the spindle itself moves forward or "nods" to do the same job. Many models by Motorola had an ejector lever, or tongue, in the record support shelf to push the bottom record from the stack of records. As another example, Webcor used the record support shelf itself, nodding or moving forward, to dislodge the record to be played.

No matter which system is used, there are adjustments for controlling the record dropping action.

- Zenith: The ejector finger must be straight and timed correctly.
- VM: Ejector lever in the spindle, the amount of travel of the lever is variable.
- Philco: The movement of the spindle can be controlled for more or less "nodding."
- Ejector lever within the record support shelf: The movement of the ejector lever can be regulated.
- Webcor: Record support shelf moves forward, amount of record shelf movement can be adjusted.

When it comes to record drop, all record changers have one thing in common—a spindle cap, spindle slider, or the angle at the top of the spindle, which prevents more than one record from dropping at a time.

For record-drop problems, check:

- Thickness of records.
  Records that are too thick will not drop correctly. Also applies to records that are too thin.
- Size of center hole.
  Worn or chipped center hole affects record drop.
- Spindle cap or slider.
  If bent, more than one record will drop. Perhaps several.
- Angle at top of spindle.
  In spindles not using a spindle cap or slider, the angle at the top of the spindle prevents more than one record from dropping at once. If the angle has been changed, several records may drop simultaneously.

(RCA makes a series of records for checking record changers. Among the tests they will aid in making are: landing and tripping, pickup sensitivity, turntable rumble and flutter, and record tracking at various recording levels and stylus pressures. These discs are available from the RCA Victor Custom Record Department, 155 East 24th Street, New York 10, N. Y. Write to the attention of the Sales Service Section. Walsco Electronic Products also makes a series of these discs. For information write to Walter L. Schott Co., 100 West Green St., Rockford, Ill.—*Editor*) END

WHAT is an output WATT?

A new approach to an old problem

By CHARLES B. GRAHAM
ASSOCIATE EDITOR

PEAK power, rated output, and now a new one, *music power* . . . what do they mean? How is the confused audiophile, dealer or technician to know what the power rating of an audio amplifier really signifies?

Many years ago we didn't have this trouble. An amplifier produced, say, "30 watts electrical output." Pure and simple. No complications. Then some fussy character asked, "Yes, 30 watts, but at how much distortion?" and the confusion started.

It was agreed that the *maximum power rating* of an amplifier would be that at which it could continuously reproduce a sine-wave input with no more than 5% distortion. (*Distortion* refers to harmonic distortion throughout this article, as EIA—Electronic Industries Association — and IHFM — The Institute of High Fidelity Manufacturers—standards are based on it . . .)

As audio equipment improved, 5% distortion began to look like too much. Manufacturers started specifying tighter standards, often around 2%. Then with high fidelity, the trend shifted to 1% and even lower distortion at rated output. All this for maximum power with a continuous signal input at 1,000 cycles.

Then one large company came out with a new rating, *peak power*. They pointed out that sudden musical transients, usually the beginnings of notes, are very brief but of high amplitude. Though they require much more power than the body of the music, they last but a fraction. of a second, and distortion would, in these brief periods, be virtually inaudible.

Thus, peak-power rating was based on the premise that an amplifier with a given rms rating could amplify transients equal to the peak voltage of the sine wave used for continuous power ratings, or 1.414 times the sine-wave voltage. Since power is equal to the square of the voltage divided by the load resistance (E^2/R) and the peak voltage is 1.414 (the square root of 2) times the sine-wave voltage, the peak power rating of an amplifier was normally set at double its continuous power output. Some amplifiers have appeared with peak ratings up to almost three times the normal undistorted output rating because of conservative continuous power rating published by the manufacturer.

Recently there have been sporadic attempts to set up standards for the high-fidelity industry. Though slowed down by the differences of philosophy between the components makers and the package hi-fi manufacturers (and even within these groups), some progress has been made. The Institute of High Fidelity Manufacturers has issued a booklet, *IHFM Standard Methods of Measurement for Amplifiers*,[1] which will probably be of great use in standardizing methods of measurement, and therefore ratings of amplifiers.

The 8-page booklet sets forth standard laboratory conditions, beginning with power-line specifications (voltage and frequency), temperature, signal input, loads and so on, and rates a power amplifier in terms of continuous power output, *music-power output*, power bandwidth and sensitivity.

Continuous power output is defined as "the greatest single-frequency power that can be obtained for a period of not less than 30 seconds without exceeding rated total harmonic distortion when the amplifier is operated under standard test conditions" (as laid down in the standard).

Music power output is "the greatest single-frequency power that can be obtained under standard test condtions without exceeding rated total harmonic distortion except that the measurement shall be taken immediately after the sudden application of a signal and during a time interval so short that supply voltages within the amplifier have not changed from their no-signal values."

Since it is impractical to measure power output and distortion under such an instantaneous condition, the IHFM specification provides that music power output shall be measured in the same way as indicated for continuous power output "except that the significant supply voltages shall be maintained at the same value as they were under no-signal conditions." The only way this can be done is to substitute temporarily a voltage-regulated power supply for the one built into the amplifier and adjust it for the proper voltage. Then the amplifier signal input is increased (from the previously measured continuous-power-output level) until the measured distortion is the same as the rated maximum for continuous output. This higher output power level is the *music power* output rating, since it is presumed to represent the *instantaneous* power output which the amplifier can handle on transient musical peaks, or the complex waveforms handled in ordinary music.

In comparing the specifications of two amplifiers with equal music power ratings, the one with the better regulated power supply would presumably show a higher continuous power rating than the amplifier with a poorly regulated cheaper power supply. It is also likely that the better regulated job's distortion vs. power output curve would be relatively flat up to the rated continuous power output level, while that of the poorer regulated amplifier would show a rapidly increasing distortion rate toward the rated continuous power level.

Power bandwidth is rated as the range between the lowest and highest frequency at which rated single-tone distortion is equaled, with the measurement made 3 db below rated continuous power output. This is a valuable standard. In the past some makers have stated frequency response in terms of the highest and lowest frequencies at which their amplifiers deliver full power at rated distortion, while others have shown frequency response curves at only 1 or 2 watts power.

The IHFM committee feels that specification of power bandwidth this way is superior to the possible conflict with IM measurements. The latter (SMPTE method) are strictly a measure of low-frequency distortion, but the frequency has never been standardized—it may be 60, 70, 100 cycles or some other choice. Standardizing this frequency might be unfair to some amplifiers. The power bandwidth figure shows clearly at what frequency the power begins to fall off, as compared to the mid-frequency power at rated distortion.

The standard also specifies conditions for measuring voltage output, distortion, hum and noise, damping factor and frequency response, both flat and equalized.

The IHFM has provided a starting point sorely needed in issuing this Standard on Amplifier Measurements (it has issued a similar one on Tuners, also $1). EIA is preparing to adopt a standard similar at least nominally to the IHFM's music power output. END

[1] Institute of High Fidelity Manufacturers, Inc., 125 E. 23rd St., New York 10, N.Y. $1.

new DISCS and TAPES

Reviewed by
Chester Santon
Station WQXR
New York City

STEREO and MONO

Several audio dealers in the New York City area report increasing use of tapes for A–B demonstration of stereo sound systems. Leonard Radio Co., active in recorded tape since early two-track days, has been featuring the Mercury *1812 Overture* (STD-90054) in their component department. In its package console department, Leonard Radio favors the exaggerated separation of RCA tape *Winterhalter Goes Latin* (CPS-156) when introducing stereo to the novice. At Arnold Audio in midtown Manhattan, the current classical demo tape is Everest's four-track *Francesca Da Rimini* (STBR-3011). Top choice in pop reels—Roger Williams' Kapp release of *Rhapsody in Blue* (KT-41008). The featured stereo disc at Perdue Radio Co. is RCA LSC-2302, *Gilbert and Sullivan Overtures*.

Music Hall Bon-Bons
Raymond Paige conducting Radio City Music Hall Symphony Orchestra
Everest Stereo Tape (4-track, open reel) STBR-1024 (7-inch; playing time, 37 min. $7.95)
***Technical Rating:* EXCELLENT**

The arrangements featured on this tape by the resident orchestra of the "nation's showplace" will jolt few listeners with their originality, but popular tunes and novelties such as *Toy Trumpet* and *Fiddle Faddle* sound far more interesting in spacious acoustics. The uniquely distinct stereo separation possible on tape is a big asset. The highs are a pleasure—flat out to the upper limit of the new playback head. The earlier stereo disc version of this same recording lacks the transparent sweetness of this tape.

GERSHWIN: *Rhapsody in Blue*
An American in Paris
Heindorf conducting Warner Bros. Symphony Orchestra
Warner Bros. Stereo Tape (4-track, open reel) BST-1243 (7-inch; playing time, 32 min. $7.95)
***Technical Rating:* POOR**

Gershwin gets a decidedly glib treatment in this Hollywood sound-stage recording with pianist Bert Shefter featured in the *Rhapsody*. The tape's recording curve may prove somewhat puzzling to owners of a wide-range playback system. Treble pre-emphasis normally found in the region of 10,000 cycles occurs here in the mid-frequencies. The huge peak intrudes upon the stereo illusion whenever fortissimo level is approached. Recording equalization almost as arbitrary as this is found in quite a number of the early four-track open-reel tapes.

STRAUSS: *Don Quixote*
Till Eulenspiegel
Rudolf Kempe conducting Berlin Philharmonic Orchestra
Capitol Stereo Record SG-7190
***Technical Rating:* EXCELLENT**

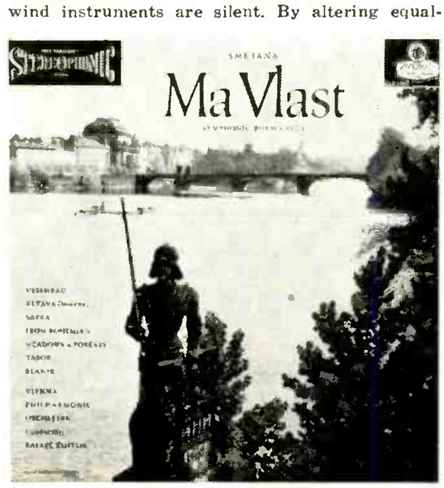
German engineers have evolved a highly successful formula for stereo recording of the Richard Strauss panoramic tone poems. The EMI mike pattern delivers completely convincing stereo in the live concert halls favored in Germany. Check the episode wherein the orchestra describes the charge of *Don Quixote* upon a flock of sheep. Stereo, as miked here, gives you a sense of movement as sounds of instruments imitating the sheep scatter in all directions. The audio quality is very impressive, placing this disc among the top recordings of 1959.

BEETHOVEN: *Symphony No. 5 in C*
Fritz Reiner conducting Chicago Symphony Orchestra
RCA Victor Stereo Record LSC-2343
***Technical Rating:* EXCELLENT**

RCA has the most exciting stereo version of the *Fifth* currently on the books. If you like your Beethoven played with lithe discipline in a wide-awake hall, investigate this one.

SMETANA: *Ma Vlast*
Rafael Kubelick conducting Vienna Philharmonic Orchestra
London Stereo Records (2) CSA-2202
***Technical Rating:* EXCELLENT**

Most catalogs list these six symphonic poems as *My Fatherland*. With a leading Czech conductor on the podium, London has released the first stereo recording of Bedrich Smetana's musical evocation of the legends and battles in the history of his native land, Czechoslovakia. Technically and musically, this is one of the most powerful stereo recordings, surpassed only by London's pace-setting opera albums. In the sections of the score that deal with the Hussite wars, transients of the full orchestra are remarkably clean even at high volume levels.



BACH: *St. Matthew Passion*
Mogens Woldike conducting Soloists, Vienna Chamber Choirs and Vienna State Opera Orchestra
Vanguard Stereo Records (4) BGS-5022/25
***Technical Rating:* EXCELLENT**

Selecting a four-record acquisition is seldom an easy choice in the stereo price range. Vanguard has met the consumer part of the way with an introductory offer—$17.85 for their version of the *St. Matthew Passion*. Despite the great difference in price, this Vanguard set stands up well in the company of the competing premium-priced German import on the Archive label.

Dinah, Yes Indeed
Dinah Shore and Nelson Riddle Orchestra
Capitol Stereo Record ST-1247
***Technical Rating:* GOOD**

In her first Capitol album, stereo emphasizes Dinah Shore's easy command of Southern charm. Nelson Riddle's arrangements mirror her personality both in intimate ballads and softly swinging production numbers.

No One Cares
Frank Sinatra and Gordon Jenkins Orchestra
Capitol Stereo Record SW-1221
***Technical Rating:* GOOD**

Separate equalization in the stereo channels is a handy feature when playing this Sinatra best-seller. The Voice, in this collection of ballads devoted to loneliness, is heard in a center position with strings massed in the left channel. Occasional woodwind and horn passages appear in the right lane. At a level high enough to give body to all of the strings, the right channel's normal groove noise becomes audible when the wind instruments are silent. By altering equalization for that individual channel, it's possible to reduce noise without excessive loss in the range of the winds.

Just For Kicks
Bob Thompson Orchestra and Chorus
RCA Victor Stereo Record LSP-2027
***Technical Rating:* EXCELLENT**

The stratospheric tinkle, plunk and tzing of upper percussion put this release into a special category. Deep cellar work of the instruments is equally effective. Novel use of voices in nonchalant pop tunes is sure to capture interest wherever stereo is on display.

French Overtures
Franz Andre conducting Belgian National Radio Orchestra
Telefunken Stereo Record TCS-18016
***Technical Rating:* GOOD**

This is the first stereo disc I've heard that does not adhere to the 500-cycle turnover of the RIAA recording curve. On my setup, some selections on the record require 300-cycle bass turnover for proper equalization. The orchestra displays ease in familiar overtures by Berlioz, Auber and Herold. The $2.98 price tag earns this one its "good" rating.

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

TCHAIKOVSKY: *Serenada for Strings*
ARENSKY: *Variations on a Theme by Tchaikovsky*
Antal Dorati conducting Philharmonia Hungarica
Mercury MG-50200
***Technical Rating:* GOOD**

These are incisive performances by one of Mercury's better orchestras. Melody is the strong point in both compositions and Dorati keeps it flowing. The string choirs balance out nicely under the jurisdiction of the single omnidirectional microphone.

CHOPIN: *Sonata No. 3 in B Minor*
Vladimir Ashkenazy, Pianist
Angel 35649
***Technical Rating:* EXCELLENT**

Chopin's last sonata receives its most realistic recording to date in this Angel mono release featuring the brilliant 22-year old Russian pianist. Earlier mono versions of this work, even when played through two channels, fall behind this disc in dynamic range and clarity of detail. Side two offers a Chopin barcarolle, a pair of waltzes and a pair of mazurkas.

Son of Gunn
Shelly Manne and His Men
Contemporary M-3566
***Technical Rating:* EXCELLENT**

Drummer Shelly Manne introduces his latest jazz group in this new installment of music from the Peter Gunn TV series. Exemplary sound for light listening. 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.*

Part II—Distortion in transistor amplifiers and what to do to keep it down

TRANSISTORS IN AUDIO

By HERBERT RAVENSWOOD

WHEN, individually, we first "discover" amplification for ourselves, there is invariably some romance about it. Many of us can barely remember the first time we put a tube circuit together and found the magic of amplification. But now, when we first put that little transistor into a circuit and find it amplifying—giving both current and voltage gain, as we discovered in the first part of this series—the magic is there, all over again.

Next, having gloated over our success, we want to put the amplification to work. It looks good on the scope, provided you keep input resistance fairly well up. But when you *measure* distortion, it is not good enough for high-fidelity applications. It is wonderfully convenient, economical and compact for such things as hearing aids and baby-alarm amplifiers, where all you do is amplify the sound, but where you need quality. . . .

This state of mind is right where most high-fidelity manufacturers are at present: "Transistors are ideal for some applications," they say, "but they are not suitable for high fidelity because of their distortion and noise." Let's take one thing at a time and concentrate on distortion.

Measuring distortion

Transistors have no monopoly on nonlinearity. A tube with a working gain of 70 or so produces at least 5% distortion. Unless conditions are optimum, it can produce more than that. So let's see what we can do with transistor distortion. But first we'll need to measure it to know which way we're going, because even 5% of second harmonic on an oscilloscope waveform *looks* pretty good. Many readers don't have a harmonic or IM distortion meter, so here's a good way to make such measurements without one.

It is a very simple setup, using an oscilloscope as the indicator (see Fig. 1), and most convenient for the calculations if you arrange to have the input signal voltage equal to the output signal voltage—or at least for the parts fed to the measuring circuit. The method consists of bucking the input against the output, so you can measure what's left, which is the distortion produced in between.

First adjust the input to the transistor by setting R1 for the desired output level at point A. Now adjust R2 to get the same voltage at point B. With switch S set on CALIBRATE, adjust the scope's vertical and horizontal gain so the trace is a 45° line, the ends of which coincide with major horizontal and vertical rulings on the graticule.

Now switch S to MEASURE and adjust R3 (NULL BALANCE) until the line becomes horizontal. (The 47,000-ohm resistors make the adjustment of this pot less critical.) Finally step up the gain of the scope's vertical amplifier with its decade switch, and you can read off the percentage of distortion as follows:

If you set the 45° line so it measured 20 divisions each way, the vertical height of the trace on the null balance will represent 0–20% (or 1% per division) for the first-decade stepup in gain. The second gives you a range of 0–2% (or 0.1% per division). If the height of your original 45° line was other than 20 divisions, the readings will be proportionate, but using 20 divisions is convenient.

Because we made the input and output voltages the same, the null point will be where the resistances measured from points A and B to the slider of R3 are equal. This will null the part of the output signal that corresponds *exactly* with the input. The part that does not cancel is distortion. As point A has the distortion and point B does not (it is our reference "pure" input), R3's slider shows just half the distortion at A. So, without altering the scope's vertical gain, the vertical scale (which we made 20 divisions) represents 200% distortion. Other positions of the vertical decade switch correspond, as before. If the input and output voltages are not equal, as we have assumed, you can still use this method, but the calculations get more involved.

Fig. 2 shows some of the displays and what they indicate. If the display slants, balance is not quite right and R3 needs further adjustment to get the reading. If it opens out into a loop as it swings from one slant to the other, there is a phase shift between input and output. This is overcome by changing the frequency until input and output are in phase (usually somewhere between 200 and 1,000 cycles) or by introducing a phase-compensating capacitor (see Fig. 3), usually a small trimmer. (Connect it across the side of the potentiometer that gives phase correction, instead of increasing the error, as determined by experiment.)

If you are interested only in distortion characteristic, it is easier to adjust the frequency. Later on when you want to investigate the dependence of distortion on frequency, you will have to use

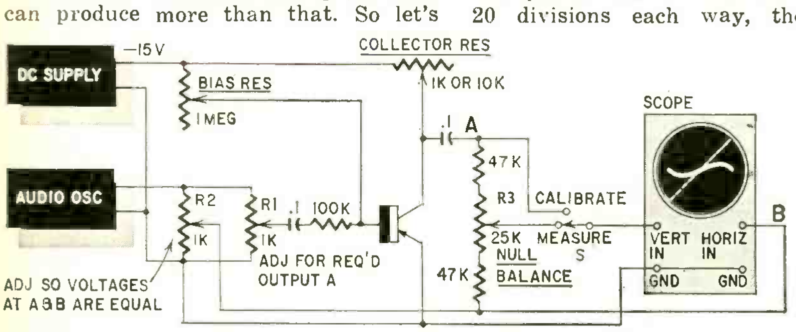


Fig. 1—Using scope balancing method to measure transfer distortion of unloaded transistor stage.

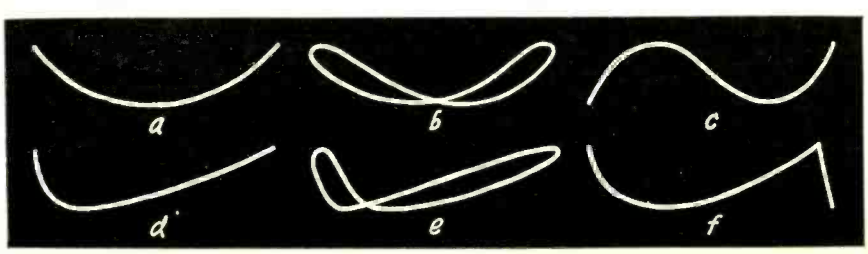
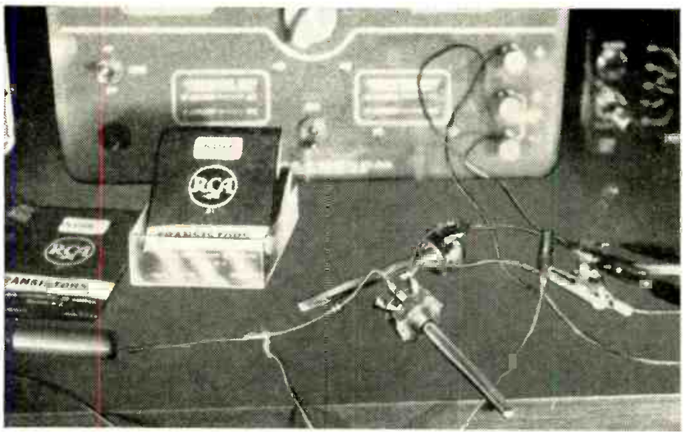


Fig. 2—Some of the traces obtained in the balanced condition: a—pure second harmonic; b—second harmonic with some phase shift; c—pure third harmonic; d—second and higher order; e—same as d with phase shift; f—curvature at one end, clipping at other.



One of Mr. Ravenswood's breadboard type setups.

the method of phase compensating.

Now let's measure

So now to the 2N109's. Let's go back over the set of conditions we explored before and see how the distortion figures show up. The results are tabulated in Table I. The lowest distortion occurs with the highest collector resistors, and the highest with the lowest collector resistors. But remember, this is without coupling the stage we are measuring to another following one, which will load down the collector considerably.

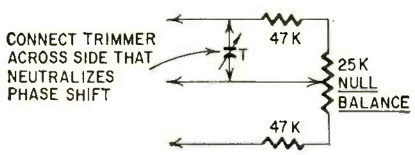


Fig. 3—Balance circuit modification eliminates phase shift between input and output.

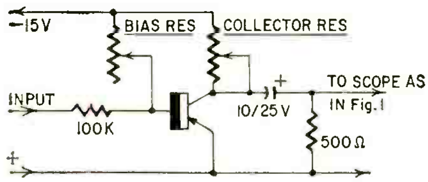


Fig. 4—Adding a resistance load to the transistor output changes the figures.

Assume the following stage's base input resistance averages 500 ohms. It is a nonlinear resistance but, as we are measuring the voltage across it, we can come nearest to predicting the overall result here by substituting a 500-ohm resistor, because it is the *current* delivered to the next base that matters. In a linear resistor, voltage indicates current waveform as well.

If we shunt the collector with a 500-ohm load, coupling it through a capacitor (see Fig. 4), several changes must be made. Current gain is reduced somewhat, and the voltage output corresponding to the same current swing is smaller, so we have to work out different voltage readings to use.

With the same bias, distortion sets in rather early, but can be held off by using a different bias, yielding lower collector voltage and higher current. This can be found by adjusting the bias until a reasonably straight line of maximum length can be obtained on the screen.

The specific magnitude of these changes, using the same range of collector feed resistors as in Table I, is given in the tabulation of Table II, which was made after adjusting with the 500-ohm coupled load.

The frequency must be raised slightly to get a balance in making the distortion measurement, because of the phase shift produced by the output coupling capacitor, which was not present before.

Here we see a pattern emerging. With high values of collector resistance, the bias has to bring the collector voltage down (and current up) to get maximum swing, which is still small. But the current gain is relatively high and the distortion small.

With lower-value collector resistors, the bias must still bring the collector lower than the open-circuit operation, but not as much as for the higher resistance. Current gain is lower, handling capacity (which in transistors is measured in *current swing*, not the more familiar, voltage swing of tubes) and distortion are higher, although coupling to the load reduces the distortion compared with the same collector resistor working open-circuit (compare with Table I).

But so far we have fed the input base with a very high resistance, as a matter of convenience. We get more gain (particularly from a voltage source) by using a lower resistance—up to a point, anyway. For input stages, at least, it will prove instructive to measure the input impedance distortion using different values of series resistance. A convenient way to do this is shown in Fig. 5.

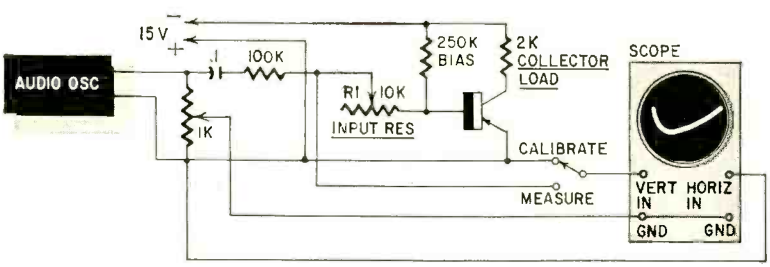


Fig. 5—Setup to measure the input base impedance with different series base resistors, on a sinusoidal current basis.

Input-impedance distortion

The original 100,000-ohm input resistor maintains essentially sinusoidal input current. Different values of series resistance are inserted between it and the transistor's base with potentiometer R1. The voltage is measured across this junction (from R1's slider to ground), from which the impedance can be deduced. But, most important, the nonlinearity of the voltage indicates the nonlinearity of the overall input impedance.

Similarly if the voltage were sinusoidal, the current would be nonsinusoidal. The results of a sequence of tests is given in Table III. Incidentally, using this circuit, the percentage of harmonic distortion reads directly, because here there is no division of the harmonic-content component by the balancing arrangement.

TABLE I

Collector resistor (ohms)	10K	8K	6K	4K	3K	2K	1K	500	250
Dc collector volts	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5
Output volts	4.7	5	5	4.8	4.9	5.1	4.9*	5*	5*
Bias resistor (ohms)	1M	800K	630K	440K	350K	250K	160K	90K	48K
Bias current (μa)	15	18.7	24	34	43	60	94	167	312
Current gain (as before)	47	50	50	48	49	51	68	68	58
Distortion (%)	1.7	1.75	2	2.5	4	6	7	7.5	15.5

*Using a reduced value input resistor to get enough drive.

TABLE II

Collector resistor (ohms)	10K	8K	6K	4K	3K	2K	1K	500	250
Dc collector volts	1.5	1.6	1.8	2.1	2.3	2.6	3.5	4	4.8
Output volts	0.35	0.45	0.6	0.8	1.1	1.5	2.2	3.2	3.9
Bias resistor (ohms)	750K	650K	520K	375K	300K	225K	125K	60K	30K
Bias current (μa)	20	23	29	40	50	67	120	250	500
Current gain (into 500 ohms)	5	6.5	9	14	20	32	52	36	20
Distortion (%)	1.7	1.7	1.9	2.3	3.5	5	6.5	10	14.5

TABLE III

Series feed resistor, 100,000 ohms
Collector resistor, 2,000 ohms
Input current held at 50μa, by keeping input at 5 volts

Value of series base resistor (ohms)	0	500	1K	2K	3K	5K	10K
Input at base resistor (mv)	45	68	92	138	187	285	535
Impedance (ohms)	900	1,360	1,840	2,760	3,740	5.7K	10.7K
Distortion (%)	32	21	15	10	7.5	5	2.5

TABLE IV

Input voltage sinusoidal (not thru 100K)
Collector resistor, 2,000 ohms
Output adjusted to 5 volts

Series base resistor (ohms)	50	500	1K	2K	3K	5K	10K	20K	50K	100K
Distortion in base current (%)	38	33	27	19	14	9	4.6	2.5	1.0	0.5
Collector voltage distortion (%)	33	27	21	17	12.5	7.8	4.5	3.5	5	6

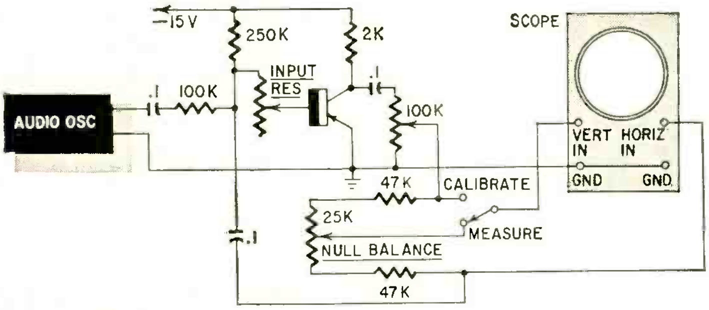


Fig. 6—Measuring input-to-output distortion for voltage input with sinusoidal current.

But how does this input-impedance distortion combine with the gain-stage distortion that follows it? If the input is a *voltage* source (which is far more usual than a current source), we can check this by picking off the input to balance against the output at this junction (see Fig. 6) or, better still, use the proposed value of input resistance directly from a true voltage source (see Fig. 7). Table IV gives the quantitative results.

From this investigation it appears that the input impedance distortion "rounds" one end of the wave, while the transistor transfer characteristic (amplification) tends to round the other (see Fig. 8). One might imagine that these opposite curvatures would tend to cancel. To a very slight extent they do. The overall result is that, instead of producing second- and higher-order *even* harmonics, which each does by itself, the combination produces some odd harmonics, particularly third, with some fifth. These components become largest when the cancellation is doing its best to reduce second.

Thermal runaway

So far we have merrily put in transistors, changed values, adjusted bias and taken our readings. Last month we found that the bias had to be adjusted differently, for almost each transistor, at least using this simple biasing circuit. For a reliable circuit, something better is needed. Added to this, especially in the higher-current conditions (lower-value collector resistors) there is a tendency to thermal runaway.

Transistor operating characteristics change with temperature. When higher currents are used, the transistors get warm. This increase in temperature boosts the transistor's gain. At the same time, the same base bias produces a larger collector current. This increases the temperature still further, building up the effect into a runaway that finishes with a pop and a cloud of smoke as the transistor burns out.

What can we do to offset variations between individual transistors and to prevent thermal runaway? One thing is to connect the other end of the bias resistor to the collector instead of the negative supply (positive with n-p-n types). Suppose the operating conditions are 5 volts at the collector, drawn from a 15-volt supply, through a 1,000-ohm collector resistor, giving 10-ma collector current and requiring 150-μa bias. The dc gain of the transistor (not taking the *coupled* load into account) is 70. For bias from the negative supply, the resistor has to be 100,000 ohms (15 volts, 150 μa). But for bias from the collector (see Fig. 9) the resistor has to drop only 5 volts, instead of 15 volts, with its 150 μa requiring a 33,000-ohm resistor.

Now suppose the transistor changes (or we use a different sample transistor) so that 150 μa finds a condition of (a) 4 volts at 11 ma, or (b) 6 volts at 9 ma at the collector. With the bias taken from the supply point, this would be the new operating condition. But with bias taken from the collector, the bias changes from 150 μa to (a) $4/5 \times 150$, or 120 μa, or (b) $6/5 \times 150$, or 180 μa. With a gain of 70, this 30-μa change in bias current will change the collector current by 70×30, or 2.1 ma, in the same direction.

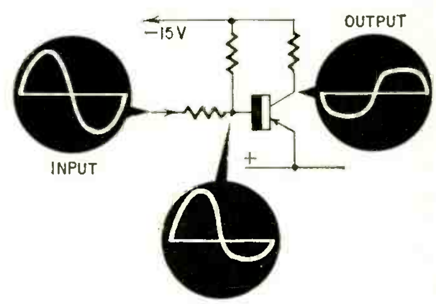


Fig. 8—Relationship between distortions due to base input resistance and nonlinear amplification.

In case (a), reduction from 11 to 8.9 ma would raise the collector voltage to 6.1. Of course this has gone further in the opposite direction than we started. Actually it is negative feedback. It reduces the deviation by more than 6 db, so the variation will be cut from 1 volt either way to about 0.45 volt. This is better, but whether it is better *enough* depends on our requirements. If more is needed, other tricks can be tried in various combinations.

One step we can use has several advantages. This is a small resistor in the emitter lead (see Fig. 10). It is a useful way of increasing the effective base input resistance *and* linearizing it. This property can be measured as before (see Fig. 6), but using no series input resistor, so only the bare base input resistance is determined, both in value and distortion effect. These results are tabulated in Table V.

Approximately, the input resistance under this arrangement can be regarded as the original nonlinear base input resistance, augmented by a resistance equivalent to the actual resistance in the emitter lead *multiplied*

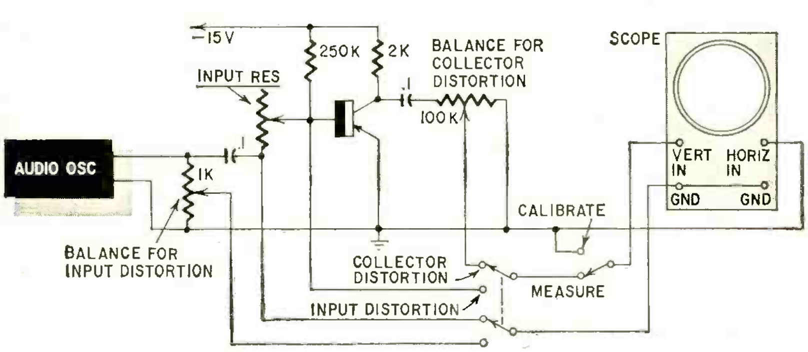


Fig. 7—Measuring input current distortion and output distortion with sinusoidal input voltage.

by the working current gain of the transistor.

This resistor also has a linearizing effect on the amplification characteristic without measurably reducing its *current* gain. This also is shown in Table V. Of course it reduces its effective gain from a *voltage* input, because it raises the effective input resistance.

This improvement may be explained as follows: Suppose that current gain is reduced during one part of the waveform, due to closing up of the curves (base and collector). This results in a smaller feedback voltage across the emitter resistance or a drop in the working current gain. The factor which the input resistance (effectively) is multiplied by falls, and the input accepts a larger signal current swing for the same voltage swing, thus offsetting the reduction in current gain during this part of the waveform.

Another advantage of the emitter resistor is the way it helps out on another trick. The effect of bias resistor feedback can be increased by using a smaller resistor. But this would produce

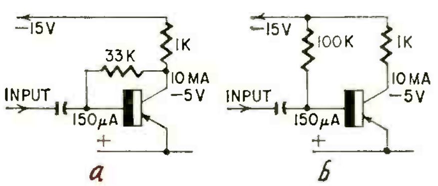


Fig. 9—Improved stability is obtained by using bias from collector (a) instead of the negative supply (b).

the wrong bias, unless something else is done. If bias current is 150 μa, we could improve this by halving the bias resistor, and then providing for the "spare" 150 μa to go to ground.

Without an emitter resistor, the base-to-ground (emitter) voltage at the operating point is probably no more than about 50 mv, which means the resistor to take the odd 150 μa has to be only about 330 ohms (see Fig. 11-a). This has to be a dc path, and thus is an effective part (in parallel) of the source resistance feeding the base. As our figures have shown, this produces considerable distortion due to the nonlinear base input resistance.

Now suppose we have a 47-ohm resistor in the emitter. With a 10-ma collector current this will drop 470 mv, raising the required base voltage to 520 mv (the original 50 mv plus the 470). As well it will add 70 × 47, or 290 ohms, to the input resistance, also linearizing current gain. But now, to increase the effectiveness of the bias feedback, the input shunt resistor (Fig. 11-b) has to drop 520 mv with the extra 150 μa, also requiring an actual resistance of about 3,300 ohms.

If we are working from a high-resistance source (compared to these values), this will drop the gain by another 6 db (in addition to the loss because of the bias feedback) due to the current division between the 3,300-ohm actual resistor and the effective 3,300-ohm input

TABLE V

CURRENT BASIS: Input, 5 volts; Input resistor, 100,000 ohms; Input current, 50 μa; Collector resistor, 2,000 ohms; Output, 5 volts							
Emitter resistor (ohms)	0	10	20	30	50	100	200
Base input (mv)	45	68	92	115	162	285	535
Input impedance (ohms)	900	1,360	1,840	2,300	3,840	5,700	10.7K
Distortion at collector (%)	6	6	6	6	6	6	6
VOLTAGE BASIS: Input resistor, 50 ohms (to measure current); Output, 5 volts; Collector resistor, 2,000 ohms							
Emitter resistor (ohms)	0	10	20	30	50	100	200
Current (μa)	49	50	50	50	50	50	50
Base input (mv)	88	110	125	140	165	285	535
Input impedance (ohms)	1.8K	2.2K	2.5K	2.8K	3.3K	5.7K	10.7K
Distortion at collector (%)	33	22	15	12	8	4.5	2.5

base resistance (which now is quite reasonably linear). On the other hand, working from a voltage source, the overall input resistance will be the two 3,300 ohms in parallel, and the linearity will be quite good. Bigger swamping of the nonlinear base resistance would make it better.

Actually, though, the emitter resistance by itself will stabilize and linearize, without sacrificing effective *current* gain, so that collector-connected bias stabilization may be unnecessary. Take the previous supposition, but use 50,000 ohms from supply minus, instead of about 15,000 ohms from the collector, with 3,300 ohms from base to ground. Normal condition is 150-μa base current, 150 μa through the 3,300-ohm 520-mv base to ground, 470 millivolts emitter to ground.

Now suppose the collector current changes (due to change of transistor or its characteristics) to 9 or 11 ma. The emitter-to-ground voltage will change to 420 or 520 mv. By the time the base voltage changes to suit, the 3,300-ohm resistor from base to ground will be taking more or less than its share of the 300 μa from supply minus, and the difference will be bringing the bias point back nearer where it ought to be.

With the bias resistor set to pass twice the required bias current (half bypassed to ground), the best stabilization that can be achieved this way is 6 db. But this can be improved by using

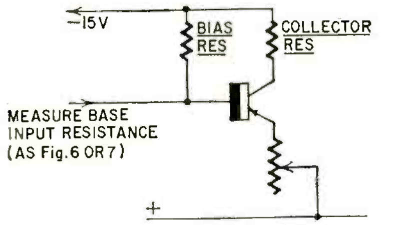


Fig. 10—Inserting emitter resistance linearizes base input resistance (and raises it) without affecting current gain. For voltage input it also linearizes gain distortion.

a larger emitter resistor (47 ohms is still very small compared to other circuit values) and by allowing the base-to-ground resistor to bypass more than a current equal to the bias current.

Thus we have quite a variety of things we can change. The best choice will depend on a number of things—input source resistance; other things

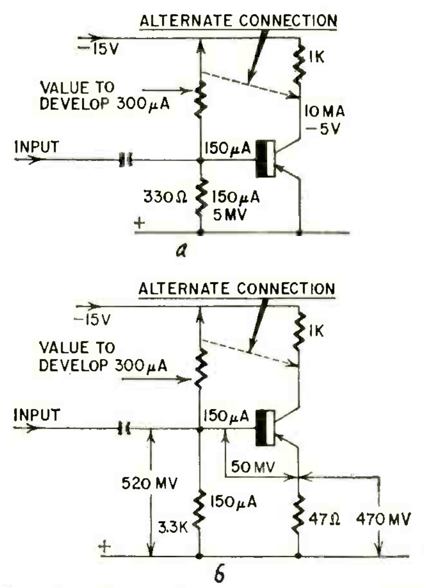
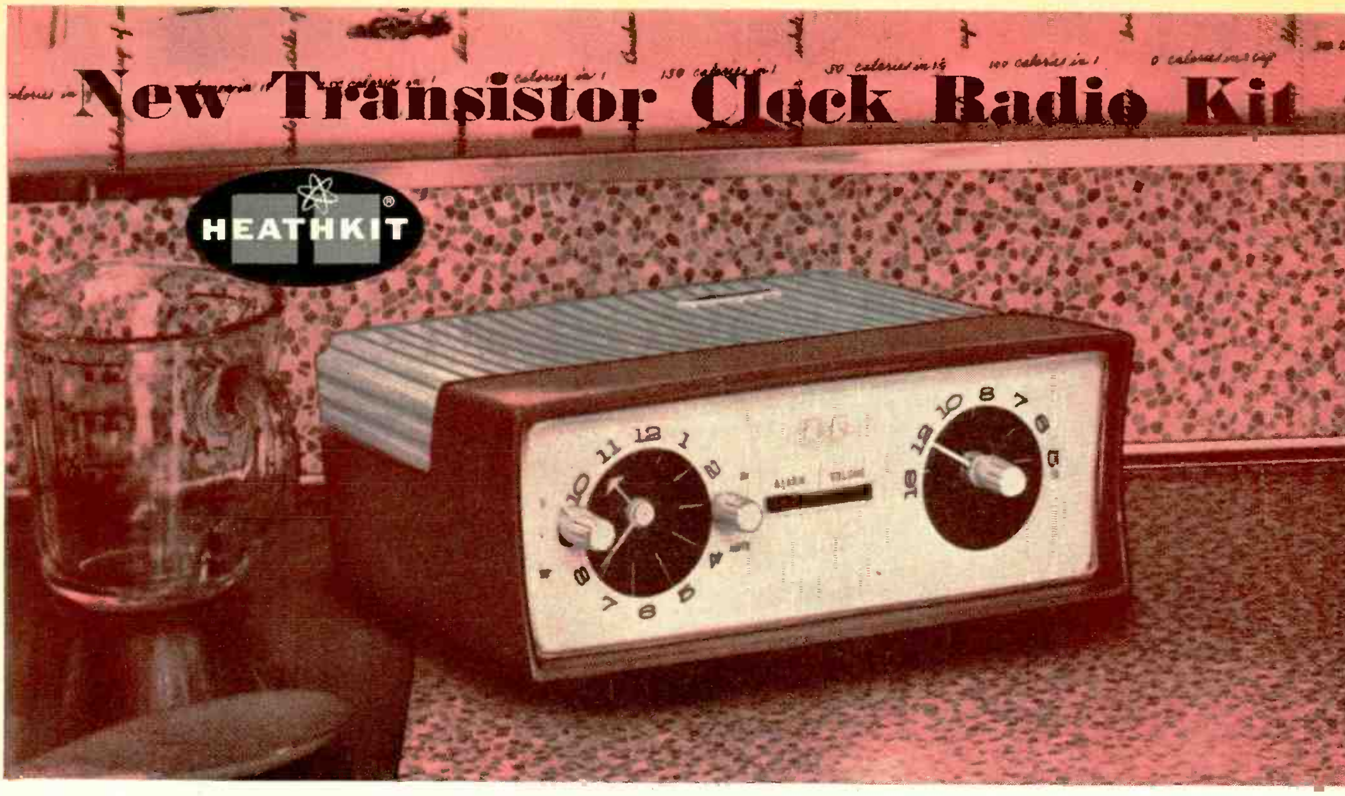


Fig. 11—How the use of an emitter resistance also aids the stabilizing problem by allowing the use of a practical value of base-to-ground resistance.

that may want to be included, such as equalizer circuits, and so on. We are already beginning to see that, although transistors (to date) have only three electrodes, they are at least as versatile as tubes with more. While there are a few things tubes will do that are difficult with transistors, it looks as if we may end up the other way, with transistors doing many jobs that tubes cannot handle.

Meanwhile we have plenty more to explore in transistors in the realms already discovered. More of that next time.

TO BE CONTINUED



EVERYTHING A CLOCK-RADIO CAN OFFER . . . AND PORTABLE TOO!

- Completely portable, all-transistor circuit
- Runs up to 500 hours on standard batteries
- Deluxe features at half the cost
- Easy to assemble

HEATHKIT TCR-1

$45.95

"YOUR CUE" TRANSISTOR CLOCK RADIO KIT (TCR-1)

Take all the deluxe features found in the most expensive clock-radios, add the convenience of complete portability, plus a modern 6-transistor battery operated circuit . . . then slash the price at least in half, and you have the new Heathkit "Your Cue" Transistor Portable Clock Radio.

Packing every modern clock-radio feature into a compact, beautifully styled turquoise and ivory plastic cabinet, "Your Cue" lulls you to sleep, wakes you up, gives you the correct time and provides top quality radio entertainment in and out-of-doors. It can also be used with the Heathkit Transistor Intercom system, opposite page, to provide music or a "selective alarm" system for one or more rooms covered by the intercom system.

An "Alarm-set" hand, hour hand, minute hand and sweep second hand grace the easy-to-read clock dial. All controls are conveniently located and simple to operate. The "lull-to-sleep" control sets the radio for up to an hour's playing time, automatically shutting off the receiver when you are deep in slumber. Other controls set "Your Cue" to wake you to soft music, or conventional "buzzer" alarm. A special earphone jack is provided for private listening or connection to your intercom or music system. At all times crystal-clear portable radio entertainment is yours at the flick of a switch.

The modern 6-transistor circuit features prealigned IF's for ease of assembly. A tuned RF stage and double tuned input to the IF stage assure top performance. The built-in rod-type antenna pulls in far-off stations with outstanding clarity while a large 4″ x 6″ speaker provides tonal reproduction of unusual quality.

Six easily obtainable penlight-size mercury batteries power the radio receiver up to 500 hours, while the clock operates up to 5 months from a single battery of the same type. Ordinary penlight cells may also be used with reduced battery life.

The handsome two-tone cabinet, measuring only 3½″ H. x 8″ W. x 7½″ D. fits neatly into the optional carrying case for beach use, boating, sporting events, hunting, hiking, or camping.

Wherever you are, you'll find "Your Cue" your constant companion. Shpg. Wt. 5 lbs.

LEATHER CARRYING CASE
HEATHKIT
NO. 93-3

$4.95

Shpg. Wt. 2 lbs.

HEATH COMPANY/Benton Harbor, Mich.

a subsidiary of Daystrom, Inc.

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)

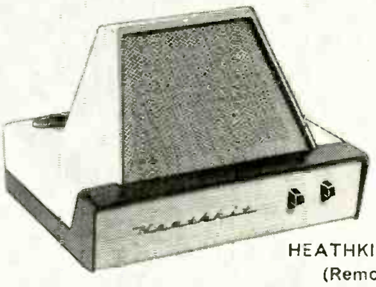
A flexible, versatile transistor intercom, has been developed by Heath engineers to enable you to set up your own communications system at an unbelievably low price.

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

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

New

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

$56.95

$5.70 down. $6.00 mo.

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

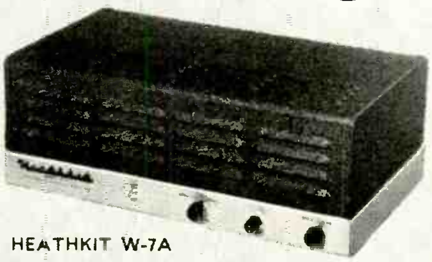
55 WATT HI-FI AMPLIFIER KIT (W-7A)

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.

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 W-7A

$54.95

New HEATHKIT Stereo Amplifiers

HEATHKIT SA-2

$52.95

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).

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 3¾" H.

New

HEATHKIT XR-2P (6 lbs.)

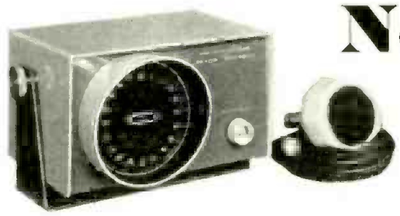
$29.95

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.

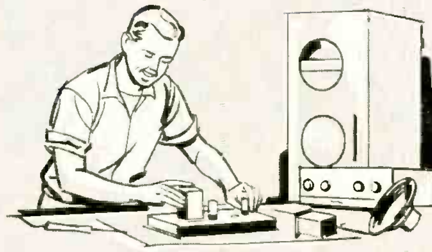
- Indicates Depth and Type of Bottom From 0 to 100 Feet
- Detects Submerged Objects (fish, logs, etc.) and Their Depth
- Completely Transistorized . . . Operates From Flashlight Batteries

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.

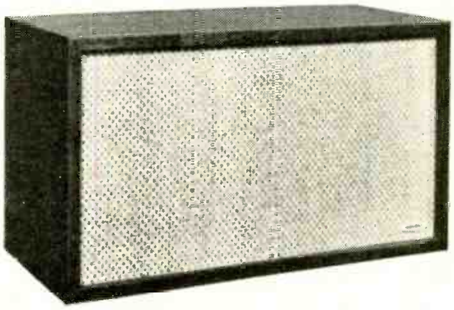
HEATHKIT FM-4

$34.95

HEATH COMPANY/Benton Harbor, Mich.

a subsidiary of Daystrom, Inc.

New "Acoustic Suspension" Hi-Fi Speaker System Kit



HEATHKIT AS-2U (unfinished)

$69^95

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

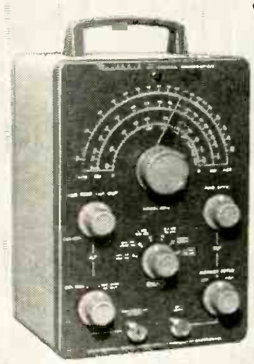
HEATHKIT FMO-1 Price to be announced

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

$27^95

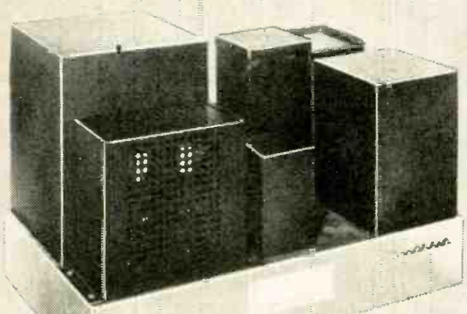
PREASSEMBLED AND ALIGNED BANDSWITCH/COIL ASSEMBLY

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:** V1 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



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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

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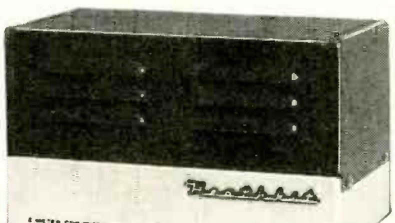
The KL-1 operates at maximum legal amateur power inputs in SSB, CW or AM service using any of the popular CW, SSB and AM exciters as a driver. Premium tubes (4—400's) push the "Chippewa" to top performance levels while a centrifugal blower provides more than adequate cooling. Shpg. Wt. 70 lbs.

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

$36.95

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

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"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.

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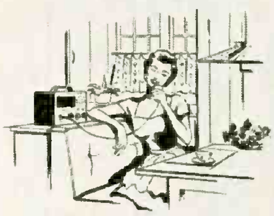

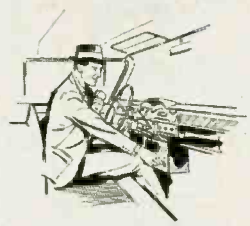

Both models include transceiver, crystal, microphone and two special power cords.

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- 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)

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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.

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FIX THAT MULTIMETER

Save money and time by making do-it-yourself repairs on this vital test instrument

By EDWIN BOHR*

ARE you trying to service TV sets or electronic circuits with a multimeter that has one or more burned-out ranges? Well, come on and get it fixed.

The intelligent technician, with a fair understanding of meter circuits, malfunctions and symptoms, can make many routine meter repairs. This will save the time, transportation and insurance costs of sending the meter to a repair station.

Furthermore, imported and kit meters, while sometimes very accurate and excellent in design, have low initial costs that make repair-station charges prohibitive.

Over 50% of all range burnouts, in both vacuum-tube and ordinary multimeters, occur when the leads are placed across high or moderate voltages with the meter in a low-ohms position.

When this happens, a high voltage (say 117 volts ac) is applied across a resistance in the neighborhood of 10 ohms. The resistance may literally vaporize. Other times a segment of the resistor will burn out. Or, if the voltage appeared across the resistor for only a split second, the turns of resistance wire may overheat, shorting adjacent turns. This last effect is not very spectacular, but it usually makes the range inaccurate.

Burned-out milliamp ranges, meter movements, voltage ranges, meter rectifiers and defective switches all account about equally for the remaining meter troubles.

At one time, bad milliamp ranges were rare. However, with TV techs measuring cathode current of horizontal output tubes, burned-out milliamp range resistors and switch contacts (from high-frequency arcs) are increasingly frequent.

No doubt there will be a slight recession of this particular damage as more technicians experience a burned-out milliamp section.

Defective resistors

Defective resistors in the various ranges account for most troubles. And the resistors damaged are usually less than 1,000 ohms in resistance. In other words, look for trouble in the low-resistance precision resistors. The high values hardly ever burn out.

The reason is simple—high values of resistance require a very high impressed voltage to exceed their wattage rating, while a low-resistance precision resistor may take a beating with an overload of less than 25 volts.

Burned-out wirewound resistors are usually easy to spot. Look for smoke, overheated wrapping or wire. If the resistors are nested in cavities, there is sometimes a smoke smudge on the inside of the case, adjacent to the cavity.

With a strong beam of light shining at the best angle, it is also possible to look into the cavity and see the damaged resistor.

Defective deposited-film resistors are hard to spot. Usually a small blister or darkening of the varnish is the only visible indication. And this is not always evident. Bad units with protective sleeves defy visual detection even more completely.

When the defective resistor (or resistors) is located, temporarily substitute the nearest value 10% unit and check the meter for proper function. You can even use the meter this way, at reduced accuracy, until you can get an exact replacement.

To order the resistor, carefully refer to the operating manual for the exact repair-part number. You can expect some help from your parts distributor in this regard. But, after all, it is your meter and you should know exactly which resistor you need before placing the order.

Ohmmeter circuits and defects

If the trouble is not obvious, you must know enough about the circuit to find it from the symptoms.

Instruction-manual circuit diagrams are one stumbling block. They are usually too small, jumbled together and almost useless to anyone but the experienced instrument-service technician who often has the circuit committed to memory anyway.

However, the practical examples and simplified circuits that follow should help. Since resistance-range burnout is most common, let's start with the ohmmeter circuits.

Fig. 1 essentially shows the very popular Simpson 260 ohmmeter circuit lifted from the complete schematic. Fig. 2 is a simplified Triplett 630. Fig. 3 is the typical ohmmeter circuit found in vacuum-tube voltmeters.

Understand these three circuits and you have a key to tracing nearly any ohmmeter symptom to its source. The circuits are fundamental and apply, with slight variations, to all but a few instruments.

Look at Fig. 1 with a selector switch in the ×1 position. When the probes are open there is no voltage across the 11.5-ohm resistor and the meter stays at its mechanical zero, indicating infinite resistance.

Now, if the probes are shorted, the full 1.5 volts appear across the 11.5-ohm resistor—except for a small voltage

*Electronic Instrument Service, Chattanooga, Tenn.

drop across the dry-cell internal resistance and wiring resistances.

Next, the ZERO ADJ knob is moved until full-scale current flows through the meter, corresponding to zero ohms.

Notice the meter is measuring the voltage across the 11.5-ohm resistor, but the scale is calibrated in ohms. If we place a 12-ohm resistor between the probes, the voltage across the 11.5-ohm resistor will be cut half and the meter will read half-scale.

This simple concept helps to analyze ohmmeter troubles mentally and to establish their cause and location.

Suppose you have a Simpson 260 (similar to Fig. 1) and the pointer always goes to zero ohms on all ohms scales, unless very high resistances are placed between the probes. In other words, the scales indicate several thousand percent low.

This clearly indicates the 11.5-ohm resistor is open, making center scale not 12 ohms, but thousands of ohms. It also disables the other ohms ranges.

Temporarily replace the burned-out 11.5-ohm resistor with a 10-ohm composition unit. This restores the ×1 range. It now indicates several ohms off at center scale, but the remaining ohms ranges operate at full accuracy.

Resistors do not always burn out. In Fig. 1, if the ×10,000 and ×100 ranges are OK, but the ×1 range *indicates* resistance much *higher* than the

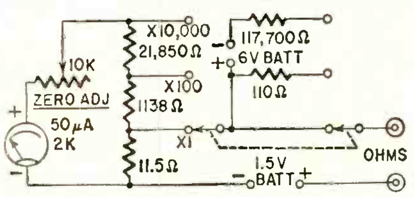

Fig. 1—In this type of ohmmeter circuit the 11.5- and 1,138-ohm resistor are most often damaged.

actual values, you can be sure the 11.5-ohm resistor is partially shorted.

Occasionally, two resistors are damaged. If it is impossible to zero the meter on its ×1 scale and the meter indicates ridiculously low on the ×100 scale, experience shows that both the 11.5- and 1,138-ohm resistors are usually defective. However, a few cases with these symptoms occur with only the 1,138-ohm resistor damaged.

It is unlikely that any of the other resistors will burn out or be damaged by overload. You may question this statement as applied to the 110-ohm resistor. However, it receives only one-tenth the 1,138-ohm resistor overload which will blow first, like a fuse.

Fig. 2 is a slightly different circuit. The ZERO ADJ shunts the meter and each ohms scale has an independent set of range resistors. Burnout of one resistor will not affect the other ranges.

The most-likely-to-burn-out resistors are the 4-, 40- and 5,000-ohm units. Occasionally, we find the 16,000-ohm resistor will change value, making it impossible to set zero by either too much or too little current.

The astute reader may notice the

change in mode of operation for both circuits (Fig. 1 and 2) on the highest range. Here the meter reads current through, rather than voltage across, the range resistors.

Fig. 3 is the common vtvm type of ohms-measuring circuit. The values listed are the same as the RCA Volt-Ohmyst Senior.

With no resistance connected to the probes, V1 directly measures the dry-cell voltage (V1's output drives a meter), since there is no voltage drop across any of the range resistors.

Center-scale marking for the RCA meter is 10 ohms. On its lowest range, the battery and wiring resistance account for about 0.25 ohm, making the lowest-range resistor 9.75 ohms. Connect a 10-ohm resistor to the probes and V1 receives only half the battery

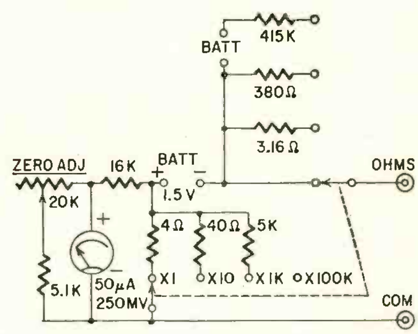

Fig. 2—Another common ohmmeter circuit. The 4- and 40-ohm resistors are usually the first ones to be damaged by overload.

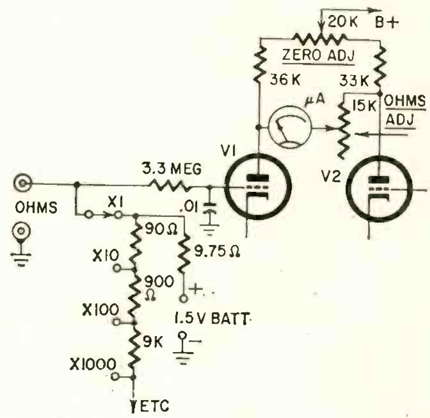

Fig. 3—In this vtvm ohmmeter circuit the 9.75-ohm resistor is normally the only one that burns out.

voltage, indicating 10 ohms at half-scale.

Usually, only the 9.75-ohm resistor burns out. With it open, the other resistors are removed from any current path. However, if the 9.75-ohm resistor opens, all ranges become inoperative. This happens because there is no longer a return to the dry cell, and V1's grid floats, except when the probes are shorted.

With probes apart, the pointer lazily drifts about or goes to either end of the scale. Connect any resistance to the probes and the pointer goes to the zero-set position.

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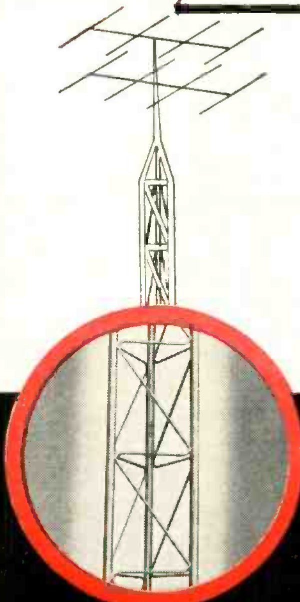

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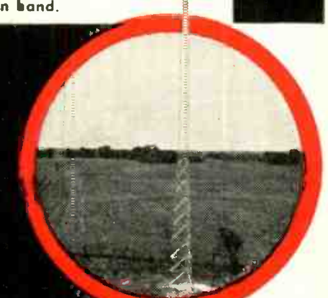

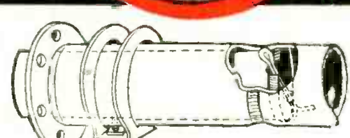

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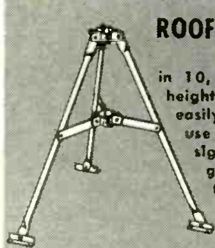

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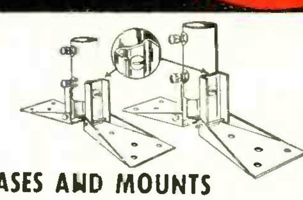

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TEST INSTRUMENTS

It is interesting to note the meter is usually not damaged, except for a bent pointer, in any of the preceding cases. The resistors take the beatings.

Milliamp circuits

When multimeters are left in the mills position and touched across voltage, a resistor is sure to blow. If the voltage is above about 10, the meter movement will also be damaged.

Fig. 4 (Simpson 260, essentially) and Fig. 5 (Triplett, essentially) are representative circuits. Both circuit

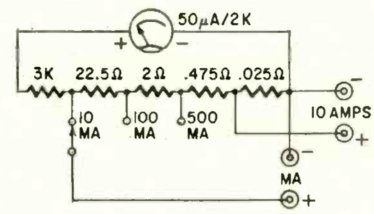

Fig. 4—If the milliampere ranges do not work and the circuit looks like this one, check the 0.475- and 2-ohm resistors first.

techniques keep switch-contact resistance from causing what would otherwise be enormous errors in these low-resistance circuits.

The Simpson circuit keeps the current-carrying-contact resistance in series with the shunt and meter circuit. Thus, it never appears between shunt and meter.

Notice if any single resistor fails all the milliamp ranges are knocked out. The 2- and 0.475-ohm resistors are most often damaged.

Fig. 5 is a special circuit that discriminates against switch resistance with a double-contact arrangement and independent shunts.

Because of the low and rather uncommon resistance of milliamp shunts, you must usually depend entirely upon factory replacement parts. Sometimes, in large electronics centers, you may find an electronics lab with the necessary special-alloy wire and measuring equipment that will wind a replacement resistor on the old bobbin.

Ac-range damage

Fig. 6 is a typical ac volts circuit. Two ac range components, R_M and the rectifier composed of D1 and D2, account for about 90% of all ac voltmeter

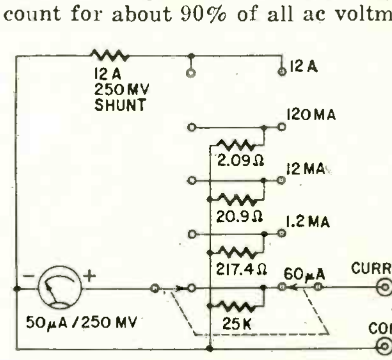

Fig. 5—Special circuit used to prevent contact resistance errors. The 2.09-, 20.9-, and 217.4-ohm resistors are frequently damaged.

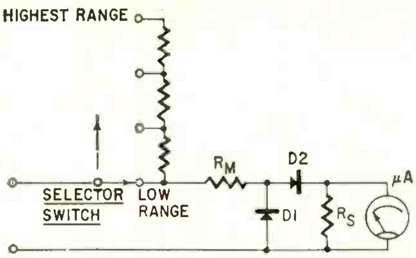

Fig. 6—Typical ac volts circuit.

defects. Invariably, a damaged R_M means the rectifier is also damaged.

R_M is the multiplier for the lowest range only, and its value must usually be chosen to provide correct calibration for each individual rectifier assembly on the lowest range. Resistor R_S adjusts the sensitivity for all ranges.

Check the diodes by disconnecting them from the meter and calibrating resistors. Next, measure each one with an ohmmeter, swapping the probes each time. If the diode is undamaged, a large difference in resistance reading should be noticed when the probes are swapped (about 10 to 1).

If the rectifier is bad, you can usually order a factory-calibrated assembly, complete with rectifier and matched values of R_S and R_M. Or, you can use the listed Conant replacement rectifier, or two germanium diodes—1N34-A's, for example.

In the last instance, check the meter for accuracy near full scale on the highest practical range. Usually, the instrument will be within tolerance. If not, change the value of R_S until a correct indication is given. Now, switch to the lowest range and adjust the value of R_M for correct calibration.

A note of caution: After soldering the diodes in place, be sure they have cooled completely before calibrating the instrument. This cooling takes several minutes.

Dc-voltage ranges

The dc voltmeter circuit is very simple. Proper resistors are simply switched in series with the meter movement to make it read full scale on a specific voltage. These resistors normally do not overheat, even with extreme high-voltage overloads. Consequently, they are a rare source of trouble.

However, electronics people are always interested in checking the accuracy of the dc ranges. Mallory mercury cells, available at electronics parts distributors, make excellent calibration standards. Each cell has a potential of 1.345 volts that changes very little with temperature, age or loading of the usual multimeter. Accuracy of these cells can be considered better than ±0.25%.

Three cells in series provide a standard voltage of 4 volts within 1%; six cells, 8 volts, and five 8-volt mercury batteries in series supply 40 volts, etc.

Inaccuracy, other than mechanical difficulties in the meter movement, is usually caused by a drop in field strength of the magnet or partial shorts in the armature. Both defects affect the milliamp, ac and dc volt calibrations equally. This establishes a good cross-check to see if the trouble is definitely in the meter-movement sensitivity.

As long as there is enough sensitivity to zero the ohms ranges, decreases in meter sensitivity do not affect ohms-scale accuracy.

Meter movement

The two causes of meter inaccuracy mentioned above must be handled by a repair station. This is true, also, of magnetic trash in the meter, badly bent pointers, poor balance, bad pivots and bearings.

If the meter-panel glass breaks or even if it gets loose, immediately seal the meter in a clean box or bag until the glass is resealed or replaced. Otherwise, microscopic particles will be pulled into the powerful magnetic meter gap with its minuscule clearance from the moving armature. This can cause the armature to hang and result in a trip to the repair station.

A local glass store can cut a replacement meter glass. Completely remove the original sealing compound and reseal the new glass with a layer of corona dope brushed around the edge of the new glass.

Switches

Contacts burn out or lose their spring pressure from overheating. This, again, requires a major repair that few technicians are equipped to handle. However, carbonization of the switch wafer is a difficulty often repaired with little trouble.

Carbonization results from a high-voltage arc between contacts. This burns the switch wafer, changing the surface to carbon.

The arc actually forms a carbon resistor between contacts. Continued use under high-voltage conditions may produce a continuous arc and completely burn through the switch.

Carbonization frequently makes vtvm's behave erratically. If everything else appears OK, check all the switch surfaces closely with sharp eyes and a good strong light.

To repair the carbonized section, completely but carefully dig and scrape away the carbonized material with a pointed knife blade. Then fill the area with one or two small drops of corona dope or Krylon.

In high-humidity areas a thin coat of silicone grease over the switch wafer and rotor is good insurance against future arcs.

Multimeter repair requires diverse and specialized experience, parts and equipment—to say the least. Many jobs simply must be handled by the specialist. However, if a multimeter user follows the preceding suggestions, he can often have his meter back in service in a couple of hours. END

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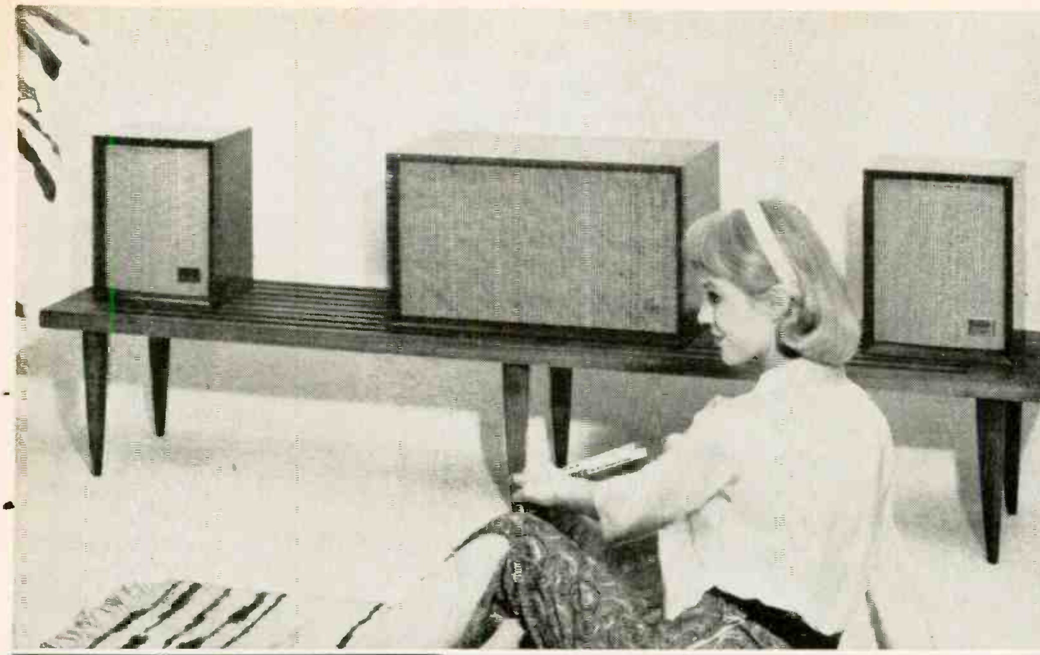

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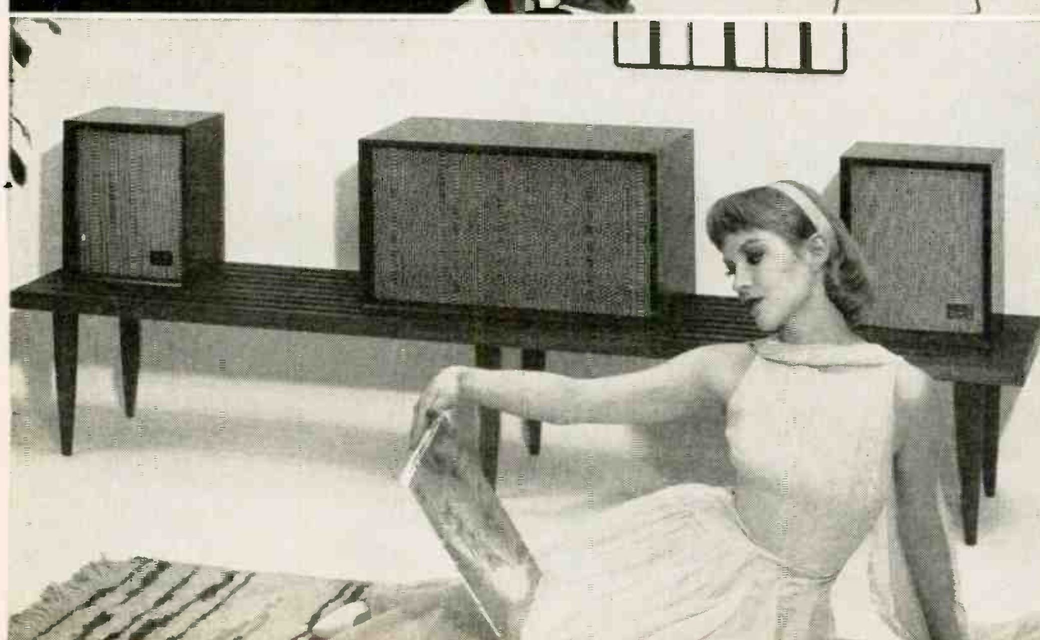

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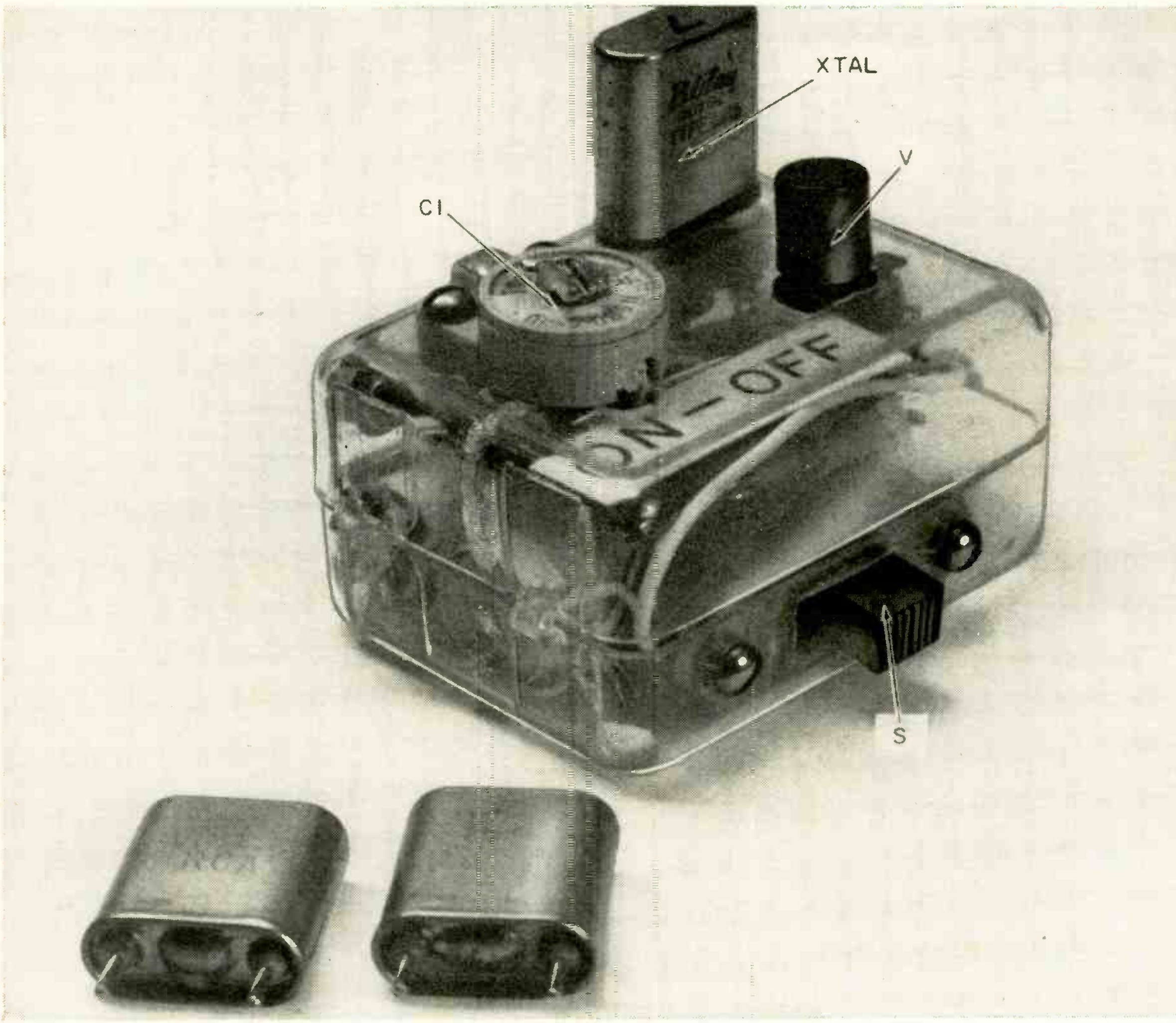


Slide switch turns the compact oscillator on and off.

MULTIPURPOSE TRANSISTOR CRYSTAL OSCILLATOR

1-transistor unit serves as signal source for TV troubleshooting, crystal-controlled oscillator for dual-conversion receiver or band-spotting with communications receiver

By F. T. MERKLER

THIS crystal-controlled oscillator illustrates the old saying "Good things come in small packages." Here is just such a good thing. Plug in any fundamental crystal in the frequency range of 1.5 to 14 mc and get good sine-wave output, without tuning adjustments of any kind. The parts required are standard, few and inexpensive. An added bonus is the tiny amount of power drawn from the battery supply. In the first model built, battery life equaled shelf life.

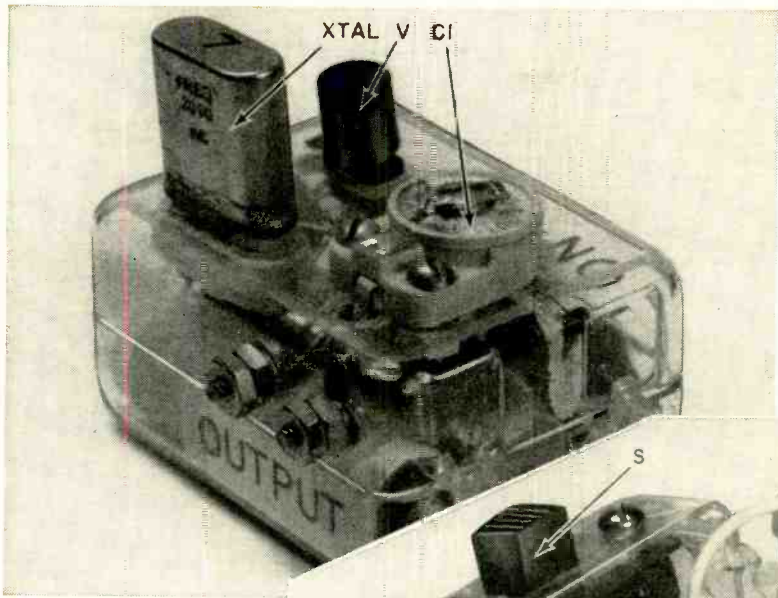
The photos give a general overall view of the oscillator, but this layout does not have to be followed. Any neat and reasonable mechanical layout of parts will work electrically. As the 2N247 is by far the most expensive component in the oscillator, I used a socket for mounting it. All wiring and visual checking is done before inserting the transistor in its socket. In this way the chances of damaging it because of excessive soldering heat or improper circuit connections are reduced. After the socket is mounted, color-code the collector connection end (a drop of nail polish is fine). The socket has five pin connections in a line; the 2N247 uses four of them. Note the gap between collector and shield. Plug the empty hole in the socket with a touch of service cement. It keeps you from inserting the transistor into its socket incorrectly.

The crystal socket is probably the next component to mount. The one to use depends on the crystal case size and pin spacing. Photos of my model show a Bliley type BH6 crystal. Pin spacing for this type is 0.500 inch. A matching socket is the National type CS-5.

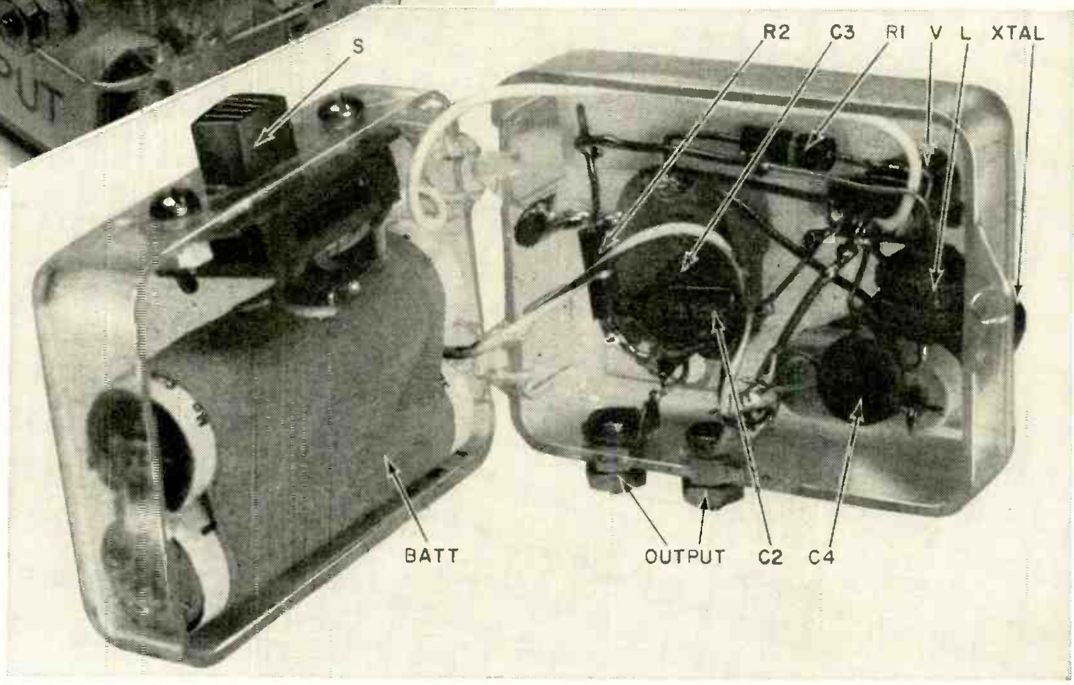
Place the ceramic trimmer adjacent and at right angles to the transistor and crystal sockets. Drill two small holes (No. 26 drill) through the plastic case and mount 4-40 screws in them to serve as the output terminals. The remaining small electrical parts are now soldered point-to-point following the schematic.

Final touch-up hints

Electrically, the schematic tells the whole story, except for miniature choke L. The circuit will oscillate without it, but output tends to drop with increas-



Output terminals are located on the rear of the case.



Compact layout makes the oscillator's small size possible.

ing frequency. The choke counteracts the drop in drive current to the transistor's base as the operating frequency goes up, by building up the impedance level of the emitter circuit. If in your application high-frequency operation is important, two things can be done to insure good results:

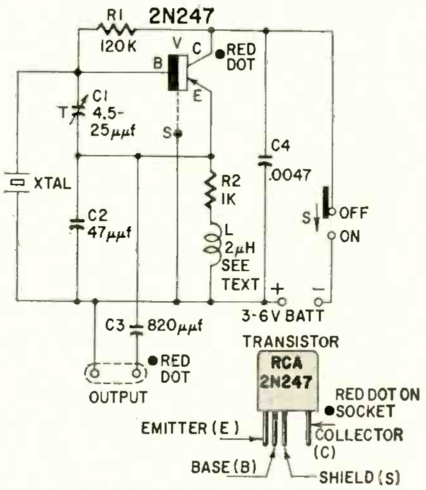
- Insert a 2-μh inductance, shown on the schematic as L.
- Increase the supply voltage to 4.5 or higher.

The second step is particularly important to the efficient use of drift type transistors. RCA application notes show a pronounced knee in the curve that relates collector volts to cutoff frequency.* Practically, if we have a collector supply voltage of 4 volts or more, the collector-voltage field extends through the impurity region near the base and the transistor gives the maximum gain of which it is capable. In neutralized amplifier circuits, the 2N247 transistor gives some gain until frequency gets beyond 50 megacycles. So any fundamental crystal (they range up to about 14 mc) will work in this circuit.

Now that you've built this small convenient oscillator, I'm sure you will find many uses for it. For example, as a signal source for TV troubleshooting, or for the crystal-controlled oscillator feeding the second mixer in a dual-conversion high-frequency receiver. The oscillator can be used as a known frequency feeding one set of plates on your scope, while an unknown frequency is fed to the other set of plates. Use it for band spotting with your high-frequency receiver. Many times, all you have to do to get a signal into a circuit under test is to place a wire clip lead on the oscillator's hot output terminal, and let this wire rest on the bench close by the trouble spot.

Adjust trimmer capacitor C1 with the aid of a scope at the highest frequency you expect to use. Set it for the cleanest-possible highest-amplitude waveform, and you're done. This will be close to a mid-range setting of the capacitor with a normal variety of crystal. END

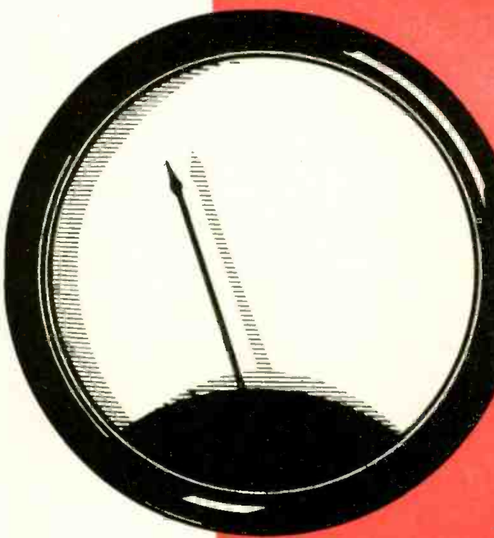
*A. Kestenbaum and J. W. Englund, *A Drift Transistor for High Frequency Use.* RCA Laboratories Bulletin LB 1045.



R1—120,000 ohms, ½ watt, 10%
R2—1,000 ohms, ½ watt, 10%
C1—4.5–25 μμf trimmer
C2—47 μμf, mica
C3—820 μμf, mica
C4—.0047 μf, ceramic
BATT—3–6 volts
L—see text
S—spst slide
V—2N247
XTAL—1.5—14 mc as desired
Xtal socket—to match crystal
Socket, subminiature 5-pin in-line for transistor
Case, 2⅞ x 2 x 1 inch (Lafayette MS-158 or equivalent)
Miscellaneous hardware

Circuit of the 1-transistor unit.

Eliminate just three faults of most ohmmeters and you can come up with a precision instrument



OHMMETERS can be accurate

By H. B. CONANT*

THOSE who must measure resistance precisely know that ohmmeters are not accurate and the average technician who has a few years' experience becomes suspicious of the instrument. It is a rare ohmmeter that gives readings within 10% of the true resistance value. Check yours against a group of precision resistors and see.

Traditionally, an ohmmeter's circuit is some version of Fig. 1. This is based upon the equation $R = \frac{E}{I}$, where E is the battery potential, I the current indicated by a dc meter and R the *total* circuit resistance in series with the battery. This includes limiting resistor R_L, variable resistor R_V, the unknown resistor R_X plus the resistance of the meter, test leads, switch contacts, wiring and even the battery.

To set the meter, we short the test prods and adjust R_V to give a zero-ohms reading. In this way, we adjust the value of R to suit the battery potential, and at this point the ohmmeter is obviously correct.

*Conant Laboratories, Lincoln, Neb.

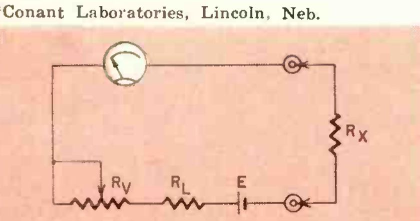


Fig. 1 — Traditional ohmmeter circuit.

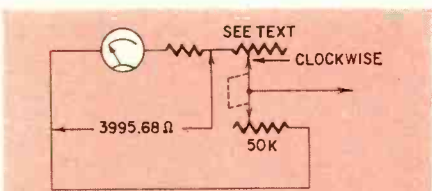


Fig. 2 — Zero-adjust control that does not change total circuit resistance.

Why then is the ohmmeter inaccurate? There are a number of reasons:

▸ A fresh D cell delivers as much as 1.65 volts and can be used until its voltage has dropped below 1.35. So, if the circuit in Fig. 1 uses a single cell and a 1-ma meter, R must be adjustable between 1,350 and 1,650 ohms. Now, if we measure an unknown resistance and the meter indicates exactly half-scale ($\frac{1}{2}$I); $2R = \frac{E}{\frac{1}{2}I}$. Obviously R_X is equal to R or something between 1,350 and 1,650 ohms, regardless of what the center-scale graduation on the scale says it is. All partial-scale deflections are similarly related to R, regardless of the battery potential or the meter sensitivity.

▸ The ohms scale was originally plotted according to the engineer's best judgment of how it should be proportioned. Scales were then printed and installed on 2% accurate dc meters. Commercial 2% meters can be off as much as one scale division of a 50-division scale.

▸ Because of overdamping of the meter movement on low-resistance ranges, the pointer creeps rather than swings up the scale, so pivot friction prevents the pointer from reaching the true scale position.

Eliminate the error

To build a precision ohmmeter, we must eliminate the causes of error.

Since all the resistance-scale graduations are unalterably related to R, the first step is to eliminate R_V from Fig. 1 so R can be made a fixed and precise value. As this is the value indicated at the half-scale point, we will want it to be in round numbers. With a fixed value for R, variations in battery voltage (E) must produce proportional variations in I—for example, $2E/R = 2I$. Since we have eliminated R_V the "ohms zero" control must vary the current sensitivity of the meter without, however, altering its resistance. The ideal

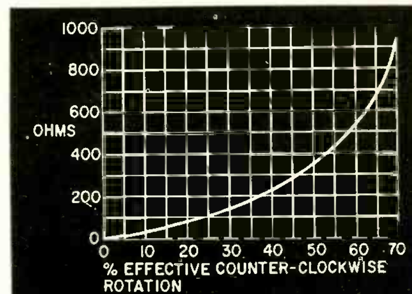


Fig. 3—Taper of pot in meter leg of zero-adjust circuit.

way to do so would call for a movable magnetic shunt inside the meter case, operated by a control on the panel. Meter current requirements must be increased only 20% with such a shunt to cover the variations in battery voltage.

Zero-adjust control

Using a conventional meter, this job becomes difficult because we must use circuitry which will shunt the meter to varying degrees without changing its resistance. Fig. 2 shows how this can be done. As the shunt control is turned to decrease its resistance, the resistance of the series control increases the resistance of the meter circuit to hold the resistance of the parallel circuit constant.

Since resistances in parallel do not have a linear relationship to variations in the value of a single resistor, either the shunt or series section of the dual control must be tapered. The resistance of the series control is much lower than that of the shunt, so the taper should be in the series control for ease of construction.

Before we can calculate resistance values and tapers, we must know the internal resistance of the meter we will use. But don't measure its resistance in the usual manner—you may damage the meter. Instead, connect it in parallel with a dc millivoltmeter of known accuracy and supply both with current from a dry cell through a resistance which is adjusted until the meter reads exactly full scale. Note the millivoltmeter reading. Then connect the meter in series

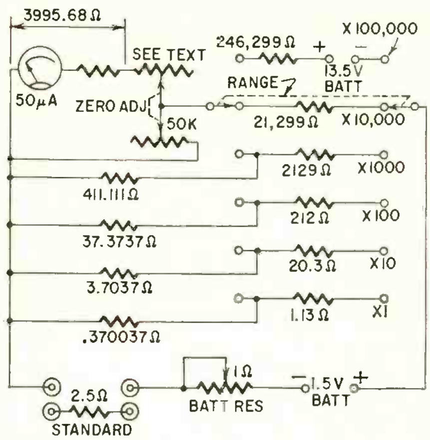


Fig. 4—Complete precision ohmmeter.

with a microammeter of known accuracy, the dry cell and the resistance. Again adjust for full-scale meter reading. Note the microammeter reading. Knowing both the full-scale voltage and current, E/I = R will tell you its internal resistance.

Since a 50-μa meter has for some years been the standard movement in vom's, we will calculate values for our precision ohmmeter around such a unit which is nominally 2,000 ohms and 100 mv. The procedure is the same for any dc meter.

We want to use a single cell for as many ranges as possible, so we find the resistance which passes 50 μa from our lowest battery voltage, 1.35. This is 27,000 ohms. But we must allow some current for the shunt so we try 25,000 ohms. It will pass 54 μa at 1.35 volts and 66 μa at 1.65. Therefore, the current through the shunt must vary between 4 and 16 μa.

Now before we find the shunt's value, we must plan to avoid overdamping the meter on low-resistance ranges. To do so we add resistance approximating that of the meter (2,000 ohms), making the effective meter resistance 4,000 ohms to drop 0.2 volt at 50 μa. The maximum resistance of the shunt control section must be 0.2/.000004, or 50,000 ohms.

Parallel-resistance calculations (R1 × R2)/(R1 + R2) give us 3,703.7 ohms as the resistance of 50,000 and 4,000 ohms in parallel. It is easier to round this value out to exactly 3,700 ohms when building the meter. Now we use a variation of the equation for parallel resistances. R is the desired value (3,700 ohms), R1 is the known value of one

(*Continued on page* 88)

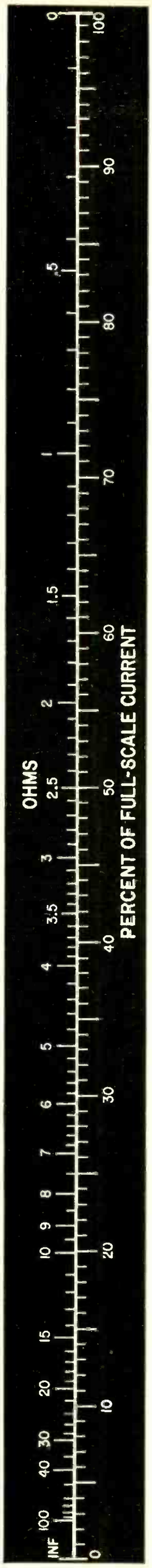
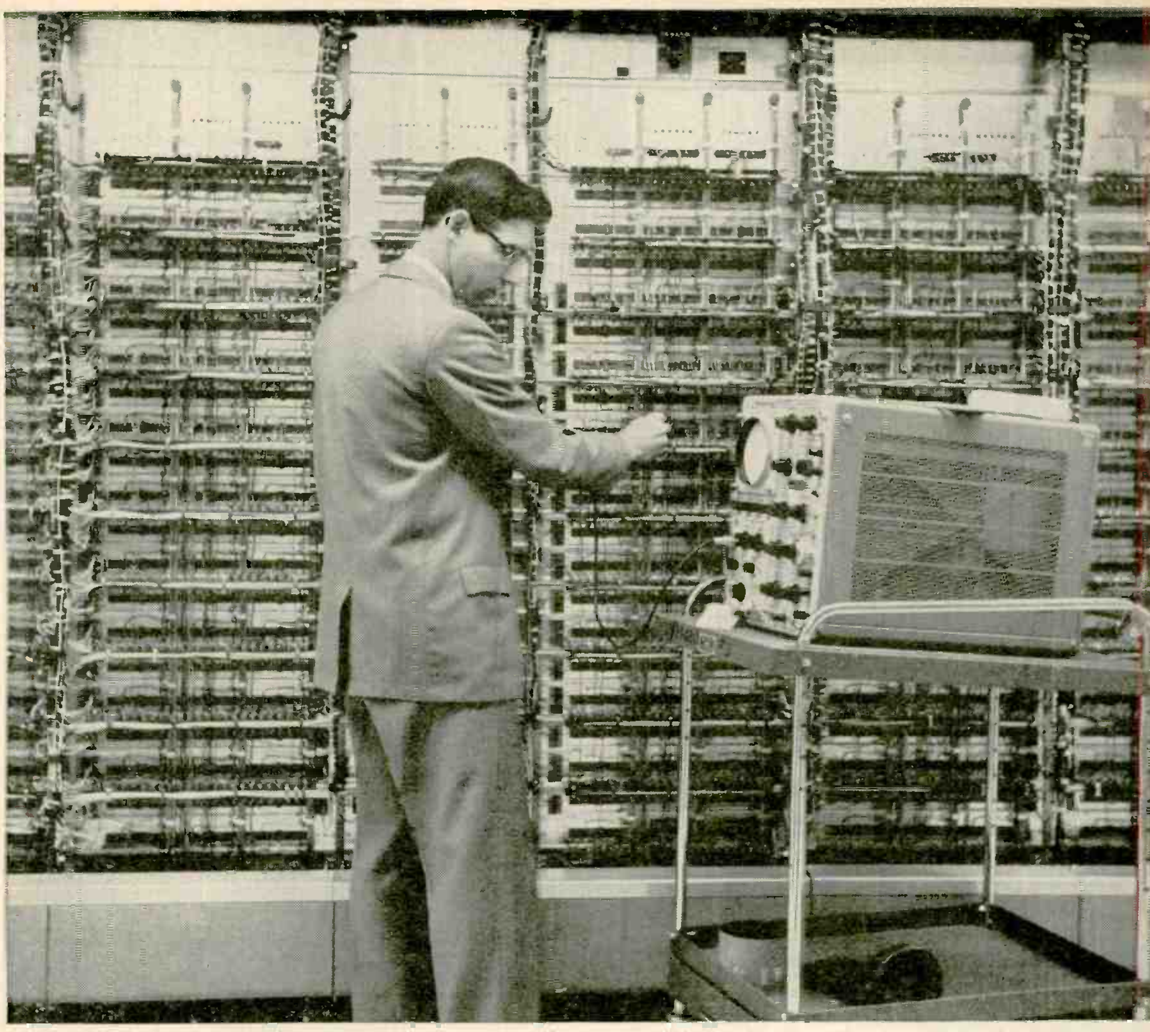
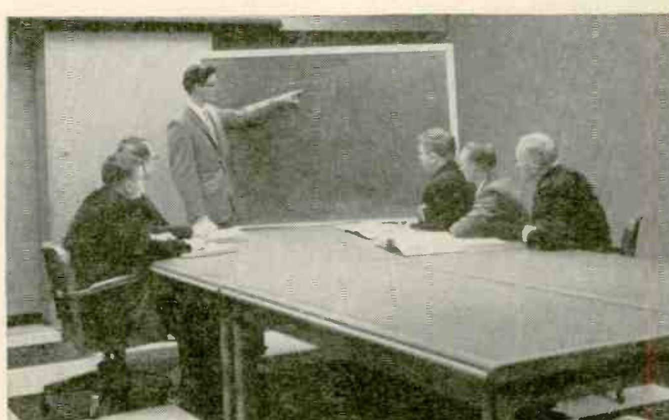


Fig. 5 — Diagram of meter scale in ohms vs percent of full-scale current.



Watching oscilloscope, Bill Wilkerson tests SAGE computer circuitry.

Adjusting SAGE computer operating console.



Bill Wilkerson instructs Field Engineers on new computer program.

TEST INSTRUMENTS

(*Continued from page* 85)

leg (50,000 ohms) and the value of the other leg is $(R1 \times R)/(R1 - R) = 3{,}995.68$ instead of 4,000 ohms for the meter leg of the parallel circuit. We adjust the meter series resistor so that it plus the resistance of the meter totals 3,995.68 ohms.

The effective meter terminal voltage at the extreme clockwise position of the dual control is 3,995.68 ohms times the meter current of 50 μa, or 0.199784 volt, corresponding to current through the parallel circuit of 0.199784/3700 = 53.9956 μa.

Now we can calculate the taper needed in the series section of the control to hold the resistance of the parallel circuit at 3,700 ohms throughout the adjustment range. At a maximum current of 66 μa, we will have a 0.2442-volt drop across 3,700 ohms. At 50 μa, the resistance of the meter leg of the circuit must be 4,884 ohms. This means that at some point in the rotation of the dual control, we will have added 4,884 ohms minus 3995.68 ohms, or 888.32 ohms. This gives us a stopping point where we have calculated the essential part of the taper.

We assume that both sections of the control are made by the same manufacturer so that both contactors engage their respective resistance elements at the same instant. We now use the resistance of the linear 50,000-ohm section at each 5% of effective rotation (50,000, 47,500, 45,000, etc.) as R1 and find the values needed in the meter leg to keep R at 3,700 ohms. When we reach 4,884 ohms as the value of the meter leg, we have determined the essential portion of the taper. It should make a curve like Fig. 3.

The constant effective meter resistance is 3,700 ohms, so R_L must be 25,000 − 3,700, or 21,300 ohms. This will be the ×10,000 range of our ohmmeter. For a ×100,000 range, we simply switch in 13.5 additional volts in series with 250,000 − 3,700, or 246.300 ohms. As the full-scale current for the ×10,000 range is 54 μa, the respective currents for ×1,000, ×100, ×10 and ×1 are 540 μa, 5.4 ma, 54 ma and 540 ma, respectively. The fixed shunt for any range is the value which passes the full-scale current minus the 54 μa of the meter circuit at the 54-μa meter-circuit terminal voltage of 3,700 ohms × 54 μa, or 0.1998 volt.

For an example, let's calculate the shunt and R_L for the ×100 range: 5.4 ma − 54 μa = 5.346 ma at 0.1998 volts = 37.37373737 ohms, as the value of the shunt. This in parallel with 3,700 ohms works out to exactly 37 ohms to make R_L 250 − 37, or 213 ohms.

All the calculated values are given in Fig. 4. For each value of R_L, 1 ohm has been deducted for the total of test lead, wiring, contact and battery resistance plus a fraction of 1 ohm set into the control marked BATT RES. After setting the ohms zero on the ×10,000

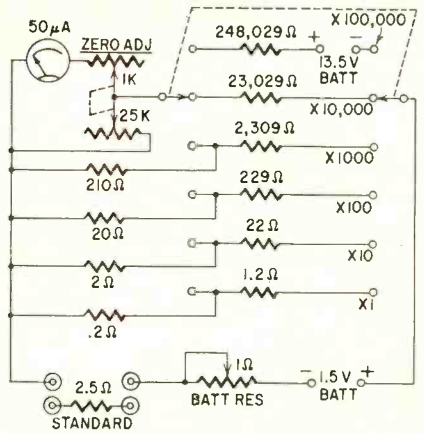


Fig. 6 — Semi-precision ohmmeter is somewhat easier to build than the unit shown in Fig. 4.

range, switch to ×1, connect test prods across the 2.5-ohm standard resistor and adjust the BATT RES control to center scale on the meter. On this ×1 range, upper-scale readings will be a little high and lower-scale readings a bit low because of the heavy current drain and the nonlinear current vs resistance characteristic of the battery. Battery resistance error can be minimized by using a larger dry cell—even a No. 6 if the ×1 range is important to you. If not, simply dispense with the ×1 range and use an ordinary size-D flashlight cell.

Resistance scales

The ohms scale is laid out mathematically since we have seen that any scale point is related to the value of R. Scale graduations should be in terms of percent of full-scale current, and for convenience we will calculate the ×10 range whose value of R is 25 ohms and will use 25 (higher than the usual voltage, but selected to simplify calculations) for the value E so that 25/25 = 1, or 100%. The current I is $25/(25 + R_X)$ so the 50-ohm point lies at 25/75 = 0.333333 times full-scale current. If the scale is laid out in % of scale arc instead, some grave errors may show up at some parts of the scale. The proper scale will be proportioned like Fig. 5, and the more points calculated and drawn into the scale, the greater the ease of reading the meter accurately.

Another circuit

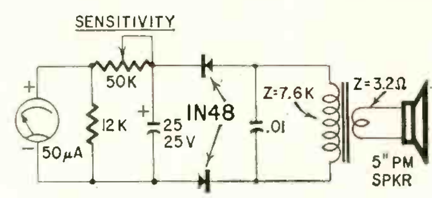
Some may be just as happy with the semi-precision ohmmeter shown in Fig. 6. Linear controls are used and are set up and connected as shown, with a resistor instead of the actual meter to avoid damaging the meter. The resistance of the parallel circuit is then measured at each 5% of rotation and each reading noted, to about 70% of rotation. Now take the difference between the highest and lowest resistance readings and also find the average between high and low. Divide the difference value by 25,000 to get approximately 1% (±0.5%). The average figure is adjusted to a round number, which is the value to be deducted from 25,000 to find the value of R_L. As shown, the circuit will overdamp the meter on low-resistance ranges. However, you can use carbon controls to get a 50,000–1,500-ohm combination to permit inserting the 2,000-ohm meter series resistor as in Fig. 4. The shunt values will have to be doubled, and effective average meter resistance calculated with the shunt in circuit to find the value of R_L. The 25,000–1,000-ohm combination shown is available as IRC part Nos. WPK-25,000 and WM-1,000. Characteristically, this "poor man's precision ohmmeter" is least accurate on the ×10,000 range (within ±1%) but 10 times as accurate on the ×100,000 range. Going to the lower-resistance ranges, the error progressively decreases and would practically vanish on the ×1 range if battery resistance fluctuations didn't appear. Battery resistance errors even on the ×1 range are still small, especially if a No. 6 is used. END

Sound-Intensity Indicator

By WM. R. SHIPPEE

THIS simple indicator can be used as an applause meter or can be calibrated to read decibels. As the circuit layout is not critical, the unit can be mounted in any type of enclosure. It requires no power source and is very easy to operate. The indicator receives all its power from sound waves moving the voice coil of the speaker in and out of the speaker magnet.

The transformer is an inexpensive audio output unit. A Stancor A-8114 or similar type is satisfactory. The speaker may be any small PM type with a 3.2- to 4-ohm voice coil. Keep leads from the speaker to the transformer as short as possible. The sound indicator's sensitivity is controlled by a 50,000-ohm carbon potentiometer. The small resistor in parallel with the meter is used as a damper. Its exact value should be determined experimentally as the internal resistance of the meter will affect it. The crystal diodes rectify the audio-frequency voltages and may be 1N48's or any similar type. The two diodes used, however, should both be the same type. The meter is a 50-μa unit picked up at a surplus dealer. If this meter were purchased new, Lafayette Radio also sells an inexpensive unit—TM-70, $7.50. END



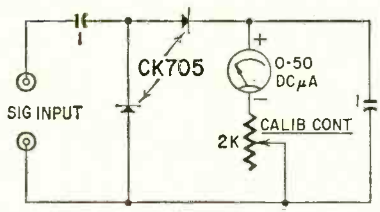
Circuit of the batteryless sound meter.

TEST INSTRUMENTS

SQUARE-LAW AUDIO MILLIVOLTMETER

By RUFUS P. TURNER

THE simple crystal meter circuit shown in the diagram gives full-scale deflection with only 100 mv rms input. The response is square-law. Input impedance is approximately 2,000 ohms at 1,000 cycles. This instrument may



Eight components, including the input jacks, are all you need to build this simple instrument.

also be used as a 0–50 ac microammeter having an insertion impedance of 2,000 ohms.

The circuit must be individually calibrated. Apply an accurately known 100-mv rms signal to the input terminals and adjust the calibration control rheostat for full-scale deflection of the microammeter. Then check the deflection for signal inputs of 90, 80, 70, 60, 50, 40, 30, 20, 10 and 5 mv.

This simple circuit holds its calibration surprisingly well. Because so few small components are required the entire circuit can be assembled in a meter box.

For rf operation, reduce the value of the two capacitors to .01 μf each. However, this will make audio response fall off. END

CORRECTIONS

In the article "2-Way Radios for Citizens Band" in the December issue the diagrams for Figs. 3 and 4 were inadvertently transposed. Our thanks to Walt Miller, of Elmont, N. Y., for bringing this to our attention.

In the December, 1959, issue the author of "Photographing TV Dx" (page 105)was incorrectly listed as George E. Simkin. The correct name is *Gordon E. Simkin* (K7JUK) well-known TV dxer and active member of the American Ionospheric Propagation Association, whose name has appeared correctly many times in our magazine. Our apologies, Gordon.

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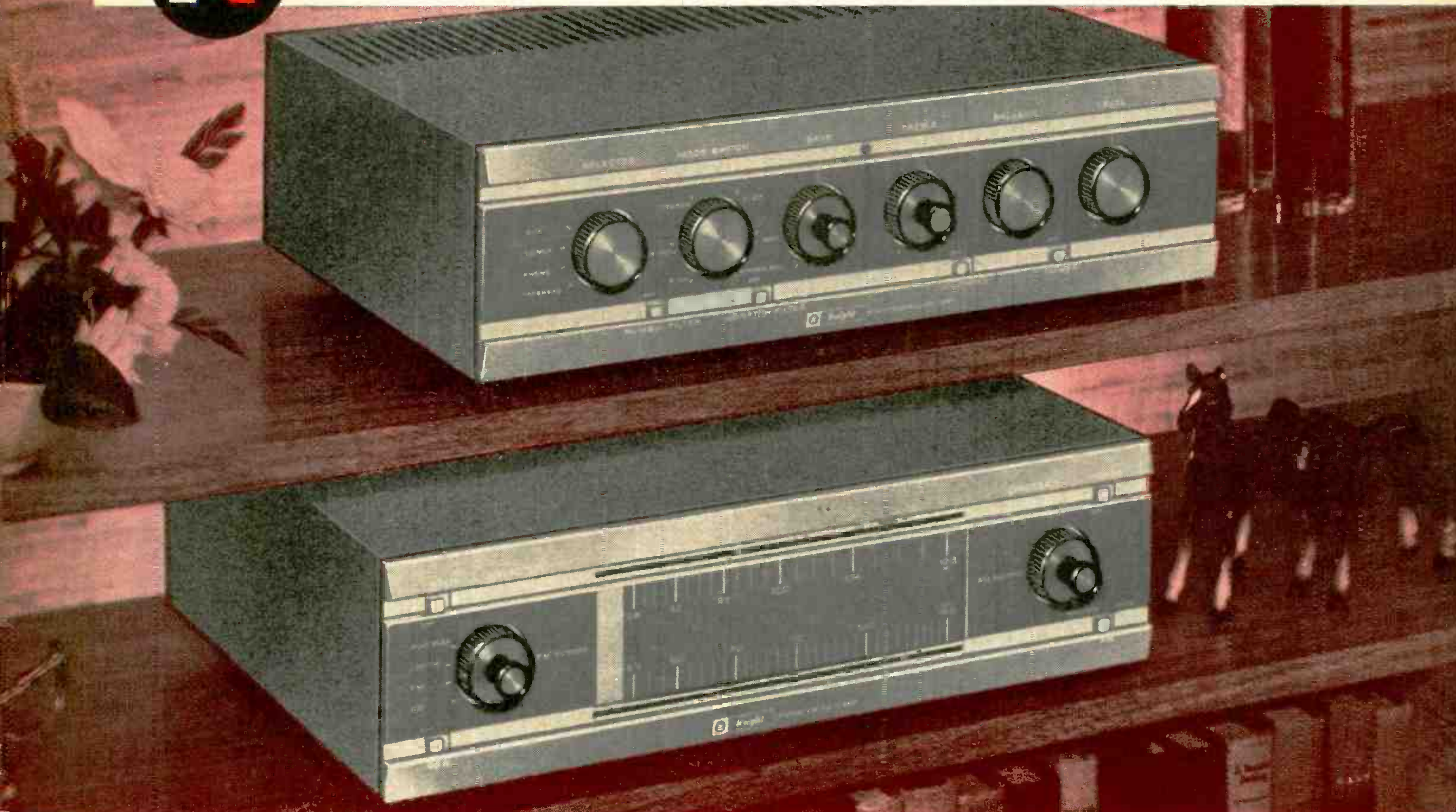

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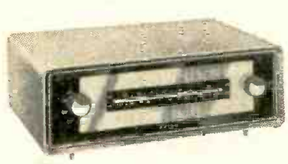

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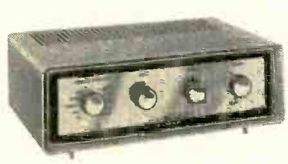

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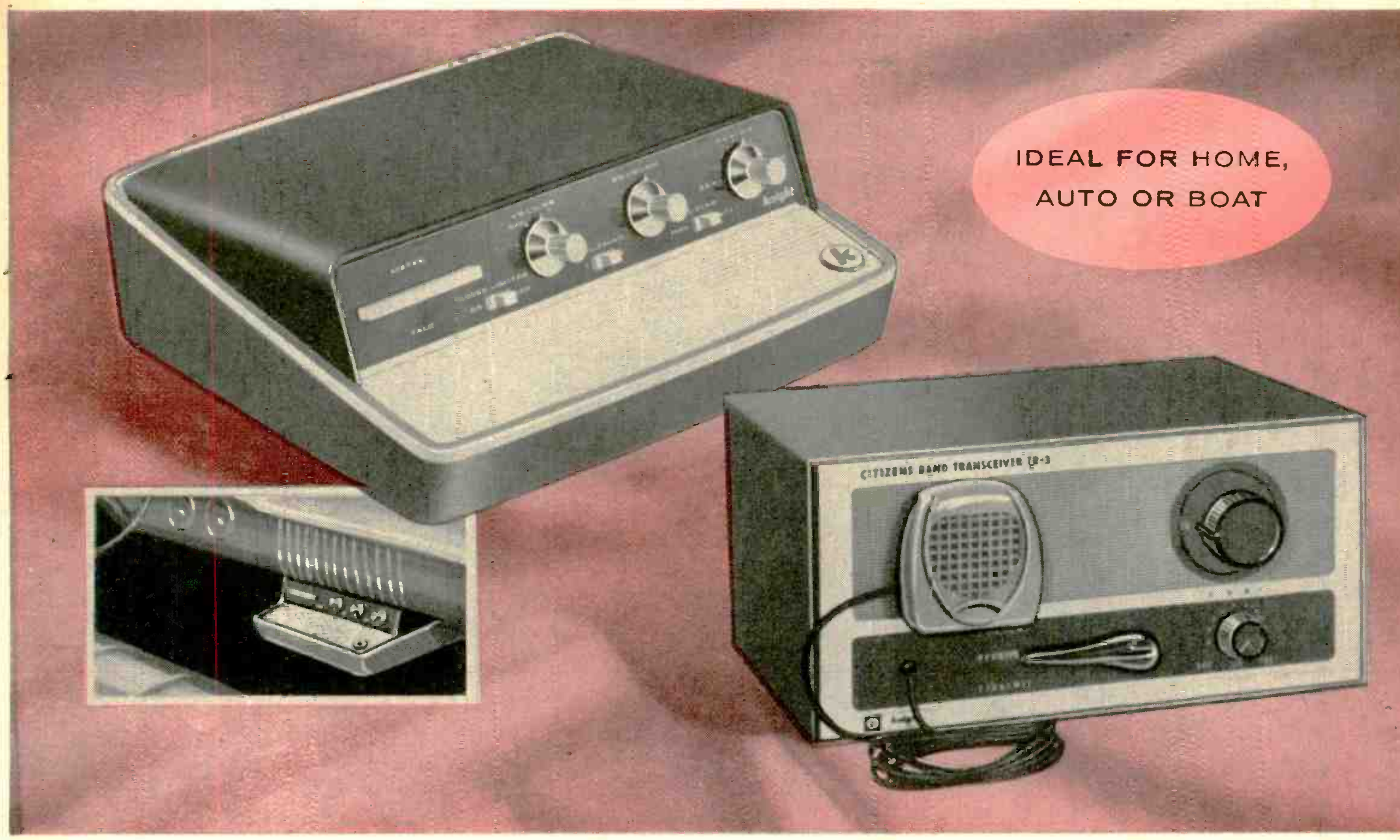

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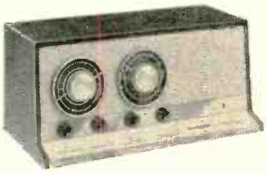

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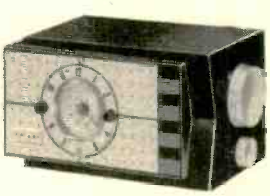

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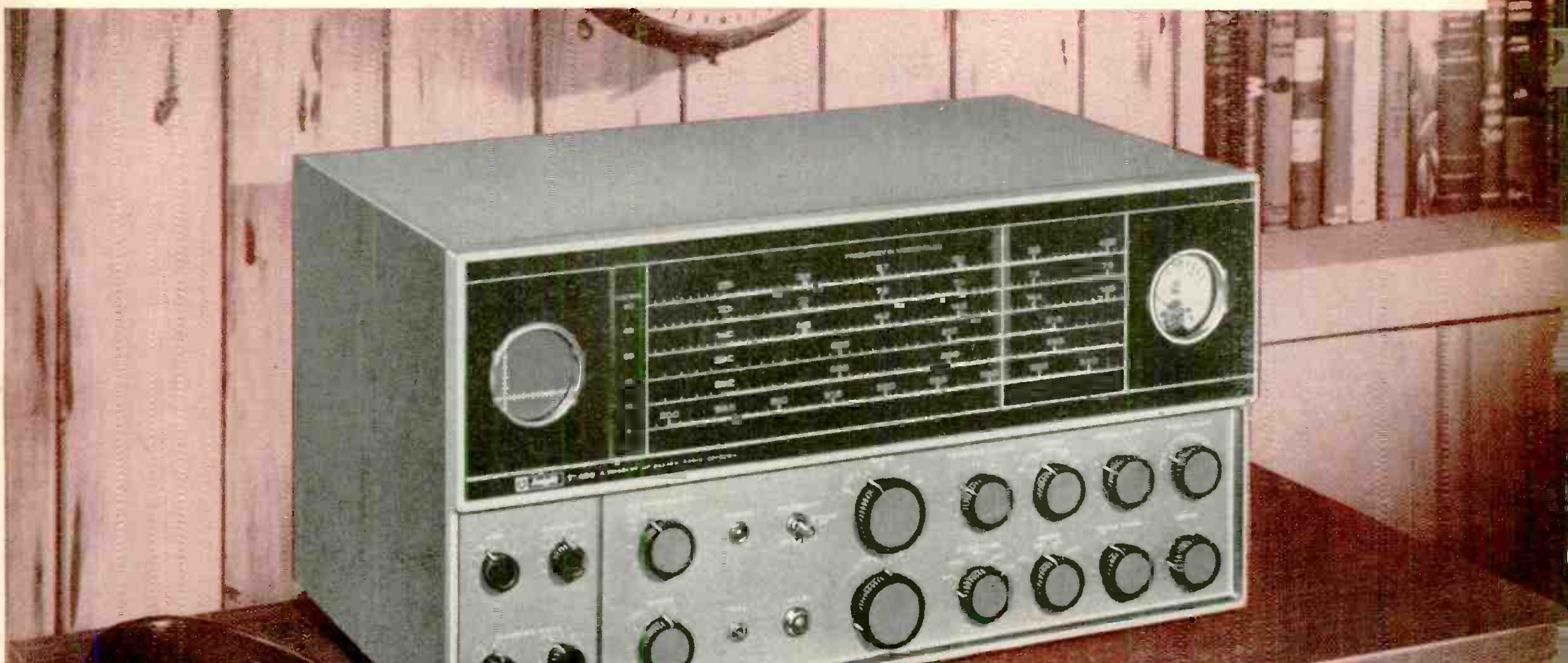

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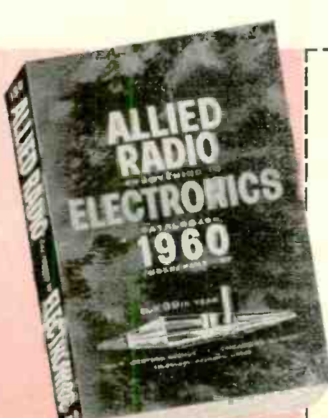

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infrared guides missiles

The hot gasses of an enemy jet or rocket powered plane become the target for infrared-guided missiles. They can even fly right up into the plane's tailpipe

By JAMES R. SPENCER*

RECENTLY, the US Air Force's F-104A Starfighter was armed with the Sidewinder, an infrared guided missile, to form a deadly aircraft-firepower combination. The 155-pound Sidewinder, a 9-foot missile that has been in use for more than 2 years, is guided to its target by infrared radiation emitted by the target. Thus the hot exhaust gases of an enemy plane become the target for this weapon. A Sidewinder, traveling at supersonic speeds, can actually zoom into the tailpipe of a jet aircraft to destroy it.

Although the actual guidance equipment aboard the Sidewinder is classified, many general questions concerning infrared and the use of infrared in homing guidance can be answered.

What is infrared?

Infrared is a form of electromagnetic radiation, similar to visible light and radio waves. It is generated by thermal agitation and radiated by everything at a temperature above absolute zero (− 273°C). High temperatures create more thermal agitation than low temperatures, so the infrared radiated by a hot object is more intense than from a cool one.

The infrared portion of the electromagnetic spectrum ranges from 400,000,000 megacycles (the high limit where infrared borders on visible light) to approximately 1,000,000 mc (the low limit where infrared approaches the higher microwave frequencies). It is easier to measure infrared in terms of wavelength than frequency, so a standard unit of wavelength for infrared has been adopted. This unit is the micron—1 micron is 1/10,000 centimeter long.

The infrared portion of the spectrum is divided into three portions (see Fig. 1)—the near infrared from 0.75 to 1.5 microns; the middle infrared from 1.5 to 10 microns, and the far infrared from 10 to 300 microns. The horizontal scale in Fig. 1 is logarithmic.

Infrared radiation can travel astronomical distances. The warmth from sunlight is infrared radiation that has traveled 93,000,000 miles. Only during the last few miles, when the radiation penetrates the earth's atmosphere, does it suffer any serious attenuation. Infrared is affected less by haze and light fog than visible light, but heavy clouds or rain can have a significant adverse effect.

At high altitudes where air-to-air combat is likely, above 30,000 feet, infrared radiation suffers little attenuation from the light, thin atmosphere.

Detecting infrared radiation

In the laboratory, thermal detectors can be used to pickup infrared radiation. They sense the heating effect caused by absorbing the radiation. However, this method can not be used for missile guidance.

Instead a photodetector forms the heart of the guidance system. In a photodetector, the absorbed photon energy either creates a voltage (photovoltaic cell) or causes a change in the conductivity of the detector (photoconductor). The photoconductive process is usually used because of the detector's small size, ruggedness and excellent infrared response characteristics. Lead sulphide photoconductors are one of the most extensively used types.

In general, photodetectors have response characteristics that limit their usefulness to the near infrared region and a small part of the middle infrared region. Fig. 2 shows the response curve of a typical lead sulphide cell as a function of wavelength. Note that the response peaks at about 1 micron and begins to cut off quite sharply at approximately 2.5 microns.

A recent development in photoconductors has extended their long-wavelength response. The new photodetectors are the indum antimonide and n- and p-type gold-doped germanium detectors. Fig. 3 shows one of them and the miniature cryostat (low-temperature thermostat) used to hold it at the normal

*Technical Editor, Philco TechRep Division *Bulletin.*

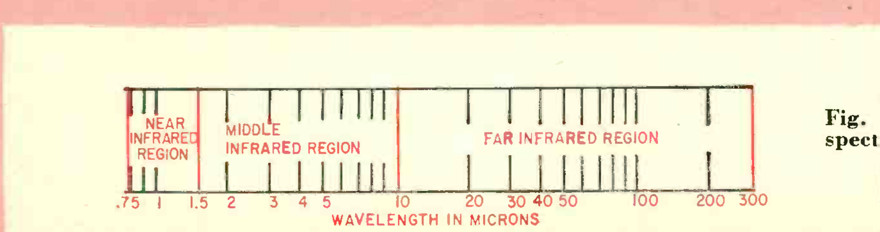

Fig. 1 — Infrared radiation spectrum showing the three infrared regions.

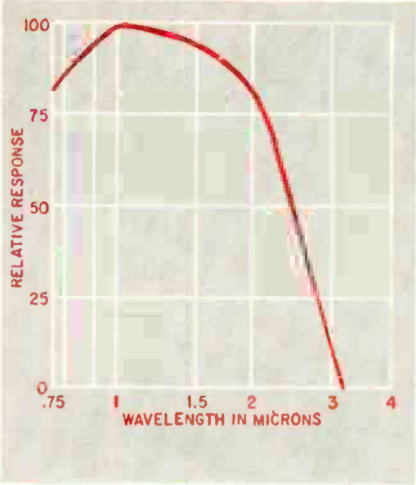

Fig. 2—Spectral response of a typical lead sulphide photocell.

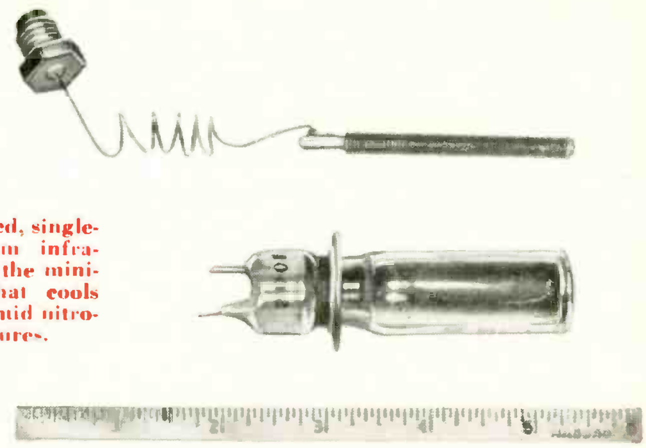

Fig. 3—Gold-doped, single-crystal germanium infrared detector with the miniature cryostat that cools the detector to liquid nitrogen temperatures.

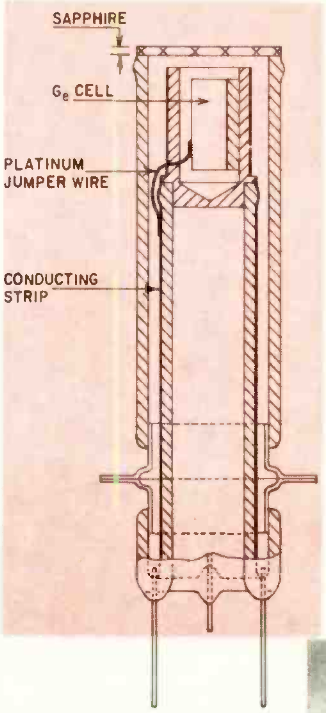

Fig. 4—Cross-section of the detector in Fig. 3.

Fig. 5—Spectral response of a gold–antimony doped germanium infrared detector.

operating temperature. Fig. 4 is a cross-section drawing of the detector's construction. The sensitive detecting elements are single crystals of indium antimonide or gold-doped germanium. Fig. 5 is the spectral response of an n-type gold–antimony-doped germanium detector. Compare this curve to the one for the typical lead sulphide cell (Fig. 2).

An optical system in the nose of the missile gathers infrared radiation emitted by the distant target and focuses this radiation upon the detector. Electrical signals from the optical system are combined with the amplified detector signal to give target direction information. These data are compared with the missile heading and the result is an error signal which is fed to a servo control system. The end result is that the heading of the missile is constantly corrected to keep it on a collision course with the target. The equipment necessary for infrared guidance is relatively simple and very compact. It is all contained within the missile—above the black band in Fig. 6.

With most guidance systems, the weakness is that the missile gets less and less accurate as it travels away from the guidance control source. But, if the source of control information is moved closer to the target, accuracy improves. For the ultimate in accuracy, the source of guidance control information should be at the target—and that's where the guiding infrared radiation originates.

Whether an infrared-guided missile can be fooled or not is classified data. But remember, both jet and rocket engines produce large quantities of heat. Removing the source of this infrared radiation from either a jet or rocket powered target also removes the target's source of propulsion. END

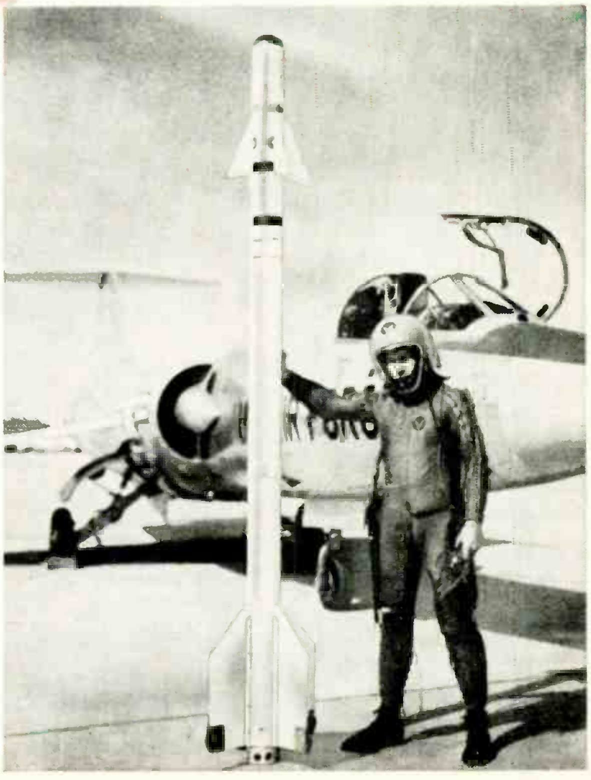

Fig. 6—The Sidewinder infrared-guided air-to-air missile. The detection equipment is all in the nose, above the black band.

ELECTRONICS

More hints from a TRANSITHUSIAST'S WORKSHOP

Nine more aids for the transistor experimenter that will save him time and cash

By MARTIN KLEIN

HAVE you ever realized that the amplifier of your six- (or more) transistor radio will also make a handy signal tracer? Just run two leads from the amplifier input (usually the volume control) to a new jack. Make a simple probe with a capacitor and a diode, and you are all set (see Fig. 1). Of course, by leaving out the diode it becomes a general-purpose loudspeaker amplifier or audio signal tracer.

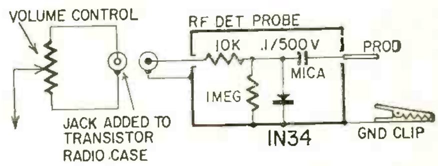

Fig. 1—Probe connected to jack added across volume control converts radio into portable signal tracer.

Mica for power transistors

Most manufacturers recommend using a thin sheet of mica to insulate a power transistor from its heat sink. You can get a good supply of these sheets by taking apart a large (0.1 μf or larger) mica capacitor. These usually consist of several dozen sheets which are coated with a metallic substance. Thin slices may be easily cut with a sharp razor blade, and the same tool will scrape off the metallic coating.

Transformer leads

The loss of a lead on a tiny transformer can sometimes be even more disastrous than a broken transistor. The leads are usually not attached very firmly and, after losing two good transformers by accidentally pulling out the leads, I devised a simple method to put an end to this. Just take the leads of the new transformer and fold them back along the sides. Next tape them down (Fig. 2). This takes the pressure off the delicate connection and almost nullifies the chance of breakage. An even better way might be to mount the transformer on a tiny terminal board with lugs, but this might waste some of the precious room in a miniature project.

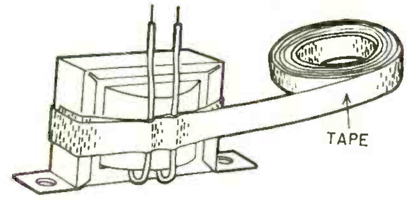

Fig. 2—Taping leads to transformer prevents pulling the leads out accidentally.

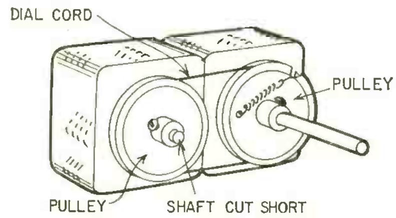

Fig. 3—Strap two miniature variable capacitors together and you have a dual unit.

Subminiaturizing

There is a simple way to subminiaturize the popular Raytheon CK722. Just slowly chip away the case of the transistor (filing is safer, but don't let friction generate too much heat) until you get to the inner metal shell. A careful job will yield a transistor almost 75% smaller, perfect for ultra-miniature work. Remember to keep track of the collector lead, since there is no red indicator dot on the inner metal case.

Regeneration controls

The builder of a transistor radio often finds that using subminiature pots as regeneration controls leaves something to be desired. Their range is crowded and it is often difficult to get that critical setting for maximum sensitivity. You will find that one of the small industrial types do a much better job. These tiny, multiturn potentiometers are ideal when you need very accurate settings.

Dual 365-$\mu\mu$f variable

Many transistor superhet circuits specify a dual 365-$\mu\mu$f variable. Unfortunately, this value has not yet come out in a dual unit of the really miniature type. You can make one out of two

(*Continued on page* 104)

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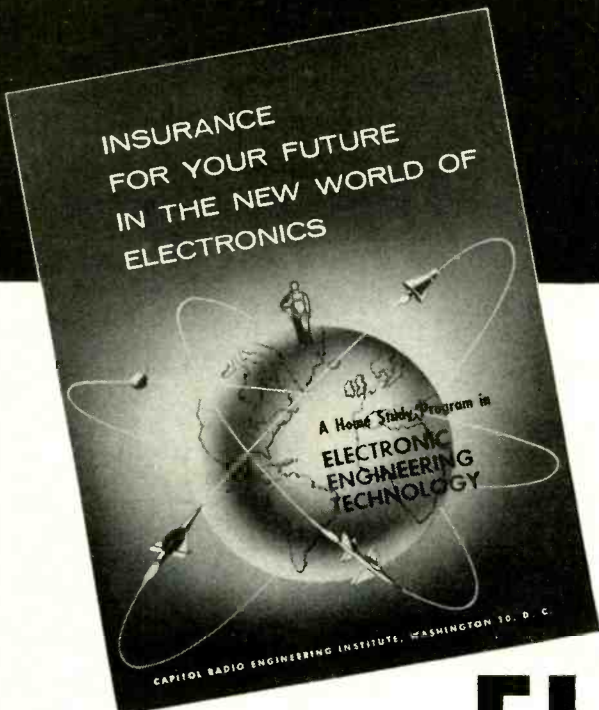

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ELECTRONICS

(*Continued from page 99*)

individual 365-$\mu\mu$f miniature units (such as Argonne AR-274). Place them side by side and glue them together. Now attach a tiny pulley to each shaft and string them together with dial cord. Make the cord tight to prevent slippage. Now cut one shaft short and put the knob on the other (Fig. 3). The one knob will control both units and you will have a very small dual 365-$\mu\mu$f variable.

Heat sinks

To get maximum efficiency from heat sinks used for power transistors, paint them dull black. Black is a much better radiator of heat, so that a small black heat sink might be much better than a larger shiny one. You can also use this principle for ordinary transistors. If a transistor is going to be near something warm, paint it with a shiny aluminum paint. If you are worried about the transistor itself heating, paint it dull black so it can easily radiate its excess heat.

Color-code transistors

After a time, the experimenters build up a supply of transistors. A handy way to identify them quickly would be to color-code them in a manner similar to the resistor color code. The first two (or three) numbers could show the transistor's beta or current gain. The next band could be gold or silver for n-p-n and p-n-p, respectively. You could use another notation for function, so you could easily spot an audio, rf or any other kind of unit. About 10 colors of 10-cent bottles of paint such as Testor's Pla (available at a hobby store) will code hundreds of transistors for rapid identification.

Holding thin wires

Sometimes it is difficult to hold very thin wires in ordinary alligator clips, since the wire slips through the teeth. The problem can be easily remedied by filing off the teeth. Now the jaws will be flush and the tiny wire will be gripped easily, putting an end to the slipping. END

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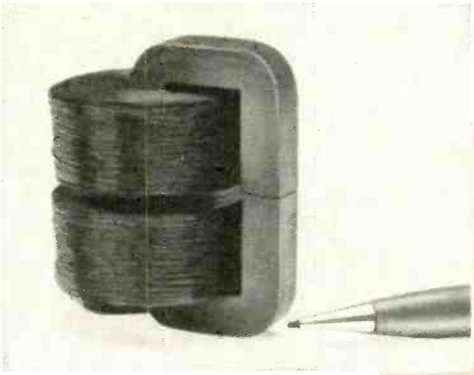
Engineering positions with the Federal Communications Commission are being added at many of the 31 field offices and 18 monitoring stations scattered throughout the country, in Washington, Alaska, Hawaii and Puerto Rico. Young engineering seniors, graduates and men with some electronics experience in general are eligible for the positions. They are all Civil Service and carry starting salaries from $4,490 to $5,880 and up, depending on experience and education.

For more information, write to the Federal Communications Commission, Washington 25, D. C.

The Hall-effect device, a known possibility since 1879, is now a reality



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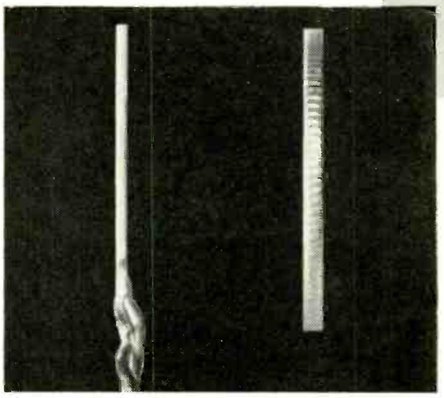


By R. WAYNE CRAWFORD and NEAL P. MILLIGAN*

IN 1879, E. H. Hall, a physicist at Harvard University, discovered an effect which has become known as the Hall effect and today is the basis for a new series of semiconductor devices. Hall determined that, when a conductor through which current is flowing is placed in a magnetic field perpendicular to the conductor, a voltage is developed across it.

For a clearer picture of this action, take a look at Fig. 1. When there is no magnetic field, the electrons flow through the conducting slab in a straight line (labeled control current) and there is no voltage difference across the slab. If a magnetic field is applied, the electrons are deflected toward the side as shown, leaving a surplus of positive charges on the opposite side of the slab. This creates a voltage difference across the slab, known as the Hall voltage. This voltage is proportional to the product of the current passing through the conductor and the magnetic flux density (magnetic lines per unit area). The magnitude of the Hall voltage for a given current and magnetic field depends on the ease with which electrons can move through the material, so the ease of movement becomes a figure of merit for the material and is called "charge-carrier mobility." The higher the charge-carrier mobility, the higher the Hall voltage for a given magnetic field and control current.

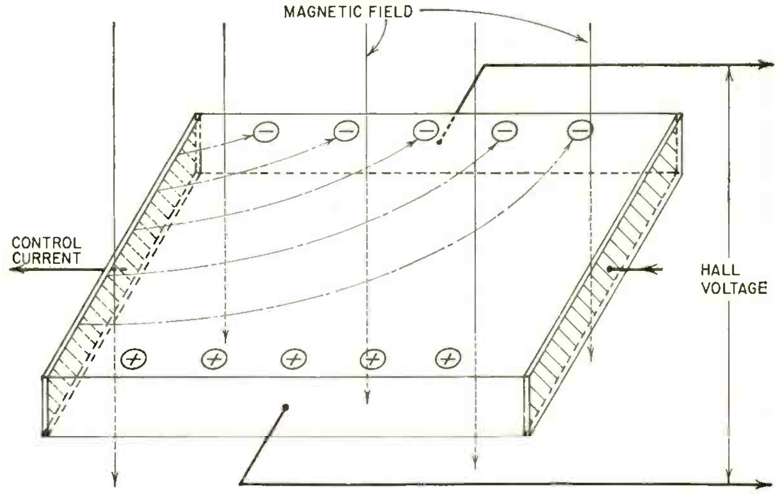


Fig. 1—Basic action of a Hall-effect device. The electrons supplied by the control circuit are deflected by the magnetic field to one side of the conducting slab. This leaves an excess of positive charges on the opposite side, thereby causing a voltage known as the Hall voltage, across the slab.

Until recently, no known material had a charge-carrier mobility high enough to allow Hall voltages great enough to be of practical use. But the development of intermetallic compounds —indium arsenide and indium antimonide—has made Hall-effect devices practical. Such Hall-effect devices are now commercially available.

For most applications, a magnetic circuit produces the magnetic field needed to operate the Hall-effect device. A sketch of such a circuit is shown in Fig. 2. The input currents passing through the coils create a magnetic field. As many coils as the physical configuration of the core will allow can be used. The top head photo shows a typical magnetic circuit using two

*Technical consultant, and manager of Applications Div., respectively, Ohio Semiconductors.

center-tapped coils. The total magnetic field is equal to the sum of the magnetic fields generated by each coil. To reduce the number of coil turns needed to produce a given magnetic field, the gap in the core is made very small. The gap can be made small since the Hall-effect device is very thin, as shown in the bottom head photo.

The Hall-effect device is truly a low-level device in all respects. The maximum control current, when operated in free air, is approximately 500 ma.

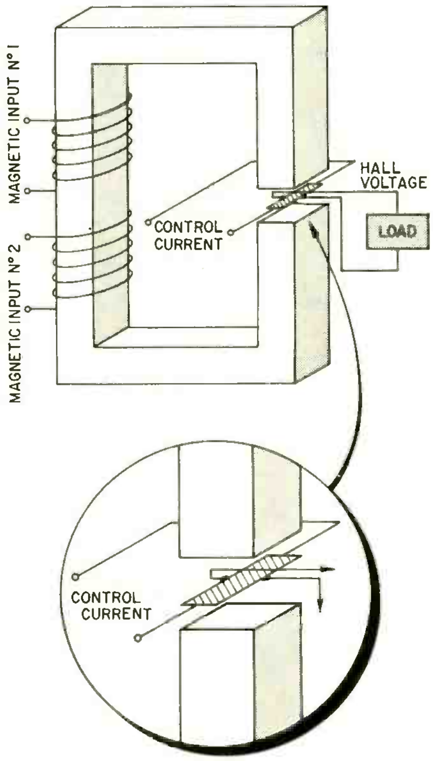


Fig. 2—Typical 2-coil magnetic circuit. The iron core concentrates the magnetic field on the Hall-effect device.

The output Hall voltage is in the order of hundreds of millivolts. The input and output impedances are on the order of 1 ohm. To obtain such low-level impedances with vacuum tubes or transistors requires complex circuits. The Hall-effect device is filling a real need in the electronics field by providing a low-impedance circuit element. It also has the property of being able to function equally well with either dc or ac inputs.

A typical Hall-effect device multiplying circuit is shown in Fig. 3. The magnetic field generated by the coil is proportional to the current flowing in the coil. The output voltage is, therefore, proportional to the product of the magnetic circuit current and the control current. If more than one coil is used in the magnetic circuit and if the control current is held constant, the output voltage is proportional to the sum or difference (depending upon their relative polarity) of the input currents. By appropriate switching, a single Hall-effect device and magnetic circuit can perform all of these functions.

The Hall-effect devices described here are new, even though the principle has been known many years. They have been manufactured in the United States less than a year. As were the first transistors, Hall-effect devices are relatively expensive today—about $25 each

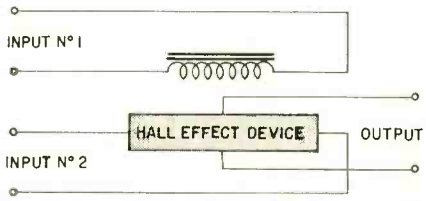


Fig. 3—An electronic multiplier circuit. The output voltage is proportional to the product of the two inputs.

in lots of one. However, it is reasonable to assume that as with transistors, their cost will drop in a short time.

The potential applications of these devices are almost limitless. They may be used in computer circuits to add, subtract and multiply. With an amplifier, they have been used to measure the earth's magnetic field. They are being used in both ac and dc power meters. They may be used to match a high impedance to a low impedance and provide isolation at the same time. These devices and the associated magnetic circuit may be considered as a dc transformer, since they provide transformer action even with direct currents.

These new semiconductor devices present an entirely new concept in the field of circuitry and will play an important role in the design of new electronic equipment. END

50 Years Ago

In Gernsback Publications

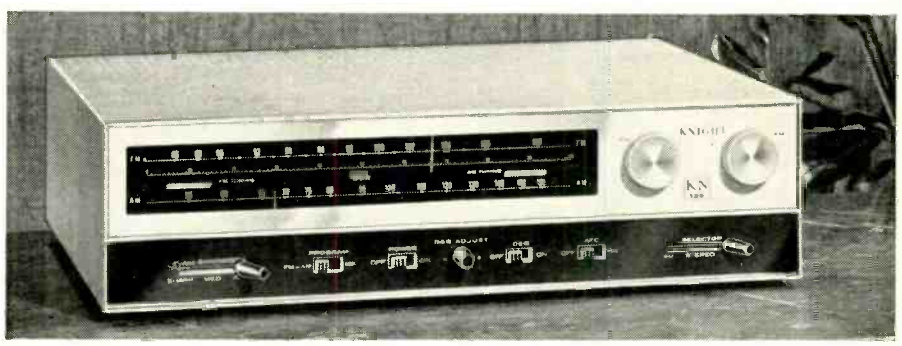
HUGO GERNSBACK, *Founder*

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

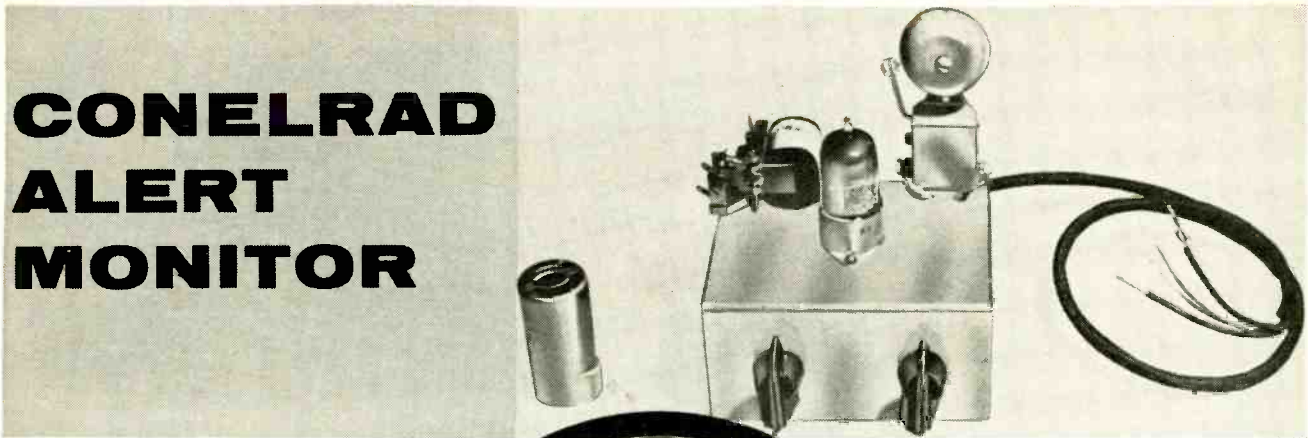
Some larger libraries still have copies of Modern Electrics on file for interested readers.

In January, 1910, *Modern Electrics*

Dr. Korn's Apparatus, by A. C. Marlowe.
A Muffled Spark Gap, by H. W. Secor.
New Tuning Arrangement.
Metropolitan Tower Radiophone.
Construction of a Hot Wire Ammeter.
Construction of a Sending Condenser, by Frederick Re Qua.
How to Make An Improved Silicon Detector, by Charles W. Gale.
How to Make A Universal Detector, by E. R. Willard.
New (French) Loud Speaking Telephone.



CONELRAD ALERT MONITOR



(Above) Completed alarm unit. This model did not have a pilot-light indicator.

(Left) One method of attaching unit to a broadcast receiver.

Automatic alarm circuit warns of a Conelrad alert

By HAROLD REED

IN the interest of civilian defense, the Conelrad plan was put into operation. Conelrad is a contraction of *con*trol of *el*ectromagnetic *rad*iation. Conelrad's purpose is to prevent enemy aircraft pilots from using the radiation of any AM, FM, TV or amateur US broadcasting station as a navigational guide and riding in on its beam to desired targets.

Certain AM stations in each area have been designated key stations. Any Air Defense Control Center can initiate a Conelrad radio alert by notifying these basic-key, relay-key and skywave-key stations by private wire or toll telephone. The key stations immediately start the following procedure:

1. Cut the program being broadcast.
2. Cut the carrier for 5 seconds.
3. Restore the carrier for 5 seconds.
4. Cut the carrier for 5 seconds.
5. Restore the carrier again.
6. Radiate a 1,000-cycle tone for 15 seconds.
7. Broadcast the Conelrad radio alert message: "We interrupt our normal program to cooperate in security and civil defense measures as requested by the United States Government. This is a Conelrad radio alert. Normal broadcasting will now be discontinued for an indefinite period. Civil defense information will be broadcast in most areas at 640 or 1240 on your regular radio receiver."
8. Remove the carrier (at the normally assigned frequency) from the air for the duration of the alert.

Authorized AM stations then operate in a sequential manner on 640 and 1240 kc, broadcasting civil defense information without aiding enemy aircraft. All other AM, FM and TV stations are required to follow steps 1–8 and leave the air for the duration of the alert.

The Conelrad plan is incorporated into FCC rules and regulations. Under these rules it is mandatory for all stations to install and maintain equipment to receive notice of radio alerts and radio all-clears. Automatic devices or a human listening watch may be used. Stations must also monitor a key station before going on the air to insure that a radio alert is not in progress.

It is disconcerting to monitor a program being radiated from any particular transmitter and the signal of another station simultaneously. Distraction from the program which a transmitter technician is radiating also results under these conditions. A number of automatic alarm circuits have been devised, some complex and costly. However, simple and inexpensive circuits can be used satisfactorily.

Simple alarm circuit

Inexpensive receivers are usually satisfactory for monitoring a key station and actuating an alarm device. Of course, if the nearest key station is a considerable distance from the monitoring point and the signal received is weak and subject to fading, a more sensitive and selective type of receiver is required.

In the circuit of Fig. 1, a negative voltage from the receiver's avc is fed to the grids of the 12AT7. The potentiometer is adjusted so that current flow through the tube is not enough to trigger the plate-circuit relay. Under these conditions the relay contacts complete the 6-volt ac circuit to the pilot light, indicating that the device is in operating condition. The receiver's volume is reduced so the program from the monitored station is not audible. If the carrier of the monitored station is interrupted, the avc voltage drops to zero and the negative voltage on the control tube's grid is removed. Increased current flows through the 12AT7, actuating the relay. The pilot light

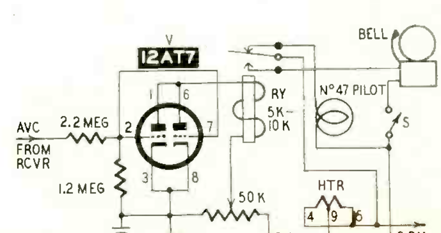
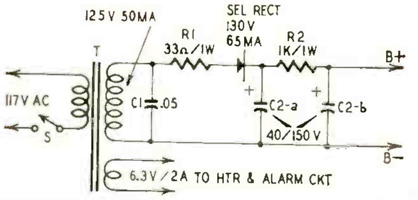


Fig. 1—Basic alarm circuit.

goes out and the 6-volt ac supply circuit to the bell or buzzer alarm is completed. The receiver's volume is then adjusted so the monitored key station can be heard. The switch is opened to turn off the alarm. This circuit has given satisfactory service. It features simplicity and a minimum of parts.



R1—33 ohms, 1 watt
R2—1,000 ohms, 1 watt
C1—.05 μf, 600 volts
C2—40-40 μf, 150 volts, electrolytic
RECT—selenium, 130 volts, 65 ma
S—spst toggle, can use receiver power switch
T—Power transformer: primary, 117 volts; secondary, 125 volts, 50 ma; 6.3 volts, 2 amps (Stancor PS-8421 or equivalent)

Fig. 2—Power supply for the monitor.

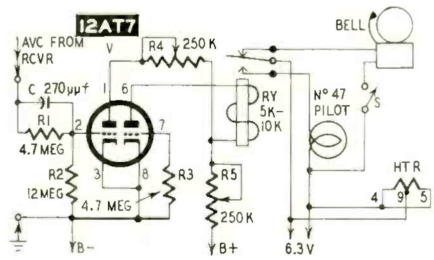
Originally, supply voltage for the control tube was taken from the receiver. However, should the receiver fail due to a bad tube or other component, the control tube could not operate to give the alarm. Receiver failure would be unknown until the next routine check. To overcome this undesirable condition, a simple selenium-rectifier supply (see Fig. 2) was provided. The 6-volt heater transformer for this tube can also operate the alarm device.

The monitor should only be used with ac receivers, or lethal potentialities may develop. If it becomes necessary to use it with an ac-dc set, the monitor's ground circuit must be isolated from its chassis and the monitor kept on a shelf in some hard-to-reach place. With an ac-dc receiver one side of the line would be connected to the monitor's ground circuit. As this is a fixed installation, the lines can be permanently wired or polarized plugs used.

Control-circuit failure

Although the problem of receiver failure is overcome, there still is the disadvantage of having no indication of failure in the control circuit or control tube itself. An arrangement that will sound the alarm, not only when the carrier of the monitored station is interrupted, but when any interruption or failure occurs in the receiver or control circuit, is shown in Fig. 3. The mechanical spring action of the relay sets off the alarm if any part fails. Avc voltage from the receiver is supplied to the grid of the first section of the 12AT7 twin triode, causing its plate current to drop. This results in an increased current flow through the second section of the tube due to the common load (R5) in the plate circuit. The relay closes, lighting the pilot lamp. Station carrier interruption or circuit failure in the receiver or control-tube circuits removes the negative voltage to the first grid, current flow in the second section of the tube decreases and the relay opens, completing the alarm circuit.

The circuit's control settings vary with each installation, depending on the carrier strength of the desired signal, the receiver avc voltage and the sensitivity and adjustments of the relay. With a table model receiver, we found that an 8,000-ohm relay would close with 2.5 volts of avc, which resulted in a plate current of 3 ma. With 8 volts of avc, the plate current increased to 5 ma. This was for reception of local stations and using the built-in loop antenna. In some locations an outside antenna may be necessary to provide sufficient signal strength for the receiver input. Other tubes, of course, can be used. 12AX7 and 12AU7 types worked satisfactorily. The 12AT7 gave the best results, closing the relay with less avc voltage. Also, it is a simple matter, by using a relay with additional contacts or another relay for 6-volt operation, to make and break one lead of the receiver's speaker automatically. Of course, this can be done manually with a small toggle switch.



R1, 3—4.7 megohms, ½ watt
R2—12 megohms, ½ watt
R4, 5—pot, 250,000 ohms, 2 watts
C—270 μμf
RY—plate relay, 5,000–10,000-ohm coil
S—spst toggle
V—12AT7
Pilot lamp, 6 volts (1)
Bell or buzzer, 6 volts (1)
Socket, 9-pin miniature, shielded (1)

Fig. 3—Conelrad alert monitor. Failure of alarm circuit or receiver sets off warning bell.

After the alarm is sounded, it is necessary to turn the speaker on to receive the Conelrad message. There is usually more than one key station in any area, so if the alarm should go off due to carrier interruption but the specified Conelrad procedure is not observed, it could be transmitter equipment failure and another station should be tuned in. During an alert, the speaker should be kept on to receive the all-clear message from the key station. This message is preceded by 1,000-cycle tone beeps for 15 seconds, followed by the civilian defense announcement: "Conelrad radio all-clear. Resume normal operation." The receiver could also be tuned to 640 or 1240 kc to receive civil defense information during the alert as well as the radio all-clear message.

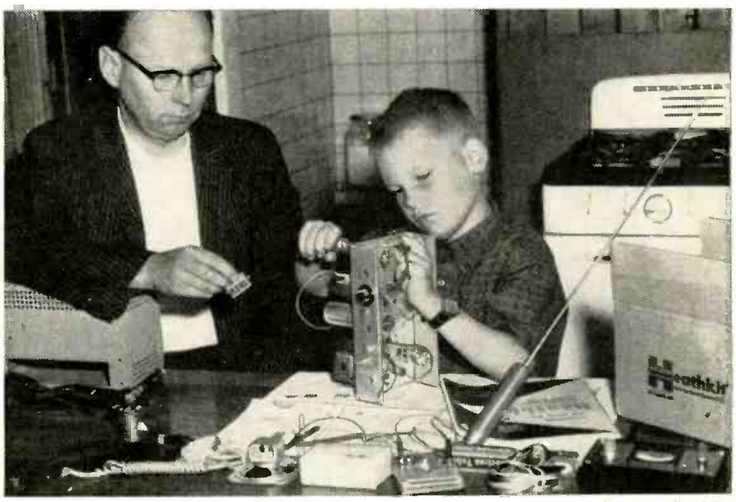
Citizens radio operators and amateurs should include this equipment. It is a simple and effective way of complying with the law that will not put them to any great expense. They will have no difficulty in making these circuits work. END

COVER FEATURE

Building Your Own CITIZENS RADIO

By assembling a Citizens-band transceiver kit you can learn a lot about Citizens radio circuits and how to repair them

By LEO G. SANDS



Jacques Saphier

Eight-year-old Lee did the mechanical assembly and his dad the wiring. The kitchen table came in handy as a workbench.

THE easiest way to become familiar with any new device—hi-fi, telescope, oscilloscope or Citizens radio—is to build one. Those who plan to service Citizens radios, in particular, should build one because there is no quicker or surer way to learn how they work and how to tune and repair them.

You could design your own Citizens radio, but that would be doing it the hard way. The easy way is to buy a kit—there are several on the market. The price runs from under \$30 to around \$100.

The kits are simple—it doesn't require previous electronics experience to build one. My eldest son, Lee, 8 years old, helped me construct mine. He is interested in Citizens radio because he has seen and heard me using it. I, as an old-timer in both mobile and amateur radio, am interested in getting even more intimately familiar with the circuits I write about. Besides, I can use Citizens radio in my business.

We picked the Heath CB-1 kit because it has a tunable receiver which will let us listen in on all 23 channels in the band. By being able to tune in all channels, we can learn a great deal about what use others are making of this new communications expressway. For the nontechnical man who wants to communicate for business purposes only, a Citizens radio with a fixed-tuned receiver would be more suitable. All he has to do to use it is turn it on and operate a push-to-talk button. The experimenter, service technician and engineer who are not confused by a tuning dial, may prefer the tunable receiver.

After we unpacked the first of the two kits, the task of installing the parts on the chassis was given to Lee. The pictorial instructions were so easy to understand that he made only one error—one tube socket was installed 180° around from the way it should have been. I did the wiring, since Lee isn't yet handy with a soldering iron. Since I wire from a schematic because of years of experience doing so, I disregarded the wonderfully explicit wiring diagrams in the kit instruction book. (Don't try it!—*Editor*)

We wired first the receiver, audio amplifier and power supply sections and then paused to test the receiver. Before inserting the power plug into the outlet, we took the precaution of measuring resistance between B-plus and the chassis so we wouldn't blow the silicon rectifiers right off. Then we checked the resistance across the power-plug prongs with the on–off switch turned on. The resistance seemed reasonable so we plugged the set in.

The receiver worked immediately. Even before we connected an antenna, we picked up signals from nearby Citizens radio stations. This set is "hot," being rated as useful on a signal as small as 1 μv at the antenna terminals. Before going further, let's take a close look at the circuitry involved so far (Fig. 1).

Receiver and power supply

The power supply uses two silicon diodes in a voltage-doubler circuit, and resistors and large capacitors for filtering.

The receiver section is simple. It uses a single 6AN8 whose pentode section is used as a broadly tuned rf amplifier and whose triode section is a superregenerative detector. The rf amplifier has two functions. It is a one-way street which amplifies signals picked up by the antenna and feeds them to the detector. At the same time it blocks the passage toward the antenna of rf energy generated in the detector.

Most of the receiver's gain is obtained in the detector stage. The superregenerative detector, using only a single tube, provides sensitivity almost as great as that of a multi-tube superhet. It has not been used in commercial receivers for more than three decades, except in rare instances, becauses of the danger of radiating harmful radio interference, and its inherent background noise when no signal is being received. It will demodulate both FM and AM. Because of their great sensitivity, hams have made wide use of superregenerative receivers, mainly in the 2- and 6-meter bands. They work well in the 11-meter band too, which is the 27-mc class-D Citizens band.

While not as selective as a well-designed superhet, the superregenerative receiver has many things in its favor. Self-limiting, it provides almost the same audio output on weak signals as on strong ones, eliminating the need for avc. This limiting action also makes it more immune to impulse type noise

(*Continued on page* 116)

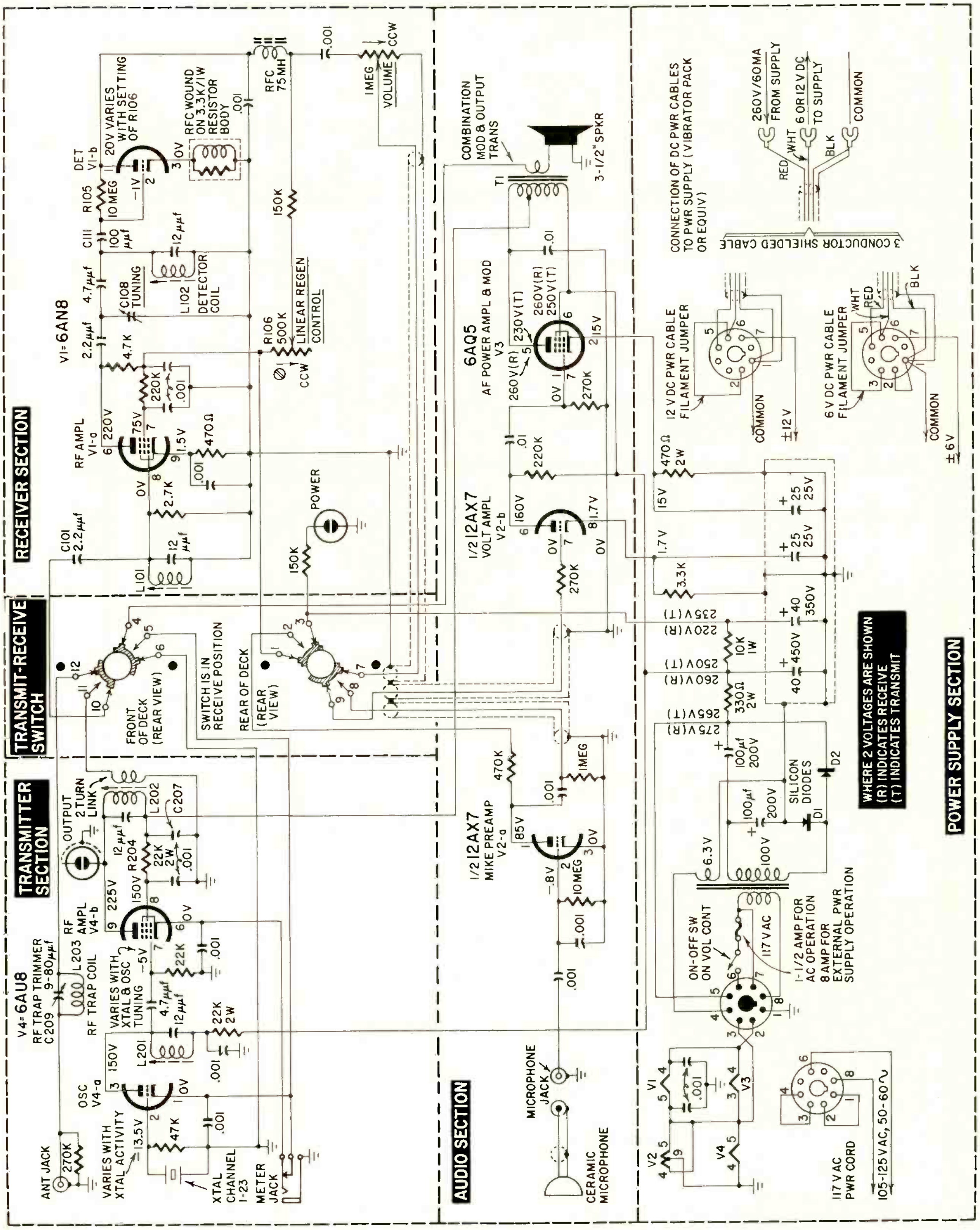


Fig. 1—Circuit of the Heathkit model CB-1 Citizens-band transceiver.

RADIO

(*Continued from page* 110)

than conventional receivers. (In FM sets, the limiters provide the noise-eliminating action.) Therefore, a noise limiter is not required.

Self-quenching detector

As can be seen in Fig. 1, the detector circuit would be an ordinary regenerative detector if it were not for the fact that the grid leak (R105) returns the grid to B-plus instead of ground, and also because of R105's high resistance.

In the Heath CB-1, the detector (a superregenerative type), is quenched at a rate of about 20 kc. The rate varies to some extent with the strength of the incoming signal as well as with the setting of R106, which adjusts detector plate voltage. Because of the complex waveforms generated by the combined effects of regeneration and quenching, a background hiss is heard in the speaker. When a signal is intercepted, the background noise is quieted, disappearing completely on a strong signal.

Testing the receiver

The audio amplifier consists of two stages. One section of a 12AX7, used as a voltage amplifier, feeds a 6AQ5 power amplifier. When transmitting, the other section of the 12AX7, functioning as a microphone preamplifier, is switched in ahead of V2-b.

When testing the receiver, we temporarily connected the inner conductor of the coaxial cable, leading to an antenna, to C101 and the cable shield to the chassis. The regeneration control (R106) was advanced just beyond the point where the background hiss started. After tuning in a weak signal, we adjusted L101's core until the background noise was at a minimum. The tuning dial calibration was set by turning the tuning dial to channel 23 and adjusting L102's core until we could hear tones being transmitted by class-C (radio-control) stations operating on 27.255 mc. (This channel is shared by class-C and -D as well as industrial, land-transportation and public-safety radio stations.)

Transmitter circuitry

When the wiring of the transmitter section and the transmit–receive switching circuits was completed, we were ready to check out the transmitter.

Hams will recognize the circuit as extremely simple. There are only two stages, exclusive of the modulator. A single 6AU8 is used—the triode section as a crystal-controlled oscillator, the pentode section as an rf power amplifier. Frequency is determined mainly by the crystal and, to a small extent, by the capacitance of the crystal holder tube socket, and the capacitance and inductance of the wiring on the grid side of V4-a. The tuning of L201 and L202, when correct, should not affect transmitting frequency.

Modulator system

Both the plate and screen of the rf

power amplifier are amplitude-modulated. The supply voltage to both is fed through T1's primary, which functions as the modulation reactor of a Heising modulator when transmitting. The plate voltage to the rf power amplifier must pass through the primary of T1 which acts as the modulation reactor, which is the modulator tube's plate load. When the modulator tube grid is swung positive and negative by an audio signal, the current through T1's primary increases as the modulator tube plate current rises and vice versa. The audio voltage developed across T1, therefore, alternately reverses in polarity. This voltage, which is in series with the rf amplifier plate voltage, varies the transmitter's rf output. At one instant, this voltage is in series-aiding with the supply voltage, increasing the transmitter output. At another instant, it is in series-opposing with the supply voltage, reducing the transmitter power output.

If the modulating voltage is so large when it is opposing the supply voltage that the rf amplifier plate actually goes negative, overmodulation is taking place. This should never be allowed to happen because the radiated signal can cause harmful interference. Overmodulation is prevented in the CB-1 by tapping T1's primary (Fig. 1). The tapped reactor is actually an autotransformer. The plate and screen voltage for the rf power amplifier is obtained at the tap where the modulating voltage will be less than the voltage developed across the entire winding of the modulator plate load. Overmodulation cannot occur because the modulator system tubes will start to limit (overload) when the audio signal voltage (from the microphone) gets too high. At the reactor, the audio voltage can't get high enough to cause overmodulation.

Switching circuits

A front-panel wafer switch is used for transferring the circuits from receive to transmit (Fig. 2). When switched from receive to transmit, it:

- Transfers the antenna from receiver to transmitter.
- Disconnects the speaker voice coil from the output transformer's secondary, converting the transformer into a modulation reactor.
- Grounds the cathodes of the oscillator and rf power amplifier tubes to activate the transmitter.
- Disconnects the plate voltage from the receiver section and applies plate voltage to the microphone preamplifier tube.
- Disconnects the receiver output from the audio amplifier and connects the output of microphone preamp to the input of the audio amplifier.

Transmitter tuning

Since the transmitter should be tuned initially when terminated in a dummy load, we connected a No. 47 pilot light to the antenna connector (Fig. 3). We also connected a vom (set to measure

50 ma dc full scale) through a phone plug to the test jack at the back of the chassis, to monitor rf power amplifier cathode current. As specified in the instruction book, we disabled the antenna filter (C209–L203) by adjusting C209 for less capacitance. Then we set the TRANSMIT–RECEIVE control to TRANSMIT and adjusted L201's slug until the dummy-load lamp glowed most brightly. Backing off (counterclockwise) on the slug, we alternately switched the transmitter on and off until we got to a point where the lamp went on each time without fail. Then we backed off the slug adjustment a quarter-turn more to obtain oscillator stability. The slug of L202 was then peaked for maximum dummy-load lamp brilliance.

Watching the vom, we noted that the cathode current varied as transmitter tuning adjustments were made. This is as it should be. When L202 is tuned to resonate at the operating frequency, the cathode current drops slightly.

Power measurement

The main reason for providing a cathode-current test jack is for measur-

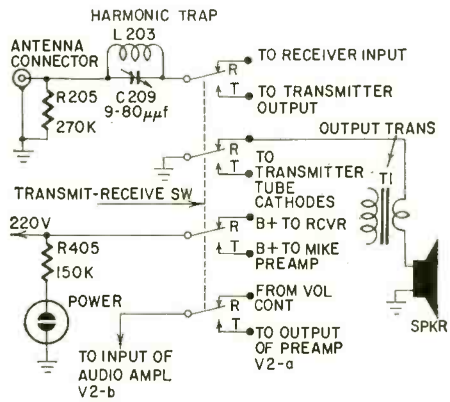


Fig. 2 — Transmit–receive switching circuits of the CB-1.

ing power input to the rf power amplifier. It must not exceed 5 watts, the legal limit. Our meter indicated 21 ma. Using the vom as a dc voltmeter, we measured the plate voltage at the junction of C207 and R204 and found it to be 235. The power input in watts, found by multiplying 235 volts by .021 ampere, was 4.935 watts.

But we had more than .065 watt of margin, because cathode current includes screen as well as plate current. So we measured the voltage across R204, the screen dropping resistor; it was 80. The screen current—determined by dividing 22,000 ohms, the value of R204, into 80 volts—was 3.6 ma. Since the screen voltage, as measured between terminal 8 of the tube socket (V4-b) and the chassis, was 155, and the screen current was 3.6 ma, we determined that the screen power input was 0.558 watt. With input power to the plate actually only 4.377 watts (4.935 − 0.558 = 4.377), we had plenty of margin. Our line voltage is on the high side, as evidenced by the short life of light bulbs. Where line voltage is normal (117 volts) or lower, transmitter power input will be less.

Not having an rf wattmeter, we could not measure the actual power output. However, the brilliance of the dummy load (No. 47 lamp) gives a very rough indication of power output. Burning at normal brilliancy, the lamp consumes 1 watt. At double its rated power (2 watts), its light output is approximately quadrupled.

Testing the transmitter

Now we were ready to test the transmitter with a live antenna. Because I am no longer interested in climbing steep roofs, we connected the transmitter through a length of RG-58/U coaxial cable to a Tele-Beam BMW ground-plane antenna suspended by a piece of nylon fishing line from a lighting fixture in a hallway.

As prescribed in the kit instruction book, we brought in our portable TV set, turned it on and then spoke into the microphone with the transmitter turned on. Sure enough, we were creating TVI as predicted. So, I adjusted C209 (part of the antenna trap) until our transmissions had the least effect on the TV set.

Fig. 1 shows that the trap is merely a parallel-resonant circuit in series with the antenna. When tuned correctly, it suppresses the second harmonic of the transmitter's signal. Because the rf power amplifier is operated class-C, its output contains not only the fundamental frequency but harmonics as well. The second harmonic is the strongest and falls right in the TV band. The trap is a filter which offers little opposition to the fundamental but a very high impedance to the second harmonic to which it is tuned.

Knowing that a No. 47 lamp is not really a good dummy antenna, but will do, we decided to retune the transmitter with the *live* antenna connected. (I have a commercial operator's license, so I can do it legally.) As an output indicator, we used a Heath PM-1RF power meter, actually a simple field-strength meter. It was placed a few feet away from the antenna and oriented so its meter scale could be seen while tuning the transmitter. A very slight readjustment of L202's slug gave maximum output. We tuned a ham receiver in another room to the transmitter frequency, using its S-meter as a supplementary field-strength indicator.

On-the-air tests

We were able to receive quite a few class-D stations on several channels, including mobile units as far distant as the Teterboro (N. J.) airport, 10 miles away, identifying their locations from their conversions.

Not having assembled the second kit yet, we made initial tests, listening to our transmitter with an RME 4303 walkie-talkie which can be tuned to any frequency in the band. Using a factory-made Citizens radio in a car as a mobile station, we could communicate solidly

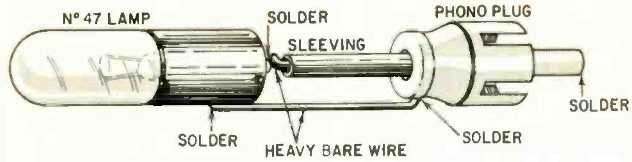


Fig. 3—A simple dummy-load antenna.

within a radius of 1 mile (and for another ½ mile, with some noisy spots). Both sets had approximately the same range.

A small difference in antenna height made a big difference in signal strength at a distance of 1½ miles. Raising the antenna only a couple of feet higher made a noticeable difference.

I plan to have the antenna installed on top of a pipe on the peak of our three-story house. This should give a big increase in range. Since our house is in a heavily wooded area, range is limited, particularly when using an indoor antenna. It will be necessary to get the antenna up above the trees. Nothing reduces communicating range at these frequencies as much as trees and dense foliage. The tests were conducted in the fall just as the leaves had started to drop. The range, even when using an indoor antenna, should increase considerably when the leaves are gone.

Antenna requirements

Others using various makes of Citizens radio report similar results. Many get up to 10-mile coverage with CB-1 units. But, for extended range, a base-station antenna mounted clear of nearby trees is generally required. In vehicles, range can be increased considerably by installing suppressors and bonding straps to reduce ignition noise. Even the inherent noise-suppression characteristics of the superregenerative detector and the noise silencer used in superheterodyne type sets will not provide more than partial relief from ignition noise, which is particularly pronounced at 27 mc. It is the level of the noise which determines the *effective* sensitivity of the receiver. Too bad something can't be done about the noise generated by passing cars.

Do's and don't's

There are a few salient points to consider when building and testing a Citizens radio. First of all, follow the wiring procedures outlined in the instruction book. Follow instructions *precisely* when wiring the crystal circuit so that variations in lead length and placement won't affect frequency.

When tuning up the transmitter, do so only with a dummy antenna. Do *not* touch the transmitter tuning adjustments when the set is connected to an antenna unless you have a first- or second-class radiotelephone operator's *license* or are in the presence of a licensed operator.

Do not transmit until you have *listened first* to make sure that your channel is not in use. To do so, you must have your receiver tuned to your transmitting frequency. If you do not know the exact dial setting for your channel, tune the receiver back and forth over that part of the dial.

Also, before transmitting, make sure a Conelrad alert does not exist. All Citizens radio stations must have provisions for receiving the Conelrad alert and all clear. It is not a matter of choice. It is mandatory. This means that you must have an automatic Conelrad monitor, or an AM broadcast receiver or TV set *turned on* and *listened to* before transmitting.

Make all on-the-air transmitter tests as short as possible to avoid causing interference to others. At the start of the test, you must announce your station's assigned call sign. The call sign must be announced at the beginning and end of every communication, except when exchanging a series of short transmissions. When conducting a series of test calls, the call sign must be announced at least every 10 minutes.

Station license

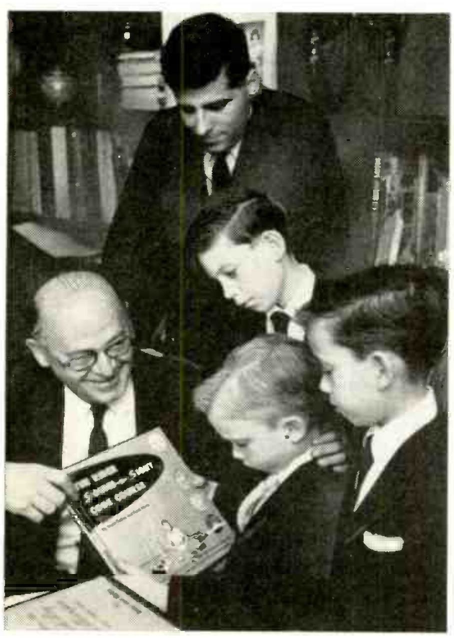
At the time of ordering your Citizens radio kits, or even before, get your station license application in the mail. (Allow at least 6 weeks for processing.) Without a license, you can't put your

The Heathkit CB-1 Citizens-band transceiver set up and ready for use.

equipment on the air. You can get license application forms at most parts jobbers that sell Citizens radio equipment or by requesting Form 505 from the Federal Communications Commission, Washington 25, D. C. This simple form, when filled in, must be notarized before being mailed to the FCC. One license application can cover any number of transmitters, of any make or type, as long as they meet the requirements specified in part 19 of the FCC rules and regulations. The latest issue of these Citizens Radio Service rules is contained in a brand new book, *Vol. VI, FCC Rules and Regulations*, which also contains the rules for the amateur and disaster service. It may be purchased from the U. S. Government Printing Office, Washington 25, D. C. for $1.25. You must have a copy of the rules on hand, since ignorance of the rules will not exempt you from violation citations or cancellation of your license. END

LEARNS CODE AT 5

Robert Alessi, 5 years old, shows his skill in International Morse code to John F. Rider, publisher, and Lewis Robins, author of the Sound-n-Sight code course. His older brother, Frank, age 9, recently passed his General-class Amateur exam. Frank is believed to be the second youngest boy ever to get his General, the youngest having been



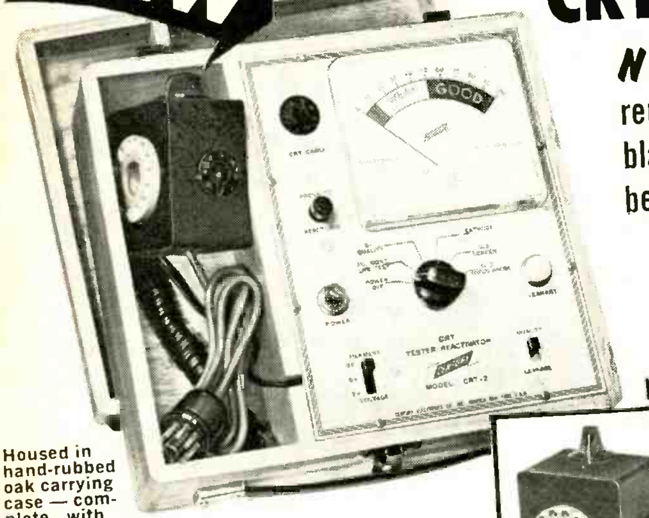
a blind boy, John Fearon, 7, of Atlanta, Ga. Robert and Frank have an older brother Patrick, 10, who also has his General class license. But the remarkable thing about Robert is that he has learned to read the code while he is still unable to read English.

The youngest girl ever to get an Amateur radio license is Sharon Pakinas, who passed her novice exam at the age of 7 and has since passed the Technician tests.

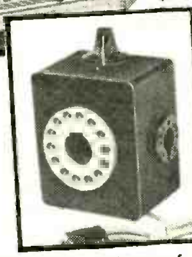
SHIPPED ON APPROVAL

NEW

CRT TESTER-REACTIVATOR Model CRT-2



Housed in hand-rubbed oak carrying case — complete with MULTI-HEAD*



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.

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.

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 tne picture tube.

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

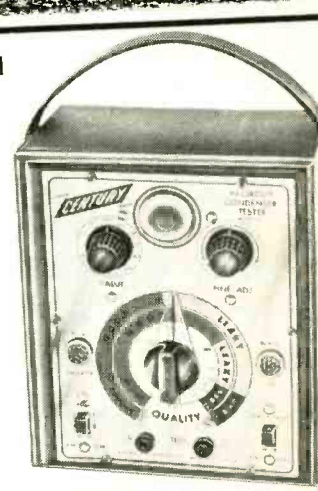
Here is an IN-CIRCUIT CONDENSER that DOES THE WHOLE JOB! The CT-1 actually steps in and takes over where all other in-circuit condenser fail. The ingenious application of a dual bridge principle gives the CT-1 a tremendous range of operation . . . and makes it an absolute 'must' for every serviceman.

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 ni-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

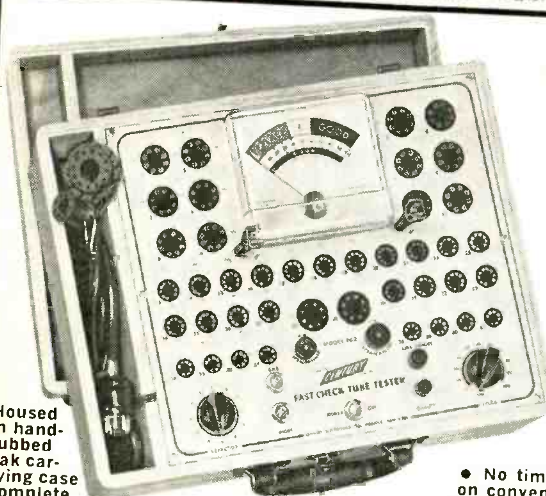
• Completely portable — self powered with long life batteries — permits use everywhere • New advanced pentode amplifier circuit assures amazingly low battery drain • Large 6" 100-microampere meter, many times more sensitive than meters used in most V.T.V.M.'s • Laboratory accuracy performance — 2% of 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.



Housed in hand-rubbed oak carrying case complete with CRT adapter

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.

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.

Model FC-2 $69.50 Net

TERMS: $14.50 within 10 days. Balance $11 monthly for 5 months.

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.

111 Roosevelt Avenue, Dept. 101, Mineola, New York

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.

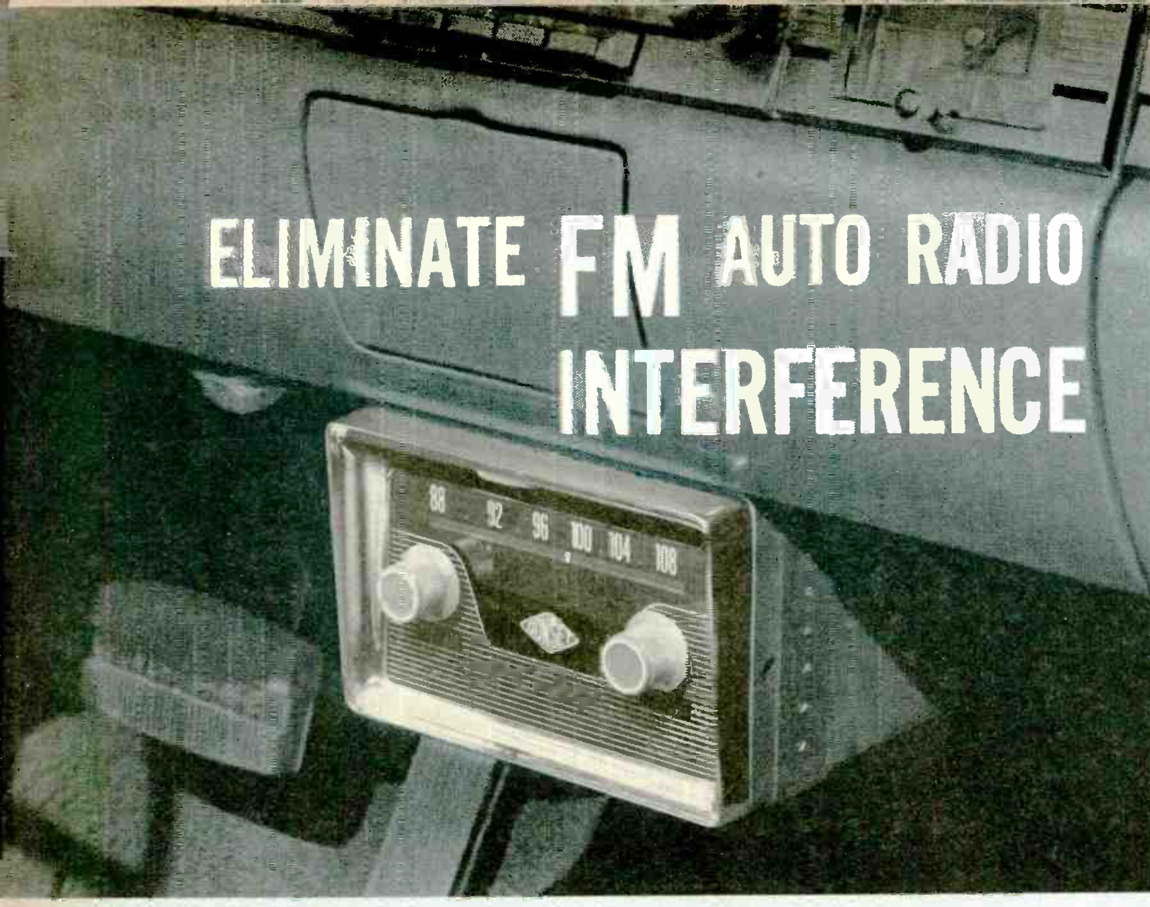
Prices Net F.O.B. Mineola, N. Y.

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 ....



ELIMINATE FM AUTO RADIO INTERFERENCE

Ignition noise can destroy the advantages of FM radio—and a few simple tricks can eliminate ignition noise

By **LARRY STECKLER**
ASSOCIATE EDITOR

THE FM radio has often proved superior to AM when it comes to noise-free listening and full-frequency response. And now that you can put an FM set in your car (see photo), no matter where you go, pleasing high-fidelity music can be yours to listen to. But auto radio, FM or AM, brings with it a new set of problems, things that didn't exist when you kept your radio at home.

FM broadcasting (88–108-mc) uses a part of the vhf band and its characteristics are similar to those of TV frequencies. Under normal atmospheric conditions these waves travel in straight lines and reception is limited by the earth's curvature. A mountain or other large object may block the reception path. So from time to time you may find yourself in an "FM dead area" and unable to receive an FM signal.

Something else to contend with is the way an FM signal can be reflected by metal buildings, hills and power lines. Often, the signal arriving at the FM receiver is a mixture of the signal direct from the transmitter and one or more reflected waves. In the home receiver, located in a fixed position, this usually has no noticeable effect. But when you put the receiver in a moving vehicle this is no longer true.

When a car carrying an FM receiver is driven along a highway, the direct and reflected waves aid and cancel each other and the signal picked up has a rapid flutter. With a strong signal, it is not noticeable, as the limiter stages keep the receiver from reacting to these changes in signal strength. But in fringe areas, where signals are weak, the flutter can be heard and is annoying.

To reduce flutter caused by weak signals some special automotive FM antennas have been developed. Gonset makes a hoop (see photo) that fits over the standard antenna and is said to increase signal strength in fringe areas from 50% to 100%. So if FM reception in your car is not satisfactory, because of excessive flutter, try one of them. You will be surprised at the difference.

When you use your standard whip antenna for FM reception, remember a couple of points. First, keep the coax connecting the antenna to the set as short as possible. Rear-fender and rear-deck antennas usually are not satisfactory for FM reception as they cannot deliver enough signal through the long antenna lead. Another type of standard antenna that usually does not work too well for FM is the automatic unit that is normally recessed into a well into the car's fender. This well is usually just the right size to act as a trap and does not let the FM signal come through to the set. In both instances, the only cure

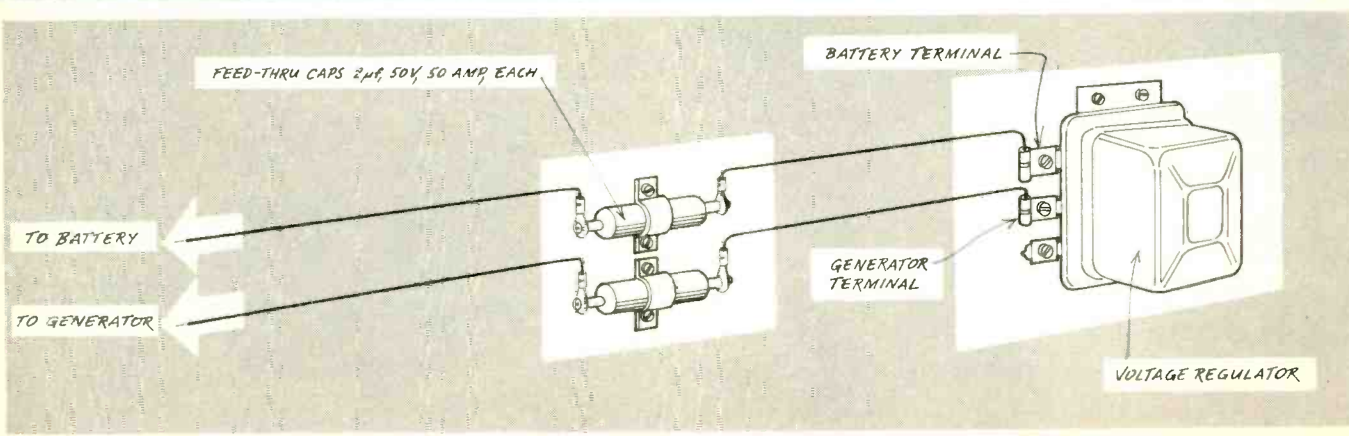


Fig. 1—Coaxial capacitors on the voltage-regulator leads stops the popping often caused by arcing breaker contacts. Although the drawing shows some lead length, leads must be short and the capacitors mounted as near the voltage regulator as possible.

is to use a standard whip on a front fender. As a last point, remember that your whip is not designed for FM frequencies so it should not be used all the way up or all the way down. Instead, extend it to about 30 inches. This will give the best possible results.

One of the first advantages you will notice after putting an FM receiver in your car is how the FM program rarely dies out, even when going over bridges or through underpasses. Then, too, FM in your car retains its most important advantage, freedom from the man-made noises produced by power lines, neon signs, street cars and most other sources of interference. But your own

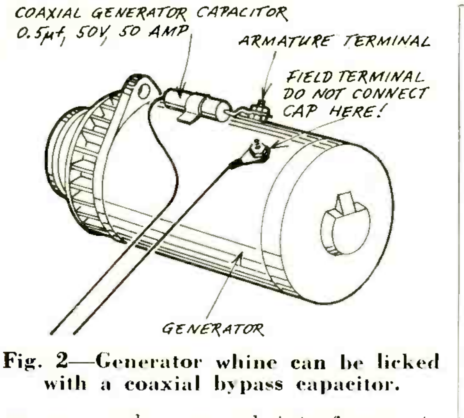


Fig. 2—Generator whine can be licked with a coaxial bypass capacitor.

car my produce enough interference to ruin reception.

Occasionally, when you put an FM receiver in a car, a considerable amount of noise is heard whenever the motor is running. Should this happen to you, there are a few things that need checking. The best place to start is at the antenna. (Incidentally, the following tips are also considerations when trying to get rid of interference in AM auto sets.)

Antenna troubles

The most common antenna fault is an improper ground. An auto antenna is usually grounded by a serrated washer which digs into the metal body of the car. If the washer is loose or if the car has an undercoating, the ground contact may be poor. For a loose washer, tighten the nut that holds it in place. A deep socket wrench is needed to do this job right. Space is at a premium and almost no other type of wrench will let you apply enough pressure to tighten the nut fully. If undercoating is the problem, loosen the antenna mounting nut, scrape the area contacted by the washer until it is bright and shiny, and retighten the nut.

Ignition interference

The car's electrical system is another common cause of interference. Spark plugs, the distributor, the generator and even the voltage regulator can be at fault. The best way to tell which component is making trouble is to carefully analyze the type of interference you hear. It usually breaks down into one of three types:

▶ A popping noise from the speaker which increases to loud buzz as engine speed increases.

▶ A whine which appears as engine speed increases.

▶ Erratic popping which changes only slightly in frequency with increases in engine speed.

The popping noise can be caused by spark plugs or the voltage regulator. When the plugs are at fault the popping turns into a buzz if you race the engine. If it's caused by the generator, the popping will be erratic and will change only slightly with changes in engine speed. If the trouble is in the spark plugs, replace them with resistor type plugs or use resistor cable between the plugs and the distributor. (Both are available either from Auto-Lite dealers or from the larger automotive parts shops.)

When the popping is caused by the regulator, it is usually the vibrating breaker contacts in the unit that are arcing. The solution is to use a coaxial capacitor between the battery terminal of the regulator and the battery lead —about a 2-μf unit should do the job (Cornell Dubilier NF-10270-1. These are rather expensive units and usually require a special order by your distributor to get them.). Its current rating should be around 50 amps. A similar capacitor should be placed between the

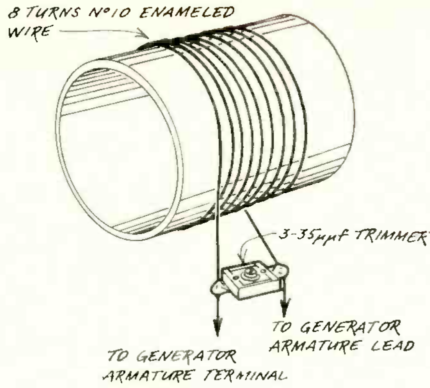
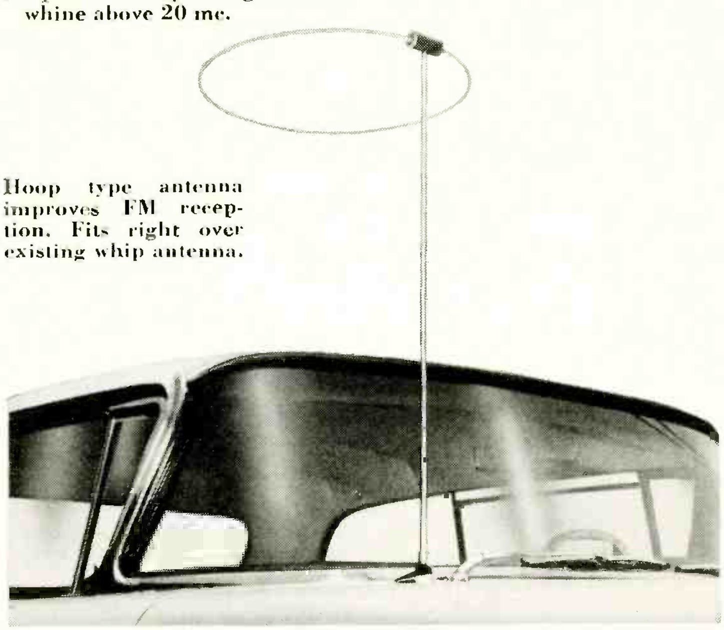


Fig. 3—Simple filter traps out generator whine above 20 mc.



Hoop type antenna improves FM reception. Fits right over existing whip antenna.

capacitor. The capacitor's other end is connected to the armature cable with a piece of No. 10 wire.

Sometimes, particularly at frequencies above 20 mc (definitely for the FM installer), a series trap is needed to stop generator whine. Such a trap is shown in Fig. 3. It is made from eight turns of No. 10 enameled wire wound on a 1-inch diameter form and shunted with a 3–35-μμf trimmer.

Another source of trouble can be the distributor. Noise originating here is usually caused by loose terminal connections or sparking in the unit.

Check all wiring and, if crimped-on terminals are used at the distributor end of the spark-plug leads, replace them with terminals soldered to the conductor. If sparking in the distributor seems to be the trouble, check the rotor. If it is worn, replace it.

regulator's generator terminal and the generator as in Fig. 1. Make sure that the cases of the capacitors are securely grounded—use a braided metal grounding strap if necessary.

When you're up against a variable whine, check the generator. A coaxial 0.5-μf (Sprague 48P18) capacitor with a current rating that exceeds the generator's output should be inserted as shown in Fig. 2. Connect the capacitor case to the generator frame. Use the screw provided for the ground connection to the usual bypass capacitor, which is removed. The lead going to the generator's armature terminal is removed and connected to one end of the coaxial

In really persistent cases of interference, connecting all parts of the motor together with a heavy grounding strap is a big help. This means the motor block, generator, battery ground, regulator, distributor, and sometimes even the hood. You'll be surprised how much this can reduce noise.

So if your car is an interference trap, try these few simple suggestions and put yourself on the road to pleasant listening—AM or FM. END

FCC CAUTIONS CITIZENS BANDERS NOT TO RAG-CHEW

The FCC has taken note of excessive air time on the Citizens band for talk other than that authorized. It is cautioning new licensees not to use the Citizens radio service:

As a hobby in itself, as opposed to its use, for example, for controlling model aircraft.

For experimental use with radio on the air. However, it may be used for [*communications* in connection with other] experiments.

For "calling CQ"; that is, attempting to communicate with unknown Citizens radio stations for the sake of making "contacts," including such amateur activities as "directional CQ's" to contact other Citizens radio stations in as many states as possible.

Dx operation; that is, attempting to make long-distance contacts with unknown Citizens radio stations.

Operation of the station as a recreational activity in and of itself, for the pleasure to be derived from such operation.

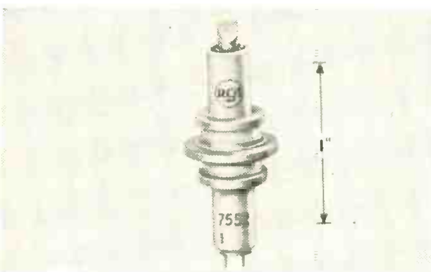
Licensees violating the principles set out above face the possible loss of license and other penalties.

NEW TUBES and SEMI-CONDUCTORS

A COUPLE of unusual items perk up this month's column—the MS-41 magnetoresistor and the 7552, a pencil-shaped ceramic-metal triode. Other points of interest are a series of tetrodes for vhf TV tuners and a 23-inch picture tube.

7552

A hi-mu triode featuring ceramic–metal construction and space-saving pencil design. It is especially suited to uhf service in portable field equipment, missile-guidance systems and satellite-communication applications. The tube



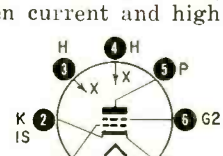
has a maximum plate dissipation of 2.5 watts and can be operated at frequencies up to 1,000 mc and higher. In a typical cathode-drive circuit having a bandwidth of 5 mc and operating at 800 mc, the 7552 has a power gain of 18 db and a noise factor of about 8.5 db. The tube's heater is rated at 6.3 volts at 225 ma.

Characteristics of the RCA 7552 in Class Al amplifier operation are:

V_P		125
$R_{cathode\ bias}$	(ohms)	50
μ		70
R_P (approx)	(ohms)	4,400
gm (μmhos)		16,000
I_P (ma)		14

2EV5, 3EV5, 6EV5

These are high-gain sharp-cutoff 7-pin miniature tetrodes designed particularly for service in vhf TV tuners. Their high transconductance, extremely low screen current and high input im-



IS=INTERNAL SHIELD
2EV5
3EV5
6EV5

pedance at 200 mc results in an improved noise figure.

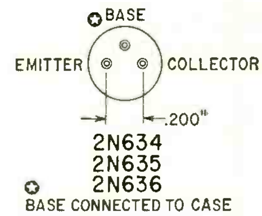
Heater ratings of these tubes are: 2EV5—2.4 volts, 600 ma; 3EV6—2.9 volts, 450 ma; 6EV5—6.3 volts, 200 ma.

Typical operating characteristics of the Westinghouse 'EV5 series are:

V_P	250
V_{G2}	80
V_{G1}	—1
R_P (k ohms)	150
gm (μmhos)	8,800
V_{G1} (cutoff bias for gm of 100 μmhos)	4.5
I_P (ma)	11.5
I_{G2} (ma)	0.9

2N634, 635, 636

A series of n-p-n high-frequency computer transistors that feature high-mobility electron flow. They are intend-



ed for use in switching and flip-flop circuits.

Maximum ratings of these CBS transistors at 25°C are:

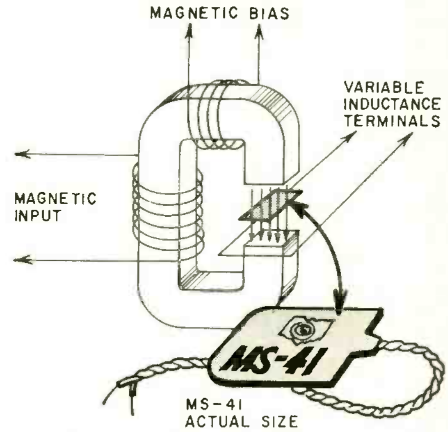
V_{CB}	20
V_{CE}	20
V_{EB}	15
P_{total} (mw)	150

Electrical characteristics at 25°C are:

	2N634	2N635	2N636
I_{CBO} (μa)			
($V_{CB}=5$)	5	5	5
($V_{CB}=20$)	15	15	15
I_{EBO} (μa)			
($V_{EB}=15$)	10	10	10
V_{CEBO}			
($I_C=600\ \mu$a, $R_{BE}=10$ k)	20	20	15
h_{FE}			
($I_C=200$ ma, $V_{CE}=0.75$)	15	25	35
$f_{\alpha b}$			
($I_E=1$ ma, $V_{CB}=5$)	5	10	15

MS-41 magnetoresistor

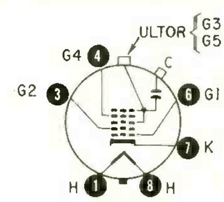
A solid-state device in which the electrical resistance is a function of an applied magnetic-field density. The



Ohio Semiconductors MS-41 uses a thin wafer of indium antimonide and has a high-field to zero-field ratio of 10 to 1 at 10 kilogauss. The MS-41 can be used in voltage-regulator, transducer, power amplifier and measuring circuits.

23KP4

A square-cornered picture tube which does not have an attached safety glass. The tube has 114° deflection but uses standard 110° sweep components. No ion trap is required and the tube is elec-



23KP4

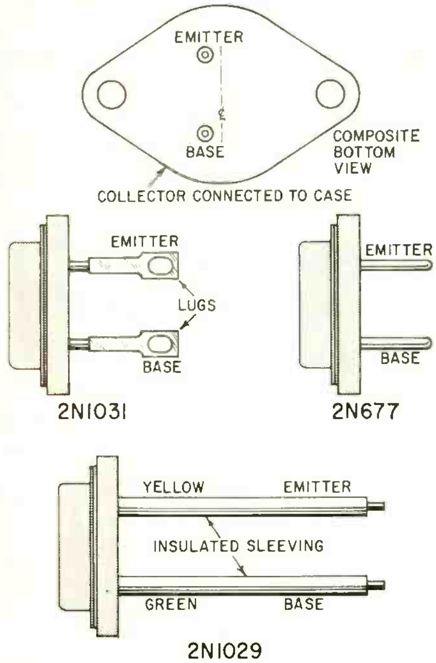
trostatically focused and magnetically deflected. Its screen is aluminized and has a conductive coating.

Design maximum ratings of the G-E 23KP4 are:

V_{ultor}		20,000
	(minimum)	15,000
V_{G4}		−500 to +1,000
V_{G2}		700
	(minimum)	400
V_{G1}	(max neg)	140
	(max neg peak)	200
	(max pos)	0
	(max pos peak)	2

2N1031, 2N1029, 2N677

These power transistors have a typical current gain of 40 at 10 amps and a maximum current rating of 15 amps. They are designed as high-current switching transistors for dc–dc converter and dc–ac inverter circuits. These



transistors can switch up to 1,000 watts, and have other applications such as power supply regulators, magnetic clutches, relay replacements, power amplifiers, motor control, etc.

Maximum ratings of these Bendix transistors are:

V_{CE}	30
V_{CB}	50
I_C (peak) (amps)	25
(average amps)	15
P_C (watts)	50
I_B (amps)	1.5

Semiconductor briefs

Industro Transistor Corp. announces the 2N1356 an improved, reliable, floating-base replacement for the 2N396-A. All electrical and mechanical specifications are the same as the prototype ex-

cept that all three leads are insulated from the case. In the prototype the base is connected to the case. Also available in this series are the 2N1353, 2N1354, 2N1355 and 2N1357. These are floating-base replacements for the 2N384, 2N395, 2N396 and 2N397, respectively. These transistors are intended for military and industrial computer use. END

TECHNICIANS' NEWS

PART-TIMERS, GOOD AND BAD

"We need a redefinition of 'part-timer' and the real culprit, the 'fringe operator'," says Kurt Wertheim in *Sarta News* (San Antonio, Tex.): "There is a vast difference between the man who runs a service business on a regular but part-time basis, with the intention of going full-time at a later date, and the night-crawler who comes out and uses his talents (?) only to pick up a few extra bucks at the expense of his tax-paying competitors.

"There is also a small minority of full-time shops that are not in commercial locations. I believe that if they have a store license, retailer's permit, bond, and operate under the law, they deserve our help to the end that they can eventually open up in the front-door type shops that they should be in.

"The 'fringe operator' is the guy we're after right now. He's one of the big complaints for several reasons. One is that he fills the set with new tubes before he decides that the repair job is too much for him. The second is that, when he does go into a set to make circuit repairs, before giving up he leaves us with a real headache in putting it back the way it was designed . . ."

(NATESA has defined part-time service technicians. See page 136, November, RADIO-ELECTRONICS. — *Editor*)

ETG HEARS TV REPS

Fall meetings of the Electronic Technicians Guild of Massachusetts, Boston Chapter, were scheduled to hear representatives of General Electric and of Motorola discuss new features of their respective 1969 TV lines at each of two regular monthly meetings.

UTICA TV STATION COOPERATES

When station WKTV, channel 13, Utica, N. Y., changed over to channel 2, the local service technicians' group, MVRTTG (Mohawk Valley Radio-TV Technicians' Guild), got together with the station to run announcements saying, "If you have any difficulty receiving the new channel, call your regular service technician or a member of the MVRTTG for service and adjustment. Call * * * * * and the member of MVRTTG nearest you will handle your call." The Guild handled 75 calls during the first month of this activity.

Subsequently, two more public-service promotions featuring Guild members and officials over the TV station and WKTV's radio station publicized the group. As a result, MVRTTG reports they've been swamped with membership applications. They're planning an adver-

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.

MICHIGAN TELEVISION & ELECTRONIC SERVICE ASSOCIATION, INC.
(MICHIGAN TESA, INC.)
1912 S. Burdick St.
Kalamazoo, Mich.
William West, Jr., Membership Chairman

TESA–LENAWEE
234 W. Church St.
Adrian, Mich.
Howard Merritt

TESA–BATTLE CREEK
988 E. Michigan Ave.
Battle Creek, Mich.
Stanley Rich, president

TESA–FLINT
4437 N. Genesee
Flint, Mich.
William Palmer

TV SERVICE DEALERS ASSN.
49 40th St., S.W.
Grand Rapids, Mich.
Charles LaRoche, president

RADIO-TECHNICIANS ASSN.
702 Mill St.
Kalamazoo, Mich.
Russell Reynolds, president

OAKLAND COUNTY ELECTRONIC ASSN.
770 Orchard Lake
Pontiac, Mich.
Bernard Seiber

S. OAKLAND COUNTY TECHNICIANS ASSN.
3390 W. 12 Mile Rd.
Berkley, Mich.
Mike Mosier

TESA–SAGINAW
3775 N. Michigan
Saginaw, Mich.
John Hooper

ELECTRONIC SERVICE ASSN.
8510 McGraw
Detroit 10, Mich.
Dale Brock, president

TELEVISION SERVICE ASSOCIATION OF MICHIGAN (TSA OF MICHIGAN)
8225 Woodward
Detroit 27, Mich.
Patrick LaForet, president

tising promotion for the phone-book yellow pages which will list the members of the Guild under its emblem.

TESA MEMBERS CATCH A THIEF

A Midwestern thief who had been posing as a service technician to gain access to shops, then stole equipment and supplies, was caught after his modus operandi was described in the *NATESA Scope* and alert members of TESA-Wisconsin worked together when he showed up in Milwaukee.

When the "con" man came to the shop of TESA member Ed Bruning Ed said he had no work but thought Jerry Hall (chairman, TESA–Wisconsin) might be able to hire him. Then Ed phoned Jerry, who got the police right over. The arrest was made soon after, due to cooperation between the service group members.

NIAGARA FALLS LICENSING

An ordinance licensing TV technicians was passed in Niagara Falls, N. Y., granting licenses for 60 days without examination. Thereafter a three-man board of examiners is to review applicants, who will pay $10 if technicians, $15 if service dealers.

SERVICE CALL $7 IN CALIF.

At a recent meeting of the Radio–TV Association of Santa Clara Valley, it was noted that general practice in that area has been to make a flat charge for service calls up to 30 minutes. One plan was discussed which would set the price at $4.95 to go to the home, and $1.50 each 15 minutes inside.

One member said his prices started at $6, with additional charges depending on distance from his shop. It appeared that most service calls were running $5.50 to $6.50, and included a basic 30 minutes' work in the home at that price.

The discussion wound up with agreement that the RTASCV would recognize $7.50 as a legitimate service-call charge, although individual firms would be allowed to set their own charges still. It appeared, however, that most shop-owners would not exceed $7 for a while, though a number said they would move up to that price at once.

EVILS OF D-I-Y TESTERS

An open letter to the public from the Oakland County (Mich.) Electronics Association details the evils of drug-store tube testers.

"Long before anyone else knew about them (do-it-yourself tube testers) we purchased several . . . because we felt that anything as important as this should meet a certain minimum standard for the protection of the general public. We compared them against the standards of the testers in our shops. They were so far below . . . we refused, for our customers' protection, to have anything to do with them.

"Do-it-yourself checkers are not capable of testing some multi-element tubes, and inaccuracies can be costly . . . only a qualified technician can properly evaluate the testing of a tube . . .

"We have yet to see a tube tester designed accurately enough to provide a thorough check and still be simple enough for the public to operate . . . just because a tube doesn't check quite up to the green mark on a tester is no indication it should be replaced. Some of these tubes will outlast two TV sets. The ones in the critical circuits are sometimes the only ones needing replacement. The do-it-yourself (usually) . . . replaces any tube that isn't quite up to par, hoping a high-voltage tube will cure his audio trouble . . . The net result here is that he buys tubes he doesn't need . . . (and) winds up with the set still not working properly.

"Some new tubes may not check out first-class. You should insist on testing any new tube before purchasing. Be on the lookout for rebranded tubes. Millions have been sold as new. We have found some tubes offered at these (d-i-y tester) locations far out of warranty date, sometimes as much as 5 years.

"You can forget all about these worries simply by making your purchases of new tubes from a local TV service dealer. He buys them from a distributor who has too much at stake to stock out-of-date tubes . . .

"When you need a prescription filled, go to a druggist . . . Likewise, when you have radio or TV trouble go to a TV service dealer."

BBB SUGGESTS

The Seattle, Wash., Better Business Bureau points out that its effectiveness would be greatly increased if its members would report advertisements that contain deceptive, false or misleading statements, or ads not in keeping with good business ethics. The BBB suggests that members finding this sort of advertising telephone or write the bureau giving all details; protest the ad to the newspaper, radio station or other medium publishing it, and call the attention of the local District Attorney to it if the advertising appears to violate any advertising statutes of the state.

PUBLIC RELATIONS ACTION

The Television Service Dealers Association of Grand Rapids has collected 30 used TV sets, put them in good operating condition and delivered them to local children's homes and hospitals.

It was part of a "TV For Tots" program in which TV stations broadcast appeals for the sets and publicized the service group's activity in fixing the sets and placing them with the needy children's institutions.

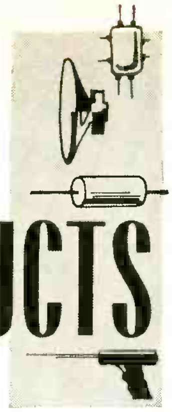
NEW ARTSNY OFFICERS

The Associated Radio Television Servicemen of New York, Inc. elected new officers for 1960: Edward Eisen, president; Charles Edwards, vice president; Herbert Schneider, executive secretary; Philip Goldfarb, treasurer. Directors elected for this year were Max Leibowitz, Martin Boxer, Henry Levine, Harold Goodman, Lou Gioia, O. Capitelli, John Wagonny, Fred Rayano, Harold Levinson, Bob Mulwitz and Hyman Brooks.

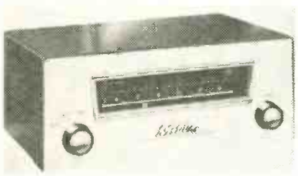
ARTS (CHICAGO) ELECTS

The Associated Radio & TV Servicemen (ARTS) elected new officers: Joseph Ehlinger, chairman; Harold Mueschen, vice chairman; Yuki Minaga, secretary-treasurer; Delmar Kotrba, sergeant-at-arms. END

new PRODUCTS

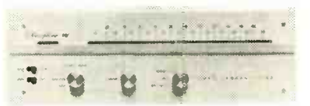


FM TUNER *Model 580* has tuned rf stage, permeability tuning, dual limiters. Afc with afc defeat, cathode-follower output. Sensitivity 1.0 μv for 20-db



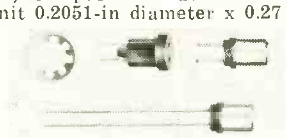
quieting, selectivity 200 kc at 6 db down, distortion under ½% at 2-volt output.—**J. W. Miller Co.**, 5917 S. Main St., Los Angeles, Calif.

FM TUNER *model CT-1*. Dial spread over 10 inches, amplified afc, afc-off switch, interstation muting switch, multiplex socket, 2 independent audio outputs for recorder and amplifier. Sensitivity 1.5 μv (by IHFM stand-



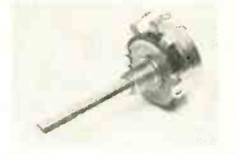
ard) 30-db quieting, image rejection 55 db, capture ratio 1.2/1, output 5 volts, hum and noise down 65 db with 1,000-μv input.—**Karg Laboratories, Inc.**, S. Norwalk, Conn.

SUBMINIATURE FUSE, *Microfuse* precision subminiature unit 0.2051-in diameter x 0.27 in



long. From 1/500 to 5 amperes. Blows at 150% in rating m0–10 seconds. Pigtail leads or plug-in, with own holder, shown above.—**Littelfuse Inc.**, Des Plaines, Ill.

HIGH-WATTAGE POTENTIOMETER without size increase is *type 45* wirewound control. 1⅛-in diameter body instead of

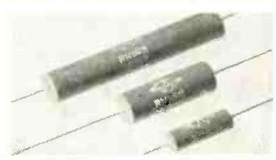


1 23/32-in usually required for 4 watts. Values 1 to 10,000 ohms, one tap only.—**Clarostat Mfg. Co., Inc.**, Dover, N. H.

ELMENCO CAPACITOR KIT *No. 17*. 55 frequently used values, all ±10%. 1,000 volts. Wax-impregnated for extra moisture resistance. Tolerance, capaci-

tance, working voltage printed on units.—**Arco Electronics, Inc.**, 64 White St., New York, N. Y.

PRECISION RESISTORS, molded deposited-carbon *type CPM Carbomold*, moisture- and heat-resistant, encapsulated. ±1%; 10 ohms to 5 megohms ½ watt, 10 ohms to 10 megohms

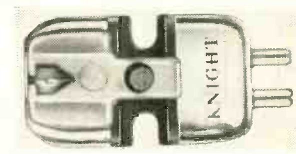


1-watt, 30 ohms to 20 megohms 2-watts. Derated full load at 70°C to zero load at 150°C.—**Hi-Q Div., Aerovox Corp.**, Olean, N. Y.

DISC CERAMIC CAPACITOR line. *Type CCD* 10% tolerance, 1,000 volts. 5–30,000 μμf. *Type 3CCD* 3,000 volts; *type 6CCD* 6,000 volts, both 20%. *Type CCTO*, zero temperature coeffi-

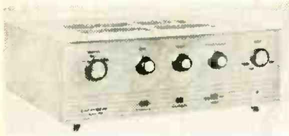
cient 2.2–100 μμf, 1,000 volts. *Type CCTN* 5.0–300 μμf. Packed five capacitors in each plastic box.—**Arco Electronics, Inc.**, 64 White St., New York, N. Y.

STEREO PICKUP *model KN-500*. Low-cost moving magnet cartridge, 0.7-mil radius, diamond readily replaceable. Response 20–20,000 cycles ±3 db,



output 9 millivolts at 10 cm/sec, separation 20 db.—**Allied Radio Corp.**, 100 N. Western Ave., Chicago 80, Ill.

STEREO AMPLIFIER KIT *model KT-236*. 18 watts per channel switchable to 36-watt mono. Dual concentric tone controls, function switch; stereo,

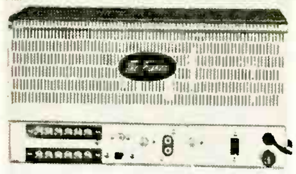


mono, reverse and phase selected by slide switches. Response 15–30,000 cycles ±1 db, sensitivity 3 millivolts (mag phono), hum and noise 70 db down, channel separation 50 db, dual tape outputs.—**Lafayette Radio**, 165-08 Liberty Ave., Jamaica 33, N. Y.

35-WATT STEREO AMPLIFIER *model LA-235* blend control variable from full stereo to monophonic. Concentric clutch volume/balance controls, tone controls. Channel-reverse and

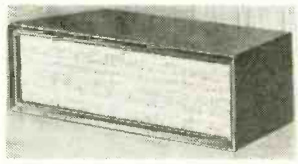
phase-reverse switches. 17.5 watts per channel, distortion under 1%, response 20–20,000 cycles at normal levels, hum and noise 65 db down, channel separation over 40 db, tape outputs. —**Lafayette Radio**, 165-08 Liberty Ave., Jamaica 33, N. Y.

STEREO POWER AMPLIFIER *model SA-100*. 2 power amplifiers, 1 chassis. 25 watts per channel music power rating at 0.8% harmonic distortion. Controls set bias, dc balance, phase-inverter balance, input



levels. Test points and cathode load splitter provided.—**Fisher Radio Corp.** 21-21 44th Drive, Long Island City 1, N. Y.

STEREO REINFORCING SPEAKERS *WS-1* extend radiation of normal stereo system



mid- and high frequencies, 250–15,000 cycles. Connect to any 4-, 8- or 16-ohm taps. Very small (11½ x 3⅞ x 4⅜ in.), finished on all sides in various woods.—**Fisher Radio Corp.**, 21-21, 44th Drive, Long Island City 1, N. Y.

L-PADS for stereo balance

and speaker level control. *Series LL*, two L-pads mounted together, 8, 15 and 50 ohms; *series LA*, 8 and 16 ohms. Include two-faced dial plate with "Balance" on one side, "Level" on other.—**Distributor Div., P. R. Mallory & Co., Inc.**, Box 1558, Indianapolis 6, Ind.

ORGAN KIT *Consolette* smaller than spinet piano, under

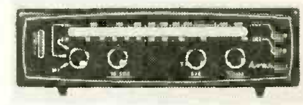
38 inches wide, has all keys any organ music requires. Two 61-note keyboards, 22 stops, 13 pedals. $2 demonstration record available; cost refunded with purchase of any kit parts.—**Schober Organ Corp.**, 2248 Broadway, New York 24, N. Y.

EQUIPMENT CABINET *model 105*. Upper-left compartment

with lift top for changer, turntable or tape machine; pullout drawer; sliding doors; removable shelf in upper-right compartment adjustable; blank panel for cutout. Choice of woods.—**Rockford Special Furniture Co.**, 2024 23rd Ave., Rockford, Ill.

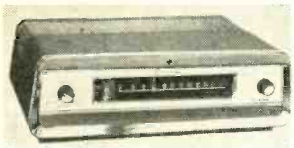
PATCH CABLES AND ADAPTERS for audio systems include nine cables with various combinations of plugs plus three adapters. Connectors and plugs molded on, cables waterproof; all contacts, solder points, wire ends imbedded in high-impact plastic.—**Vidaire Electronics Mfg. Corp.**, 44 Church St., Baldwin, N. Y.

COMPONENT LINE includes dual 10- and 20-watt amplifiers, preamplifiers and FM–AM tuner. *Model BM611* (shown) has electron-ray tuning indicator, afc, cathode-follower output, afc-defeat switch, volume control. FM sensitivity 6 μv full limiting, output 2.5 volts for 75-kc deviation, image rejection



33 db. AM sensitivity 20 μv for 100-mv output at 30% modulation, selectivity 3 db down at 5 kc, image rejection 40 db.—**Beam-Echo International, Ltd.**, 820 Greenwich St., New York 14, N. Y.

TUNER AND AMPLIFIER KITS *models 20LJK* and *101-GTK* (tuner shown). *20LJK* stereo amplifier, two 10-watt power amplifiers, response ±0.5 db 20–20,000 cycles hum and noise 80 db down. Function, balance, loudness, bass, treble

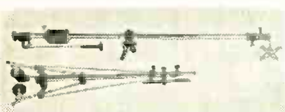


controls. Tuner has tuning eye. afc, two limiters. Both also available wired.—**Grommes Div., Precision Electronics, Inc.,** 9101 King St., Franklin Park, Ill.

30-WATT PUBLIC ADDRESS amplifiers include *Model MX30* (shown). 4 mike inputs (or three mikes and magnetic or crystal phono), 35–20,000 cycles ±2 db. Distortion 1%; output 4, 8, 16 and 163 ohms; balanced 20- and 70-volt taps. *Model M330* similar, only three mike inputs *Model M030* 30-watt

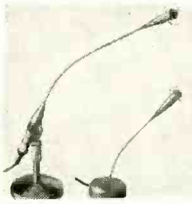
booster amplifier, high impedance and (with transformer) 500-ohm inputs.—**Bogen-Presto Co., Div. of Seigler Corp,** Box 500, Paramus, N. J.

PORTABLE BOOM for microphones extends up to 9 feet



high, 18 feet out; collapses to 5¼ and 7 feet, respectively, in two pieces, for automobile storage. *Model BS-37* deluxe boom has numerous standard and special features for positive positioning, rapid safe adjustment, great flexibility.—**Atlas Sound Corp.,** 1449 39th St., Brooklyn 18, N. Y.

MICROPHONE *model 652* mounted on thin nonreflecting tube uses either of two clear



plastic baffles for 6- or 3-db boost at 6,000 cycles. Output level −60 db. Weighs 11 ounces. —**Electro-Voice, Inc.,** Buchanan, Mich.

RESONANCE LOWERING kit softens cones of loudspeakers. *Flexicone* lowers resonant frequency 10 to 40 cycles. Kit includes brush and three bottles of mixture. Kit does one 15-in, two 12- or four 8-in cones.—**Porter & Dietsch, Inc.,** 2459 University Ave., St. Paul 14, Minn.

AUDIO MIXER *model VC-220* accepts 2 audio signals; mixes, feeds any high-impedance high- or medium-gain input. Inputs 500,000 ohms, output 500,000 ohms. Input jacks for standard phone plugs and phono plugs.—

Olson Radio Corp., 260 South Forge St., Akron, Ohio.

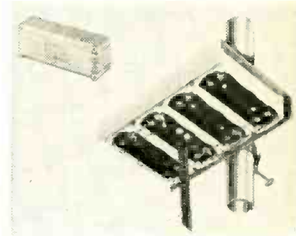
TURNTABLE-ARM ADJUSTMENT kit includes miniature *Microgram* stylus-pressure gauge and turntable level. Pressure gauge indicates 1 to 10 grams in 1-gram steps.—**Clevite Walco,** 60 Franklin St., East Orange, N. J.

RECORDER CLEANER uses bottle-contained felt applicator to clean tape-recorder heads, capstan pressure rollers and guides. Won't mark or mar plastic parts of machines.—**Chemtronics, Inc.,** 122 Montgomery St., Brooklyn 25, N. Y.

TRANSISTOR INTERCOM KIT *model XI-1* master station calls any combination of 5 remotes. Uses eight ordinary C flashlight cells for 300 hours on. Not used when systems not talking. Remote stations *XIR-1* are 45-ohm 4½-in speakers. Master

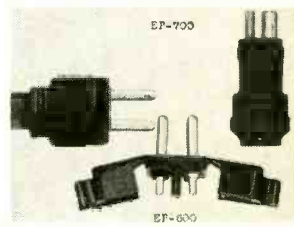
handles up to five remotes.—**Heath Co.,** Benton Harbor, Mich.

ANTENNA MIXING NETWORK *series TX* low-loss, high-isolation units accept signals from up to 9 antennas for



transmission over single lead. *Model TX-FM* combines TV and FM signals.—**Jerrold Electronics Corp.,** 15th and Lehigh Ave., Philadelphia 32, Pa.

MASTER TV CONNECTORS *Tug-Plug* permit plug-in connections without special tools for installation. *EP-600* fits 300-ohm ribbon lead; *EP-700* for



RG-59/U coaxial line.—**Entron, Inc.,** Box 287, Blandensburg, Md.

GET *more!* DO *more!* MAKE *more!*

PROFIT PROFESSIONALLY ON EVERY CALL WITH

NEW B&K LOW-COST PROFESSIONAL Model 550 *DYNA-QUIK*

DYNAMIC MUTUAL CONDUCTANCE TUBE TESTER

Model 550

NET $119.95

Every service-technician now can easily check tubes the B&K professional way! Only with a *genuine dynamic mutual conductance tube tester* can you make a complete and accurate test under the actual dynamic operating conditions of the TV set. The compact new "550" is not just an emission checker. *It completely checks more tubes faster*—with laboratory accuracy. And the cost is so amazingly low, it pays its way over and over again! Take a tip from thousands of professional servicemen—*use B&K Dyna-Quik*. There is nothing like it.

Get More for Your Money
—IN SPEED, ACCURACY, AND VALUE

Save Customers
—SAVE CALL-BACKS, SAVE COST

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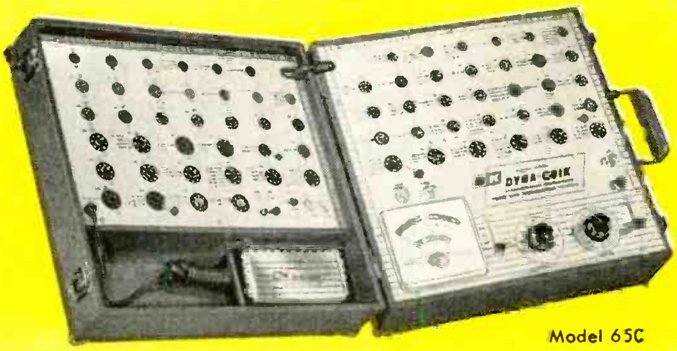

Model 650

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B&K

B&K MANUFACTURING CO.
1801 W. BELLE PLAINE AVE • CHICAGO 13, ILL.

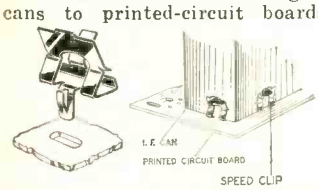
Canada: Atlas Radio Corp., 50 Wingold, Toronto 10, Ont.
Export: Empire Exporters, 277 Broadway, New York 7, U.S.A.

TUBE SAVER is compact unit plugging into wall socket. *TV Life Saver* reduces initial current surge through tube heaters using the *Surgistor* developed by

the company. Two models, for 100–275-watt sets, and for 250–400 watts.—**Wuerth Tube Saver Corp.**, 9125 Livernois Ave., Detroit 4, Mich.

HIGH-STRENGTH ADHESIVE bonds up to 3,000 lbs per square inch. Impervious to water, solvents, temperature changes. Base resin and hardener are mixed just prior to use.—**G-C Electronics Co.**, 400 S. Wyman St., Rockford, Ill.

SPEED CLIP for mounting if cans to printed-circuit boards

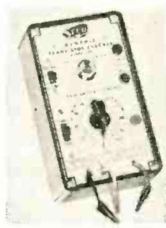


requires no tools; makes ground connection also. Removed with simple tool.—**Tinnerman Products, Inc.**, Box 6688, Cleveland 1, Ohio.

CAPACITOR SUBSTITUTION BOX *model SW-142*. 8-position switch for eight common values

from .001 to 0.25 μf. All capacitors rated at 6,000 volts.—**Olson Radio Corp.**, 260 So. Forge St., Akron, Ohio.

DYNAMIC TRANSISTOR CHECKER model 100 tests wide range of types under circuit conditions, using 1.5-volt battery in checker. NE-51 glows if transistor is good, stays out if bad. Handles and safely identifies n-p-n and p-n-p types. Varying base current with control knob al-



lows matching transistors by noting point at which neon glows. Output jacks for scope or ac meter, clip-on self-storing leads available when use of transistor socket not practical.—SECO Mfg. Co., 5015 Penn Ave. So., Minneapolis, Minn.

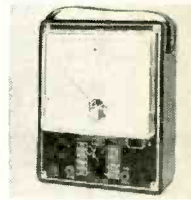
FM TEST GENERATOR KIT *model FMO-1* provides output for all rf, if and detector sections of FM sets and tuners. 90, 100 and 107 mc. 400-cycle modulation available; audio also available separately. 10.7-mc

variable sweep width 200-kc to over 1 mc for if alignment. 100-kc markers each side of 10.7 marker. 10-mc crystal-controlled oscillator for calibration.—**Heath Co.**, Benton Harbor, Mich.

VOLT-OHM-MILLIAMETER *model 109*. 4½-in meter, 40 μa movement. Five ac voltage ranges to 3,000 volts at 10,000 ohms per volt, five dc ranges to

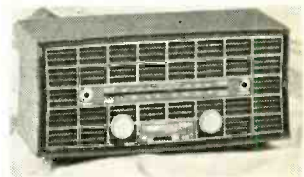
3,000 volts at 20,000 ohms per volt, three each alternating- and direct-current ranges, three resistance ranges to 20 megohms. Kit or factory-wired.—**Electronic Measurements Corp.**, 625 Broadway, New York 12, N. Y.

POCKET VOM KIT *83Y708* 13 ranges, 1,000 ohms per volt. Five dc ranges to 500 volts, four ac ranges to 500 volts, three direct-current ranges to 100 ma, one resistance range to 30,000



ohms. 2½-inch meter.—**Allied Radio Corp.**, 100 N. Western Ave., Chicago 80, Ill.

AIRCRAFT-BAND receiver covers aircraft frequencies 108–130 mc and standard broadcast band. Built-in antenna, speaker, 2 phone jacks. 110 volts ac. Kit



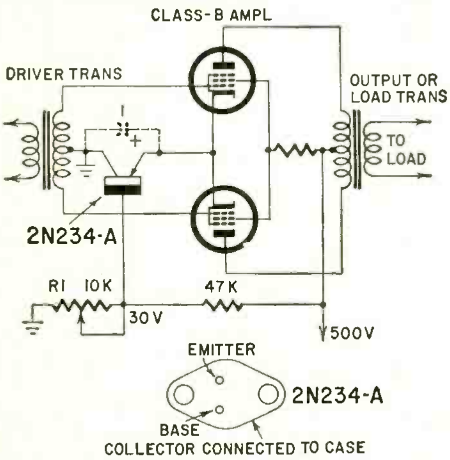
to convert for auto use available.—**Nova-Tech, Inc.**, 1721 Sepulveda Blvd., Manhattan Beach, California.

All specifications on these pages are from manufacturers' data.

NOTEWORTHY CIRCUITS

CLASS-B BIAS CIRCUIT

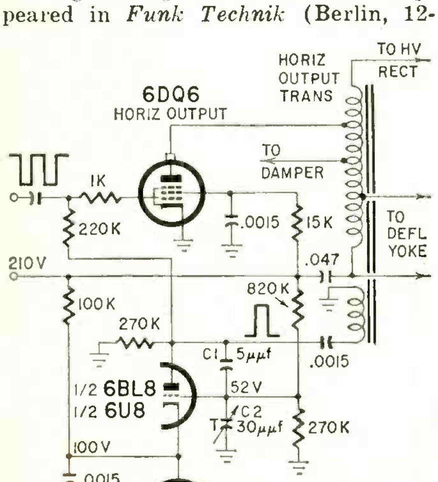
The transistor bias circuit is recommended for use in portable Class-B amplifiers and modulators where a negative grid bias supply is not available. The transistor can be used to sup-



ply well-regulated bias to the class-B amplifier's cathode. The cathode voltage will be equal to the bias voltage, which should be adjusted with R1 for the particular tube being used. The transistor should be bypassed by a 1-μf capacitor (dashed lines) for hi-fi applications.—*Bendix Semiconductors*

WIDTH STABILIZATION

A clever circuit for stabilizing picture size against supply-voltage variations and high-voltage current variations appeared in *Funk Technik* (Berlin, 12-



58). The diagram shows that only an additional triode is needed—here the triode section of a 6BL8 or 6U8.

A varistor is connected between the triode's cathode and ground to stabilize cathode potential at 100 volts. A resistance divider between B-plus and ground sets the grid voltage at 52, so the grid is normally 48 volts negative with respect to the cathode and the tube is cut off. There is no plate current, and the horizontal output tube's grid simply returns to ground through two resistances in series.

A separate winding on the horizontal output transformer provides a positive pulse proportional to the output of the power stage. It is applied to the triode's plate and simultaneously to its grid through a voltage divider made up of capacitors C1 and C2.

During retrace, the triode conducts and passes a current which is mainly a function of its grid voltage, that is a function of the output power and also of the dc supply voltage since its fixes the grid's dc potential. The voltage drop developed across resistor R is used as a bias for the horizontal output tube.

Experimental results show that picture width does not vary appreciably for tube currents between 50 and 150 μa, and for B-plus voltages between 170 and 250.—*M. De France* END

Technotes

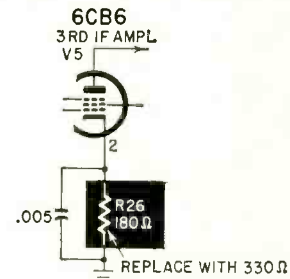
RCA 7-BT-9J

If you don't get any audio output from this transistor radio, make sure that the crystal diode detector (CR1) is not shorted to the can of the third if transformer (T4). Place a piece of tape on the can to cover the spot that the diode might contact. —*C. S. Lawrence*

SPARTON 21322

The set lost sync on strong locals but was OK on weaker channels.

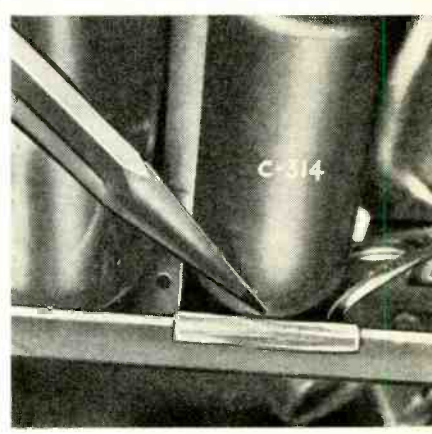
The scope showed sync compression originating in the last if amplifier. The



cure called for replacing cathode resistor R26, 180 ohms, with a larger value, 330 ohms. The added bias permits a more normal input to the video detector from the third if amplifier.—*Phillip Monroe*

G-E PORTABLE MM

The set had a slightly undersized raster and sound and picture were missing. Resistance checks indicated a short on the 135 volts developed at the cathode of the audio output tube. This line feeds the if and other tubes. Since the short remained even with these



tubes removed, the chassis was wiggled out of the case—and the short vanished. Flexing the chassis would make the short come and go.

Close inspection revealed that the can terminal of capacitor C314 was grounding to the chassis apron. After moving the capacitor to clear the short, a piece of plastic insulating tubing was cemented to the apron to prevent a recurrence of the fault.—*Allan F. Kinckiner*

EMERSON 163-D

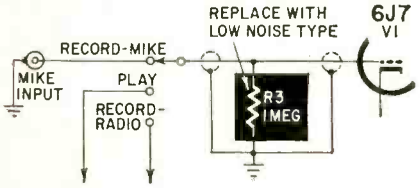
Complaint: No high voltage.

Reason: Horizontal output transformer has high resistance. Check B-boost voltage. If it is 200 volts instead of the normal 430, and everything else checks normal, measure the resistance between horizontal output transformer terminals 5, 4 and 6. If you find 150 ohms or higher instead of 36, replace the transformer.—*Harry C. Keller*

BRUSH SOUNDMIRROR MODEL 414

Complaint: Noisy recording and reproduction.

Cure: Replace 1-megohm resistor R3 (grid leak resistor of first amplifier,



V1) with a deposited film or other relatively noiseless type of resistor. Do not overheat while soldering the replacement into position or it may become noisy also.—*Lawrence Shaw*

HORIZONTAL FOLDOVER

One headache problem in older TV receivers is horizontal foldover. This trouble is usually caused by a longer retrace time in the flyback transformer than in the horizontal oscillator, and frequently occurs in sets that use the Synchroguide circuit.

Since the trouble is associated with a characteristic of circuit components, no easy cure is available. But the simplest way to overcome the foldover is to blank it out. Only a narrow band of the picture is lost.

The easiest way to blank out the foldover is by using the picture tube's first anode. Simply connect 100,000 ohms and 400,000 ohms resistance in series between the damper tube's plate and cathode. The lead from the picture tube's first anode should be connected to the junction of these resistors. If this does not completely cure a particular case of foldover, substitute 330,000 ohms for the 400,000 ohms recommended. If you get too much blanking, increase the 400,000 ohms to about 470,000 ohms.—*Blackburn Hall*

G-E 646 PORTABLE RADIO

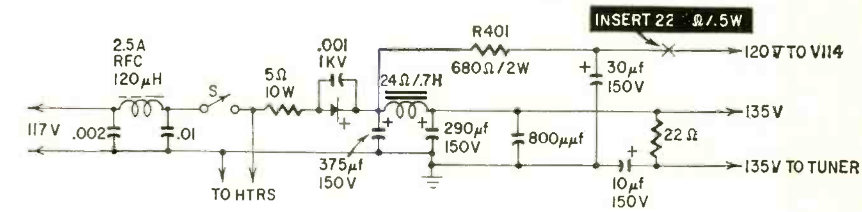
The set would not track the low-frequency stations properly. No low frequency adjustment of the oscillator coil is provided nor is a padder capacitor available for low-frequency adjustment.

A turn of No. 18 solid wire was fashioned into a loop which could be moved up and down on the oscillator coil. One end of the loop was grounded to B-minus. To get satisfactory low-frequency tracking, the loop adjustment was manipulated. Then the high-frequency trimmers were readjusted as in any other alignment when the coil inductance is shifted.—*A. R. Clawson*

G-E 14P1209

Complaint: Barkhausen oscillation which appears only on channel 5.

Add a 22-ohm ½-watt carbon resistor in series with the audio output tube's (V114) B supply and resistor R401 (see diagram).—*Larry Steckler* END



new PATENTS

AUTOMATIC TUNING FOR RF TRANSMITTER

Patent No. 2,860,249

Robert W. Merriam, Seekonk, Mass.

This circuit tunes itself. Bimetal spirals are connected in the rf path. When heated by the current, the spirals tend to expand, causing rotation of the variable capacitor.

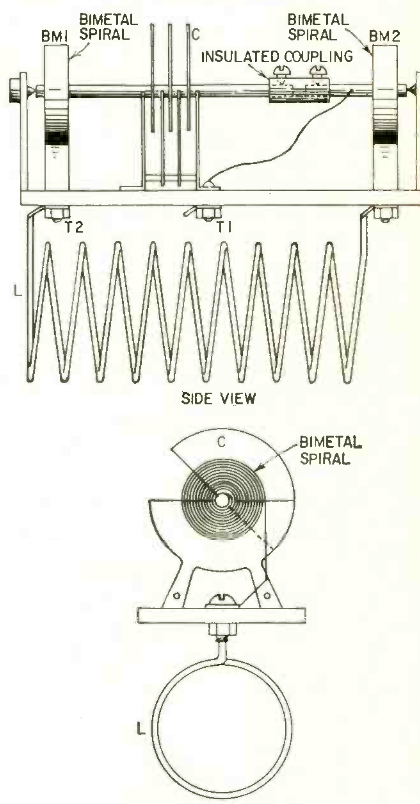


Fig.1

Fig. 1 shows a physical arrangement of the components. Fig. 2 is the corresponding diagram. When the tank is in tune, equal currents flow in L and C, so each bimetal spiral (BM) exerts the same force. Since the spirals are wound to

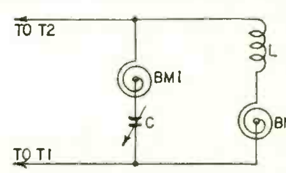


Fig.2

oppose each other, there is no net force. If the tank is off tune, more current will flow through L or C, as the case may be. Then C will tend to rotate until tuning is restored.

DIODE AMPLIFIER

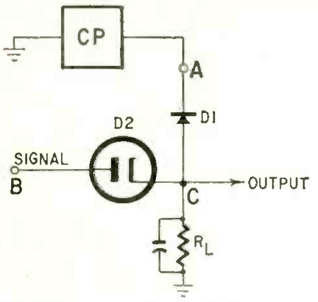
Patent No. 2,879,409

Arthur W. Holt, Silver Spring, Md. (assigned to USA, as represented by Secretary of Commerce)

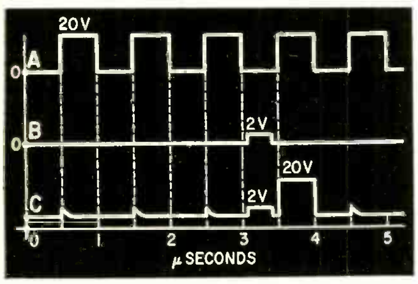
A diode blocks when its cathode is more positive than its anode. In a semiconductor, blocking cannot occur instantly after a period of conduction. This is because the carriers remaining in the semiconductor must first be swept out. For a short time after reverse bias is applied, a large reverse current flows. This principle is used to obtain pulse amplification in a diode.

CP is a clock-pulse or square-wave generator which energizes amplifying diode D1. Positive pulses from a signal source pass through a second diode, D2. Output is taken across R_L. The diagram shows how voltages vary at points A, B and C, with respect to time.

D1 is reverse-biased by the 1-mc pulse from



CP, so it does not conduct. At 3 μsec, a signal pulse (2 volts positive) is impressed. Since CP is zero at the time, it constitutes forward bias for D1. Thus the next CP causes a large reverse current through D1 and R_L. With a



typical gain of 10, the output pulse will be 20 volts.

Diode D1 may be considered to behave like a transistor under the rapidly reversing bias. During the instant of *forward* bias, the diode acts like an emitter-base junction. During *reverse* bias, it acts like a collector-base junction.

IGNITION SYSTEM

Patent No. 2,898,392

Ralph L. Jaeschke, Kenosha, Wis. (Assigned to Eaton Mfg. Co., Cleveland)

This system has a transistor and a transformer to generate sparks. Oscillator V is protected against surges by diode D1. GEN is a four-pole generator (only two are shown) of low

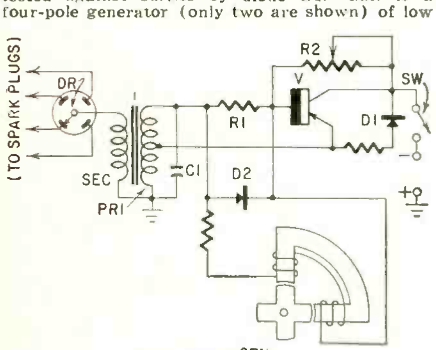


Fig.1

frequency. It is driven at half the engine's speed.

The generator's output is a flattened wave whose negative peaks are further clipped by diode D2 to a suitable value to bias the transistor. At −3 volts on the base, V begins to

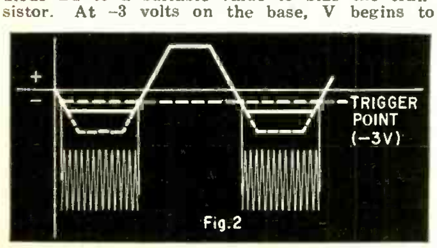


Fig.2

oscillate. During the other half-cycles, V is blocked. The oscillator frequency is about 15 kc, and T-C1 are tuned to it.

Transformer T's secondary induces a voltage of about 10 kv which is delivered to the spark plugs through rotor DR. END

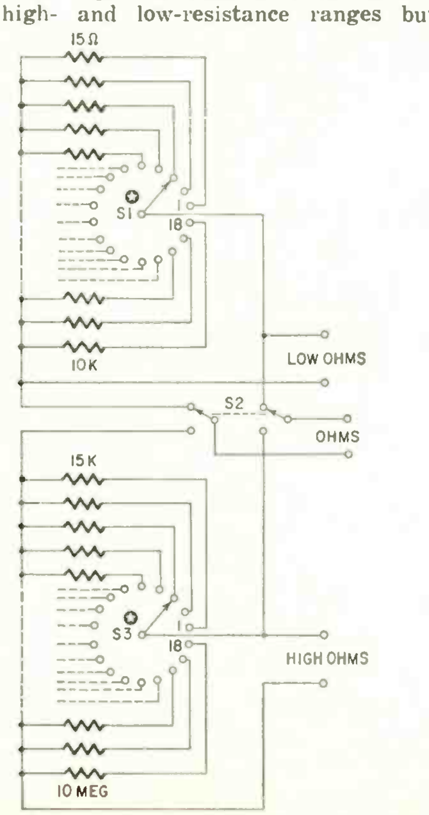
DON'T USE A HEAT LAMP

Instead of using a heat lamp to make an intermittent set act up, I use a soldering pencil (mine has a 37-watt tip) because the lamp heats up too large an area, making it difficult to localize the component which is changing value greatly or opening or shorting because of heat.

I lay the point of the pencil on suspected components, plate and cathode parts first because they carry the greatest current; screen resistors and bypass capacitors next. Grid resistors rarely get hot so I skip them. I leave the hot tip on each component long enough to heat it up, but not enough to ruin it, meanwhile watching the screen. The system works fine! It's important to wait for each component to cool down after testing before trying the next part. Heat lamps are for the birds!—*George Hrischenko*

RESISTANCE-BOX MODIFICATION

Some resistance substitution boxes have separate selector switches for high- and low-resistance ranges but



✪ S1 & S3 ARE SIMPLIFIED DRAWINGS OF 18 POINT RANGE SWITCHES IN EICO 1100

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only a single set of output terminals. A simple modification lets the operator use low and high ranges simultaneously. This greatly increases their utility in such applications as circuit design. For example, the low range may be used as a variable cathode resistor while the high range is used as a variable plate resistor. Also, the high range can be parallelled across the low range for precise low-range trimming to values not in the original box. Or the low range can be connected in series with the high to permit similar trimming of the high-range values.

In the modified box, individual ranges are fully isolated from each other and connected to two sets of binding posts, which are added to the box. The original spdt switch is replaced with a dpdt unit. This way the original output binding posts can be switched to either of the resistance ranges.

This modification was made to an Eico model 1100K resistance box, but is also applicable to others of similar design. In the Eico box, the additional binding posts are conveniently arranged in a line with the original pair with standard ¾-inch spacing between members of a pair.—*Edward Buder*

DRILLING THIN METAL

When drilling thin metal, brace it so it won't bend by using a soldering iron to stick on a blob of solder at the site of the center punch mark.

The diameter of the solder should be slightly smaller than the drill used and 1/16 inch thick. The solder easily gives way to the drill and holds it there until the hole is started.

Even more accurate drilling is possible if the top of the solder is flattened by filing.—*Harvey Muller*

TURNING TOUGH SCREWS

In cramped quarters on a chassis where it's difficult to turn a screw with an ordinary screwdriver, I use a blade from an interchangeable screwdriver set chucked in a tap wrench. This tool not only enables me to turn screws in inaccessible places, but the T-handle gives better leverage on other jobs.—*Allen C. Johnston*

COLOR-CODE THOSE TOOLS

If you have trouble keeping the tools you carry in your toolkit from getting mixed up with bench tools in the shop, mark the toolkit ones with bands of bright-colored cellophane tape. If you have ever unloaded your pockets on the bench at the end of a busy day and neglected to put the contents back in your toolkit for use the next day, you'll truly appreciate this kink. The tape is more durable than paint so it won't wear off with frequent handling. If you have more than one kit of tools you want to keep separate, use two colors of tape.—*John C. Abraham*

LIQUID METAL SERVICE AID

Ever attempt to replace a back on a TV set only to find the screw holes stripped and too enlarged for the screws?

Whenever I encounter a minor problem of this type, I just reach into my toolkit for the tube of liquid metal that I carry. Now available at most hardware stores, the liquid plastic-powdered metal compound is very handy for many minor service problems. It dries hard like metal and can be used to mend wood, plastic, porcelain, glass and all kinds of metals. It can be drilled, filed, sanded, sawed and painted. Don't try to use it for solder joints designed to pass electricity, though—most of these compounds are pretty good insulators!—*Joe J. Carlson*

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.

TINY TRANSISTOR TRANSFORMERS for industrial use are listed in *catalog 275*. Several size groups in a variety of types and inpedances are detailed. Others can be wound to specifications. Smallest ones measure only 0.237 x 0.340 x 0.280 inch and weigh only .05 ounce.—**Frank Kessler Co. Inc.**, 41-45 47th St., Long Island City 4, N. Y.

CAPACITORS FOR INDUSTRIAL and commercial use are listed with dimensions and brief specifications in a 6-page catalog of the company's complete capacitor line.—**Astron Sales Corp.**, 255 Grant Ave., East Newark, N. J.

AC VOLTMETER battery - operated *model 403A* is described with complete specifications in a 2-page catalog sheet. —**Hewlett-Packard Co.**, 275 Page Mill Road, Palo Alto, Calif.

UNIVERSAL TUBE TESTERS are discussed by Bud Tomer in *Tech Tips* bulletin *PA-500, The Final Authority*, which points out why the equipment is the best for testing tubes.—**CBS Electronics**, Danvers, Mass.

TUBE AND TRANSISTOR TESTERS and other servicing instruments are pictured and described with prices in a small 6-fold brochure.—**Seco Mfg. Co.**, 5015 Penn. Ave. S., Minneapolis, Minn.

MICROMINIATURE CAPACITOR electrical and physical characteristics with charts and drawings covering values to .01 μf are shown on 2-page catalog sheet.—**Vitramon, Inc.**, Box 544, Bridgeport, Conn.

TANTALUM AND ALUMINUM capacitors are described with specifications and dimensions in each of two 4-page bulletins. *GEA-7008* concerns high-capacitance small-size tantalum units for low-voltage transistor applications; *GEA-6819A*, computer-grade aluminum units of 300 to 150,000 μf. — **General Electric Co.**, Schenectady 5, N. Y.

AN/MS CONNECTORS for Government and commercial use are listed with diagrams of pin connections and wire sizes. Plugs accommodating from 1 to

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The Progressive Radio "Edu-Kit" is the foremost educational radio kit in the world, and is universally accepted as the standard in the field of electronics training. The "Edu-Kit" uses the modern educational principle of "Learn by Doing." Therefore you construct, learn schematics, study theory, practice trouble-shooting—all in a closely integrated program designed to provide an easily-learned, thorough and interesting background in radio.

You begin by examining the various radio parts of the "Edu-Kit." You then learn the function, theory and wiring of these parts. Then you build a simple radio. With this first set you will enjoy listening to regular broadcast stations, learn theory, practice testing and trouble-shooting. Then you build a more advanced radio, learn more advanced theory and techniques. Gradually, in a progressive manner, and at your own rate, you will find yourself constructing more advanced multi-tube radio circuits, and doing work like a professional Radio Technician.

Included in the "Edu-Kit" course are sixteen Receiver, Transmitter, Code Oscillator, Signal Tracer, and Signal Injector circuits. These are not unprofessional "breadboard" experiments, but genuine radio circuits, constructed by means of professional wiring and soldering on metal chassis, plus the new method of radio construction known as "Printed Circuitry." These circuits operate on your regular AC or DC house current.

THE "EDU-KIT" IS COMPLETE

You will receive all parts and instructions necessary to build 16 different radio and electronics circuits, each guaranteed to operate. Our Kits contain tubes, tube sockets, variable, electrolytic, mica, ceramic and paper dielectric condensers, resistors, tie strips, coils, hardware, tubing, punched metal chassis, Instruction Manuals, hook-up wire, solder, etc.

In addition, you receive Printed Circuit materials, including Printed Circuit chassis, special tube sockets, hardware and instructions. You also receive a useful set of tools, a professional electric soldering iron, and a self-powered Dynamic Radio and Electronics Tester. The "Edu-Kit" also includes Code Instructions and the Progressive Code Oscillator, in addition to F.C.C.-type Questions and Answers for Radio Amateur License training. You will also receive lessons for servicing with the Progressive Signal Tracer and the Progressive Signal Injector, a High Fidelity Guide and a Quiz Book. You receive Membership in Radio-TV Club, Free Consultation Service, Certificate of Merit and Discount Privileges. You receive all parts, tools, instructions, etc. Everything is yours to keep.

SERVICING LESSONS

You will learn trouble-shooting and servicing in a progressive manner. You will practice repairs on the sets that you construct. You will learn symptoms and causes of trouble in home, portable and car radios. You will learn how to use the professional Signal Tracer, the unique Signal Injector and the dynamic Radio & Electronics Tester. While you are learning in this practical way, you will be able to do many a repair job for your friends and neighbors, and charge fees which will far exceed the price of the "Edu-Kit." Our Consultation Service will help you with any technical problems you may have.

J. Stataitis, of 25 Poplar Pl., Waterbury, Conn., writes: "I have repaired several sets for my friends, and made money. The "Edu-Kit" paid for itself. I was ready to spend $240 for a Course, but I found your ad and sent for your Kit."

FROM OUR MAIL BAG

Ben Valerio, P. O. Box 21, Magna, Utah: "The Edu-Kits are wonderful. Here I am sending you the questions and also the answers for them. I have been in Radio for the last seven years, but like to work with Radio Kits, and like to build Radio Testing Equipment. I enjoyed every minute I worked with the different kits; the Signal Tracer works fine. Also like to let you know that I feel proud of becoming a member of your Radio-TV Club."

Robert L. Shuff, 1534 Monroe Ave., Huntington, W. Va.: "Thought I would drop you a few lines to say that I received my Edu-Kit, and was really amazed that such a bargain can be had at such a low price. I have already started repairing radios and phonographs. My friends were really surprised to see me get into the swing of it so quickly. The Troubleshooting Tester that comes with the Kit is really swell, and finds the trouble, if there is any to be found."

PRINTED CIRCUITRY

At no increase in price, the "Edu-Kit" now includes Printed Circuitry. You build a Printed Circuit Signal Injector, a unique servicing instrument that can detect many Radio and TV troubles. This revolutionary new technique of radio construction is now becoming popular in commercial radio and TV sets.

A Printed Circuit is a special insulated chassis on which has been deposited a conducting material which takes the place of wiring. The various parts are merely plugged in and soldered to terminals.

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Progressive Building, Dept. 160G, 1184-86 Broadway, Hewlett, N. Y.

52 contacts are shown in this 4-page catalog sheet of Amphenol connectors.—**Schweber Electronics**, 60 Herricks Rd., Mineola, N. Y.

MULTIPLIER PHOTOTUBES are thoroughly explained, their applications described and typical circuits given in the 72-page second edition of *Multiplier Photo-Tubes* — **Industrial Tube Sales Div., A. B. DuMont Laboratories, Inc.**, Clifton, N. J. $1.

ANTENNA CATALOG includes technical data, pickup patterns, detailed drawings of over 40 antennas for Government, commercial and amateur service, along with towers, baluns and rotation and indication systems. *Technical Data and Catalog* has 41 pages.—**Telrex Laboratories**, Asbury Park 25, N. J.

MICROMHOMETER for professional tube testing is pictured and described in this 8-page brochure. *Model WT-100A* details are in booklet 3F771.—**Commercial Engineering Dept., RCA Electron Tube Div.**, 415 S. 5th St., Harrison, N. J.

SWITCHING TRANSISTORS for medium and high speeds are listed with full characteristics and typical operating conditions in the 24-page booklet *Medium and High-Speed Switching Transistors.* — **Sylvania Electric Products Inc.**, 1100 Main St., Buffalo, N. Y.

VOLTAGE REGULATORS with transistor electronics, *IET series* (Instantaneous Electronic Transistorized) are shown with ratings, dimensions and weights in 8-page bulletin *SE-L2596. IET Stabiline* units have input range of 95–135 volts and adjustable output of 110–120 volts.—**Superior Electric Co.**, Bristol, Conn.

DIALS, DRIVES, POINTERS and associated mechanisms including planetary drives and vernier dials are shown with dimensions in 8-page *Bulletin 59-6.*—**National Radio Co., Inc.**, 37 Washington St., Melrose 76, Mass.

ASSEMBLY TOOLS for electronic bench work, including special screw and nut drivers; many styles of tweezers; various pliers, cutters and nippers; special soldering and holding aids are shown in a 16-page catalog *Component Assembly Tools and Instruments.*—**R. N. Hunter Sales Co., Inc.**, 9851 Alburtis Ave., Santa Fe Springs, Calif.

AMPLIFIER MEASUREMENTS, new booklet prepared by Institute of High Fidelity Manufacturers committee, is the second in the institute's series of high-fidelity component standards. It follows the earlier *Standard Methods of Measurements for Tuners.* — **IHFM**, 125 E. 23rd St., New York 10, N. Y. $1.

SPECTRUM ANALYZERS, curve tracers, sweep-frequency generators and special-purpose instruments for ultrasonic and microwave study are detailed in a 12-page *Catalog Digest.* — **Panoramic Radio Products, Inc.**, 520 S. Fulton Ave., Mount Vernon, N. Y. END

MOVING?

If you're moving please don't forget to send us your old address as it appears on your latest copy of the magazine. Include the numbers shown beside your name. If possible, send us the actual address label which is pasted on the lower right hand corner of the front cover. Be sure to include your postal zone number (if any) with your new address. If we receive this information before the 20th of the month, you will continue to get RADIO-ELECTRONICS without interruption.

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BUSINESS and PEOPLE

Edward J. Danneberg was elected to the new post of vice president for personnel of Tung-Sol Electric, Newark, N. J. He had been director of industrial relations.

E. Leslie Peter was appointed sales manager of the newly formed Canadian division of Tung-Sol Sales Corp., with offices in Montreal. He has served with Tung-Sol in various managerial capacities since 1957.

Raymond T. Leary was appointed general sales manager of Cornell-Dubilier Electric Corp., South Plainfield, N. J. He had been vice president and sales manager of the Distributor Div.

Joseph Ferrante joined the company as research director in dielectrics at the new research laboratory in Norwood, Mass. He comes to Cornell-Dubilier from Tobe Deutschmann Corp.

K. B. (Ken) Price joined Merit Coil & Transformer Corp., Hollywood, Fla., as sales manager. He comes from Sprague Products Co., where he was regional sales supervisor.

David H. McGalliard joined the Daystrom-Weston Sales Div. of Daystrom, Inc., Murray Hill, N. J., as distributor sales manager. He'd been with Remington Rand.

R. Edward Lawrence was appointed manager, industrial tubes and semiconductors-Merchandising, for RCA Electron Tube Div.'s Distributor Products Dept., Harrison, N. J. He had been manager, merchandising-semiconductor products for the department.

Supreme Electronics Corp., subsidiary of Hickok Electrical Instrument Co., broke ground for a 25,000-square-foot addition to its plant in Greenwood, Miss. R. D. Hickok, president of Hickok, and David Hughes, director of marketing (second and third from right), attended the ground-breaking ceremonies along with E. G. Perkins, president of Supreme (second from left), and local civic officials.

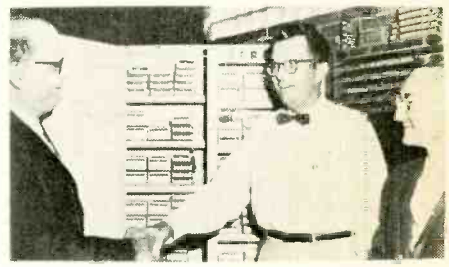
Donald L. Mauer was named a sales engineer for Triplett Electrical Instrument Co., Bluffton, Ohio. He joined the sales staff of the company last summer and has an extensive background in electronics sales work.

Carl L. Sundberg was named distributor sales manager for Oxford Components, a division of Oxford Electric Corp., Chicago. He had been with Oxford in various departments including production, expediting, and in a supervisory capacity in all phases of manufacturing and engineering.

Don Kirkendall was appointed assistant manager of advertising and sales promotion of Electro-Voice, Inc., Buchanan, Mich. He had been with Interstate Electronics Supply Corp. He succeeds **Dean Nordquist** who was recently named assistant sales manager of the Electro-Voice Cartridge & Needle Div.

Thomas E. Gootée joined Page Communications Engineers, a subsidiary of Northrop Corp., Washington, D. C., as assistant director of maintenance and operations. He accepted the position after a 17-year civilian–military career with the Army, where he was in communications–electronics work since World War II, most recently as civilian liaison official for the Office of the Chief Signal Officer.

Aerovox, New Bedford, Mass., awarded first prize in its "Name This Cabinet" contest held at the Parts Show in Chicago in May, to Doug Ealy, purchasing agent for Southwest Wholesale Radio, Inc., Phoenix, Ariz., who suggested the name "Capaci-Door." The winner received a cabinet with $500 worth of Aerovox electrolytic capacitors



as his prize. Matt Simon (left), sales manager for the Aerovox Distributor Div., is shown making the award while Verne Linsley, area sales representative, looks on.

Reed Waldron was promoted to sales promotion manager of the Distributor Div. of International Resistance Co., Philadelphia, Pa. He has been on the staff since 1955, most recently as promotional assistant in the Distributor Div.

Harold Seagren joined Audiotex Mfg. Co., Division of G-C-Textron, Rockford, Ill., as Eastern sales manager. He was formerly with F. W. Means & Co.

EIA PRODUCTION AND SALES

(first 9 months)	*1959*	*1958*
TV set production	4,488,857	3,572,189
Radio production	10,927,252	7,686,197
FM radio production	367,804	176,061
TV retail sales	3,811,754	3,468,090
Radio retail sales	5,285,878*	4,556,545*
Receiving tube factory sales	315,797,000	291,718,000
Picture tube factory sales	6,857,682	5,844,665

*Excluding auto receivers

Lewis T. Stein, merchandising assistant in the Industrial Components Div. of Allied Corp., Chicago, was promoted to the position of product merchandiser. END

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TYPE	EACH	TYPE	EACH	TYPE	EACH	TYPE	EACH	TYPE	EACH
OZ4	$ .85	5CQ8	1.30	6BF5	1.35	6DQ6	1.10	12AV6	.60
1AX2	.70	5J6	.75	6BF6	.55	6DT6	.60	12AV7	.85
1B3	.95	5T8	.86	6BG6	2.25	6J5	.70	12AX4	.95
1S5	.60	5U4G/GB	.75	6BH6	.70	6J6	.60	12AX7	.65
1T4	.55	5U8	.75	6BH8	.90	6K6	.80	12B4	.70
1U4	.45	5V6	.55	6BJ6	.65	6L6	1.15	12BA6	.60
1U5	.55	5Y3GT	.55	6BK5	1.40	6S4	.60	12BD6	.60
1X2A/B	.95	6AB4	.55	6BK7A/B	.90	6SA7	.80	12BE6	.60
2AF4	1.00	6AC7M	.90	6BL7	1.55	6SC7	.80	12BH7	.80
3AF4	1.05	6AF4	1.05	6BN6	.75	6SK7	.75	12BQ6	1.10
3AL5	.46	6AG5	.65	6BQ5	.70	6SL7	.90	12BY7	.80
3AU6	.55	6AG7M	1.25	6BQ6	1.10	6SN7	.85	12C5	.60
3AV6	.45	6AH4	1.30	6BQ7A	1.10	6SQ7	.85	12CU5	.60
3BN6	.75	6AH6	1.35	6BR8	.95	6T4	1.00	12CU6	1.10
3BU8	.75	6AK5	.85	6BU8	.70	6T8	.95	12DQ6	1.10
3BY6	.60							12F8	.65
3BZ6	.60							12K5	.70
3CB6	.60							12L6	.65
3CF6	.65							12SA7	1.00
3CS6	.60							12SK7	.85
3DT6	.55	6AL5	.55	6BX7	1.65	6U8	.85	12SN7	.90
3Q4	.65	6AM8	.85	6BY6	.60	6V6	.80	12SQ7	.90
3S4	.65	6AN8	.95	6BZ6	.65	6W4	.80	12V6	.55
3V4	.70	6AQ5	.55	6BZ7	1.10	6W6	.95	12W6	.75
4BC8	1.00	6AS5	.90	6C4	.50	6X4	.45	12X4	.45
4BN6	.75	6AT6	.55	6CB6	.70	6X5	.65	19AU4	.85
4BQ7A	1.10	6AT8	.85	6CD6	1.70	6X8	.85	19T8	1.00
4BS8	1.00	6AU4	1.00	6CF6	.70	6Y6	.95	25AX4	1.15
4BZ7	1.10	6AU5	1.75	6CG7	.65	8AU8	.90	25BQ6	1.10
4CB6	.60	6AU6	.65	6CG8	.80	8AW8	.95	25CD6	1.50
4DT6	1.00	6AU8	.90	6CL6	1.35	8CG7	.65	25CU6	1.10
5AM8	.80	6AV5	1.60	6CM7	.70	10DE7	1.15	25DQ6	1.10
5AN8	.85	6AV6	.55	6CN7	.70	11CY7	.75	25L6	.85
5AQ5	.55	6AW8	.90	6CQ8	1.35	12AD6	.55	25W4	1.10
5AT8	.85	6AX4	.95	6CS6	.70	12AF6	.60	35C5	.65
5AU4	.95	6BA6	.65	6CS7	1.15	12AQ5	.56	35L6	1.00
5BK7	.90	6BC5	.60	6CU5	1.00	12AT6	.60	35W4	.50
5BQ7	.98	6BC8	1.10	6CU6	1.10	12AT7	.76	35Z5	.70
5CG8	.85	6BD6	.65	6CY7	.75	12AU6	.60	50C5	.70
5CL8	.80	6BE6	.55	6DE6	.70	12AU7A	.70	50L6	.75

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Quan.	Type	Quan.	Type	Quan.	Type	Quan.	Type
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3	1B3	1	6AS5	1	6CD6	5	12AU7A
1	1R5	1	6AT6	1	6CG7	1	12AV6
1	1S5	1	6AT8	1	6CM7	1	12AX7
1	1T4	5	6AU6	2	6CU6	1	12B4
1	1U4	1	6AU8	1	6DQ6	3	12BA6
1	1U5	1	6AV6	5	6J6	1	12BE6
3	1X2A/B	1	6AW8	1	6K6	2	12BH7
1	3CB6	2	6AX4	1	6S4	1	12BQ6
1	3V4	3	6BA6	1	6SA7	1	12BY7
1	5AM8	1	6BC5	1	6SK7	1	12CU6
1	5AQ5	1	6BC8	5	6SN7	1	12SA7
1	5J6	2	6BE6	1	6SQ7	1	12SK7
3	5U4G	1	6BG6	1	6T8	1	12SN7
1	5U8	1	6BH6	5	6U8	1	12SQ7
2	5Y3	1	6BJ6	2	6V6	1	25BQ6
1	6AC7M	1	6BK7A	2	6W4	1	25CU6
3	6AG5	1	68N6	1	6W6	1	25L6
1	6AH6	2	6BQ6	1	6X4	2	35W4
1	6AK5	2	6BQ7A	1	6X5	1	35Z5
5	6AL5	1	6BZ6	2	6X8	2	50C5
1	6AM8	2	6BZ7	1	7AU7	2	50L6
1	6AN8	1	6C4	1	12AT6		

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MISSILES AND SATELLITES, by David Mark. Cowan Publishing Corp., 300 W. 43 St., N. Y. 36, N. Y. 6 x 9 in. 96 pp. $1.50.

Space travel is such an interesting and mysterious topic that it is sometimes difficult to tell where truth ends and fiction begins. Here is a factual account that will make good reading for technicians and laymen. It tells of missiles, from the early Chinese rockets to the present.

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TRANSISTORS IN RADIO, TV AND ELECTRONICS by Milton S. Kiver. McGraw-Hill Book Co., Inc., 330 W. 42 St., N. Y. 36, N. Y. 6 x 9 in. 424 pp. $7.95.

This new edition will bring the technician up to date on transistor practice and use. It begins with basic theory of semiconductors, showing what they are and how they work. Subsequent chapters describe their applications. Practical circuits are given, many with actual component values.

The author discusses recent developments in transistors, service techniques, amplifier design and gives a number of experimental circuits that the reader may build. A thorough exposition for the serious practical experimenter and technician.—*IQ*

BASIC ELECTRONIC TEST PROCEDURES, by Rufus P. Turner. Rinehart & Co. Inc., 232 Madison Ave., N. Y., N. Y. 9½ x 6¼ in. 316 pp. $6.50.

Radio, television, hi-fi, computers or space-borne electronics—the problems involved in testing such equipment are the same. This well illustrated basic text clearly shows, through the use of step-by-step instructions, how to measure all kinds of electronic phenomena. Subjects from the correct use of meters to transmitter tests and measurements are included. A special chapter at the end of the book shows how industrial electronic measurements are made.—*LS*

PIN-POINT TRANSISTOR TROUBLES IN 12 MINUTES, by Louis E. Garner, Jr. Coyne Electrical School, 466 W. Superior St., Chicago 7, Ill. 5½ x 8 in. 478 pp. $5.95.

When a radio comes into the shop for quick repair, we need service data, troubleshooting suggestions and alignment procedure. Such information is found here on radios, amplifiers, and TV. Control and test instruments are also described.

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(*Continued on page* 156)

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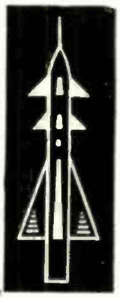

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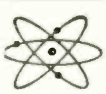

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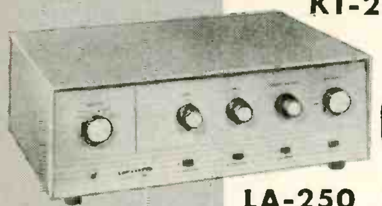


KT-250

IN KIT FORM 64.50

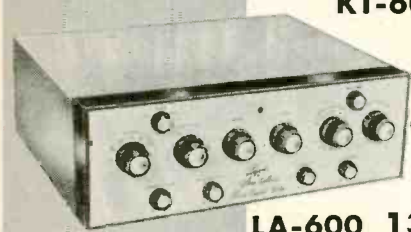
LA-250 89.50
COMPLETELY WIRED

50 WATT INTEGRATED STEREO AMPLIFIER

● RESPONSE 17-21,000 CPS ± 1 DB (at normal listening level) ● UNIQUE "BLEND" CONTROL ● PREMIUM EL86 OUTPUT TUBES ● 50 WATTS MONAURAL—25 WATTS EACH STEREO CHANNEL ● CLUTCH-OPERATED VOLUME CONTROL ● SEPARATE BASS & TREBLE CONTROLS

A completely new stereo high fidelity amplifier with a high quality of reproduction, remarkable versatility and new distinctive styling. Full range of controls include a unique "blend" control for continuously variable channel separation—from full monaural to full stereo, 4-position Selector, Mode, Loudness and Phasing switches plus outputs for 4, 8 or 16 ohm speakers. Harmonic distortion less than 0.25%, IM distortion less than 1%. Hum and Noise 74 db below full output. 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 WX Stereo Amplifier Kit	5.00 Down	Net 64.50
LA-250 WX Stereo Amplifier, wired & tested	5.00 Down	Net 89.50



KT-600

IN KIT FORM 79.50

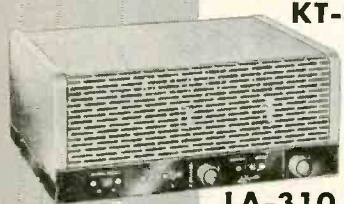
LA-600 134.50
COMPLETELY WIRED

PROFESSIONAL STEREO CONTROL CENTER

● RESPONSE 5-40,000 CPS ± 1 DB ● UNIQUE STEREO & MONAURAL CONTROL FEATURES ● PRECISE "NULL" BALANCING SYSTEM ● CONCENTRIC INPUT LEVEL CONTROLS

A truly professional stereo preamplifier and master audio control center—solves every stereo/monaural control problem. Features unique Bridge Control for variable cross-channel feed for elimination of exaggerated channel separation effects—plus controlled 3rd channel output. Has all-concentric controls—including clutch-operated Volume Balance control. Provides complete and advanced facilities for accepting, controlling and providing undistorted gain for any and all program sources. Sensitivity 2.2 mv for 1 volt out (low level inputs). Dual low impedance "plate follower" outputs 1500 ohms. Response 5-40,000 cps ± 1 db. Less than .03% IM distortion. Less than .1% harmonic distortion. Hum and noise 80 db below 2 volts (high level inputs). Uses 7 new 7025 low-noise dual triodes. Size: 14" x 4½" x 10⅜". Shpg. wt., 16 lbs. Complete with all parts, tubes, deluxe cabinet and detailed instruction manual.

KT-600 WX Stereo Preamplifier Kit	5.00 Down	Net 79.50
LA-600 WX Stereo Preamplifier, wired and tested	5.00 Down	Net 134.50



KT-310

IN KIT FORM 47.50

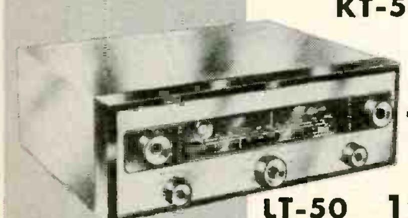
LA-310 72.50
COMPLETELY WIRED

STEREO/MONAURAL POWER AMPLIFIER KIT

● 36 WATT STEREO AMPLIFIER—18 WATTS EACH CHANNEL ● EMPLOYS 4 PREMIUM-TYPE 7189 TUBES ● 2 PRINTED CIRCUIT POARDS FOR SIMPLIFIED WIRING ● RESPONSE BETTER THAN 35-30,000 CPS ± ½ DB AT 18 WATTS ● LESS THAN 1% HARMONIC OR IM DISTORTION

A superb basic stereo amplifier in easy-to-build kit form. Unit may be used with a stereo preamplifier to provide two 18 watt stereo channels or, at the flick of a switch, as a fine 36 watt monaural amplifier. Controls include 2 input volume controls, Channel Reverse switch and Monaural-Stereo switch. Dual outputs for 4, 8, 16 or 32 ohm speakers. Input sensitivity .45 volts per channel for full output. Tubes are 2-6AN8, 4-7189, GZ-34 rectifier. Size 10-9/16" d x 5¼" h x 13¼" w. Complete kit with cage, all parts, tubes and detailed instruction manual. Shpg. wt., 22 lbs.

KT-310 WX Stereo Power Amplifier Kit	2.00 Down	Net 47.50
LA-310 WX Stereo Power Amplifier, wired and tested	5.00 Down	Net 72.50



KT-500

IN KIT FORM 74.50

LT-50 124.50
COMPLETELY WIRED

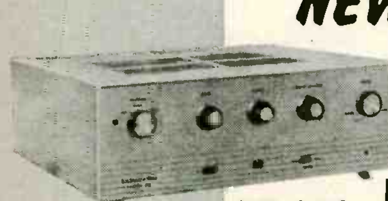
FM-AM STEREO TUNER KIT

● 11 Tubes (4 dual-purpose) + Tuning Eye + Selenium rectifier provide 17 tube performance ● Multiplex Output for new Stereo FM ● Armstrong Circuit with Dual Limiters and Foster-Seeley Discriminator ● Extreme Sensitivity and Wide Frequency Response.

A precision engineered, highly stable tuner—perfect for lifelike stereo FM-AM broadcast reception, FM reception and/or AM reception. Features separate tuning and volume controls for AM and FM. Magic eye on AM and FM, plus automatic frequency control on FM for accurate tuning—stations are "locked" in. Other deluxe features include cathode follower outputs and 5-position Function Selector. Efficient, broadband circuitry on AM with built-in antenna. FM section features include 2 microvolts sensitivity for 30 db quieting, frequency response 20-20,000 cps ± ½ db and full 200 KC bandwidth. Two printed circuit boards make wiring simple—even for such a complex unit. Complete kit includes all parts, deluxe cabinet and detailed instruction manual. Size is 13¾" W x 10⅜" D x 4½" H. Shpg. wt., 22 lbs.

KT-500 WX FM-AM Stereo Tuner Kit	5.00 Down	Net 74.50
LT-50 WX Same as above, wired & tested	5.00 Down	Net 124.50

NEW!



IN KIT FORM

KT-236 52.50

LAFAYETTE 36-WATT INTEGRATED STEREO AMPLIFIER KIT

● 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

This exciting new amplifier kit combines dual preamplifiers and dual 18 watt power amplifiers on one compact chassis. Instant selection from monophonic to stereophonic is provided by the turn of a switch. An amazing new "Blend" control gives continuously variable channel separation from full monophonic to full stereo. The concentric clutch-operated volume control offers independent or simultaneous level adjustments of both channels. Dual concentric bass and treble controls furnish 4 independent tonal adjustments. Harmonic distortion less than 0.15% at normal listening level. I.M 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 WX Stereo Amplifier Kit	5.00 Down	Net 52.50

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NEW! *Lafayette* 50 Watt Complete Stereo Phono System

COMPONENTS

LAFAYETTE LA-250 50-WATT STEREO AMPLIFIER . .	89.50
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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~~

COMPLETE STEREO SYSTEM

174.50

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. 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 31 MD7 (.7 Mil) diamond stereo cartridge. Supplied with the Lafayette 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.

HF-681WX Hi-Fi STEREO PHONO SYSTEM with choice of cartridge and mahogany, walnut or blond changer base (please specify)
5.00 Down .... Net **174.50**

HF-683WX Same as HF-681, but with 2 Lafayette Eliptoflex Series Bookshelf Enclosures (please specify finish). Shpg. wt., 143 lbs.
10.00 Down .... Net **229.95**

HF-682WX Stereo AM-FM-Phono System. Same as HF-681 but including the Lafayette LT-50 stereo tuner. Shpg. wt., 85 lbs. 28.75 Down, 10.00 Down .... Net **287.50**

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BOOKS *(Continued from page 152)*

radio models from many manufacturers. It provides photos, diagrams and schematics. The text tells how to proceed to find the defect quickly. The last section incorporates much useful transistor data.—*IQ*

18 STEREO AMPLIFIERS, tested and evaluated by American Audio Institute, 394 E. 18 St., Paterson, N. J. 5½ x 8½ in. 65 pp. $2.50.

Tabulated results of 19 tests on each of 18 integrated stereo amplifiers are weighted and evaluated to provide comparative amplifier ratings for engineer, audiophile or prospective purchaser. The tests are explained in detail in the introduction. Amplifiers made by Bell (four models), Bogen (two), Fisher, G-E (two), Harman-Kardon (three), Pilot (two), Scott (two), Sherwood and Stromberg-Carlson are reported on.

PROPERTIES, PHYSICS AND DESIGN OF SEMICONDUCTOR DEVICES, by John N. Shive. D. Van Nostrand Co., Inc., 120 Alexander St., Princeton, N. J. 6 x 9 in. 487 pp. $9.75.

To most of us, transistors dominate the field of semiconductors, but thermistors, varistors and photocells also have important uses. This book covers *all* these devices, while emphasizing transistors. It is prepared for the upper-class student or graduate to pave the way for advanced study.

Part 1 analyzes the behavior of each of the above semiconductors and gives its chief applications. Part 2 goes deeper into the theory and physics of each. The book is well illustrated with diagrams and photos, and gives a good balance of theory and practice.—*IQ*

OFFICIAL REGISTRY OF PUBLIC SAFETY RADIO SYSTEMS (1959). Edited by Ethel V. Sleeper. Communications Engineering Book Co., Monterey, Mass. 8½ x 11 in. 162 pp. $4.

A directory listing call signs, frequencies, addresses, the number of mobile units authorized and the manufacturer of transmitters used in stations operated by municipal, county, state, zone and interzone police; fire departments, special emergency, highway maintenance, forestry conservation services and local governments. In Part 1, the licensees are listed alphabetically by state and city. Part 2 has listings by frequency with call signs, location and type of service.

SILICON ZENER DIODE HANDBOOK, Motorola, Inc., Semiconductor Div., 5005 E. McDowell, Phoenix, Ariz. 5½ x 8½ in. 126 pp. $1.

This handbook is concerned with the theory, design characteristics and applications of the Zener diode—a special kind of semiconductor voltage-limiting diode. It is illustrated with characteristic curves, schematic diagrams and charts. An accompanying Zener Diode Slide Rule Calculator ($1) quickly and easily solves the problems associated with the design of Zener diode circuits.

END

ADVERTISING INDEX

Radio-Electronics does not assume responsibility for any errors appearing in the index below.

SCHOOL DIRECTORY PAGE 153

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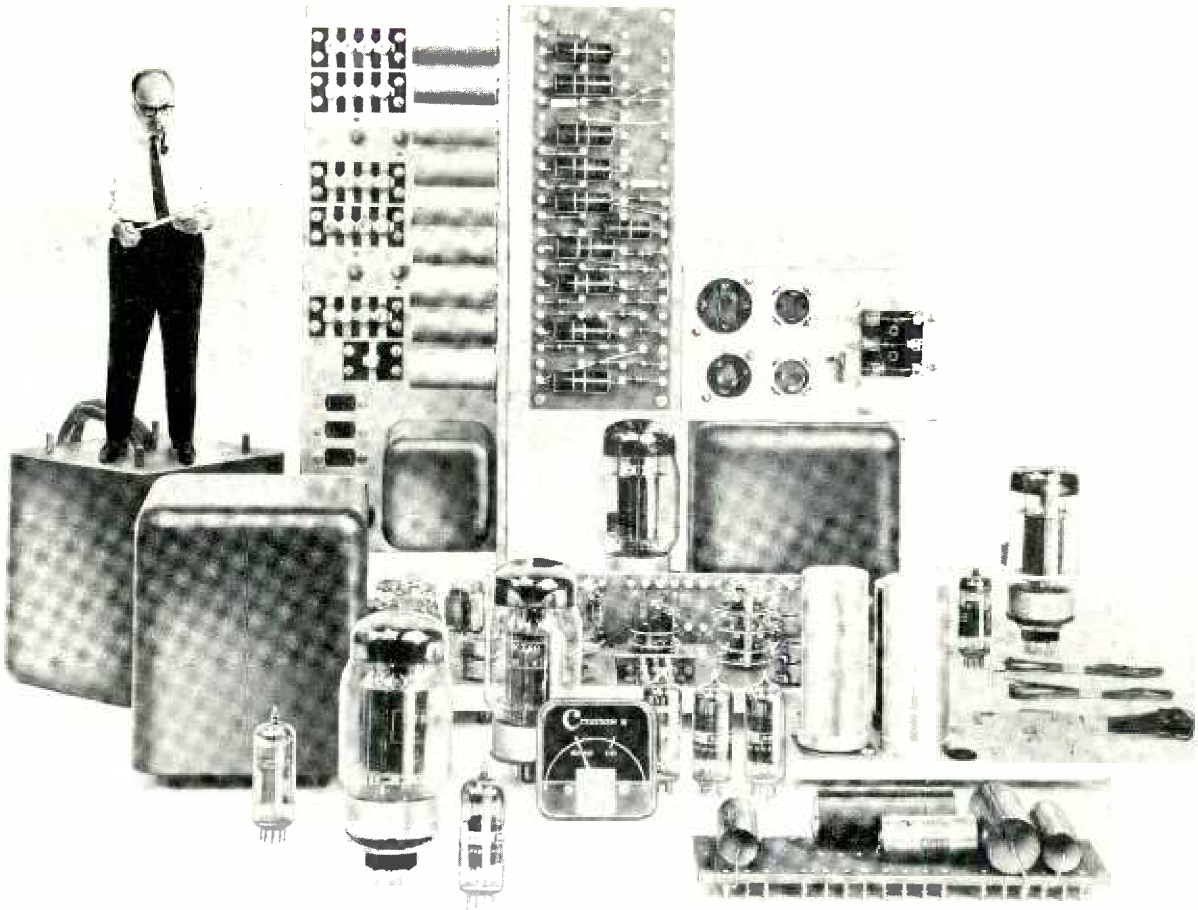

We don't pack an engineer into each new Citation Kit but...

...the engineering *built into* each kit is so precise that the unit constructed in the home will be the equal of the factory-produced instrument.

It is far more difficult to design a kit than to produce a completely manufactured product. In the plant the engineer can control his design from the moment of inception until the final packaging. The kit builder has only his tools, his ingenuity and little, if any, test equipment.

Therefore, the complex process of in-plant production and control which guarantees the fine finished product must somehow be *embedded* in the kit design. The Citation engineering group at Harman-Kardon, headed by Stewart Hegeman, has succeeded in doing just this in the design of the new Citation I, Stereophonic Preamplifier Control Center and Citation II, 120 Watt Stereophonic Power Amplifier.

Only heavy duty components, operating at tight tolerances, have been selected for the Citation Kits. As a result, even if every component is operated at its limit – remote as this possibility is – the instruments will perform well within their specifications.

Rigid terminal boards are provided for mounting resistors and condensers. Once mounted, these components are suspended tightly between turret lugs. Lead length is sharply defined. The uniform spacing of components and uniform lead length insure the overall stability of the unit.

Improper routing of leads, particularly long leads, can result in unstable performance. To prevent this, the Citation II is equipped with a template to construct a Cable Harness. The result: each wire is just the right length and in just the right place to achieve perfect performance.

These truly remarkable achievements in Control Engineering are only a few of the many exciting new developments in kit design from the Citation Division of Harman-Kardon.

THE CITATION I, *Stereophonic Preamplifier Control Center,* is a brilliantly designed instrument, reflecting engineering advances found only in the best professional equipment. The control over program material offered by the new Citation I enables the user to perfectly re-create every characteristic of the original performance. (The Citation I – $139.95; Factory-Wired – $239.95; Walnut Enclosure, WW-1 – $29.95.)

THE CITATION II, *120 Watt Stereophonic Power Amplifier,* has a peak power output of 260 Watts! This remarkable instrument will reproduce frequencies as low as 5 cycles virtually without phase shift, and frequencies as high as 100,000 cycles without any evidence of instability or ringing. *At normal listening levels, the only measurable distortion in this unit comes from the laboratory testing equipment.* (The Citation II – $159.95; Factory-Wired – $219.95; Charcoal Brown Enclosure, AC-2 – $7.95.) All prices slightly higher in the West.

Harman-Kardon has prepared a free detailed report on both of these remarkable new instruments which we will be pleased to send to you. Simply write to Dept. 100, Citation Kit Division, Harman-Kardon, RE1, Westbury, L. I.

Citation I

Build the Very Best **CITATION KITS** *by* **harman kardon**

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