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Radio-Electronics

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BURNOUT PROOF V-O-M

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Suggested U.S.A. User Net

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Megohms:	0-1-100 (4,400-440,000 at center scale).

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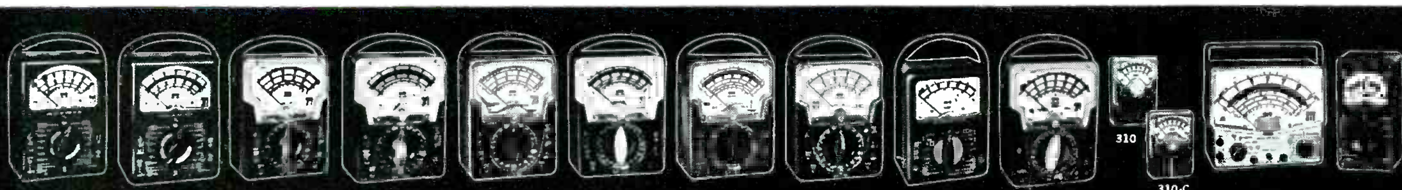

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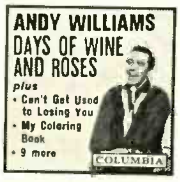

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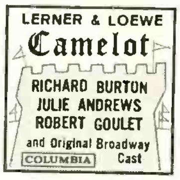

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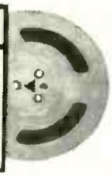

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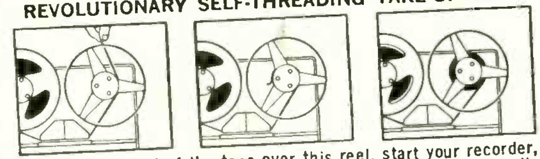

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The tapes you want are mailed and billed to you at the regular Club price of $7.95 (occasional Original Cast recordings somewhat higher), plus a small mailing and handling charge.

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Radio-Electronics

FEBRUARY 1964 VOL. XXXV NO. 2

Over 55 Years of Electronic Publishing

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Radio-Electronics is indexed in *Applied Science & Technology Index* (Formerly *Industrial Arts Index*).

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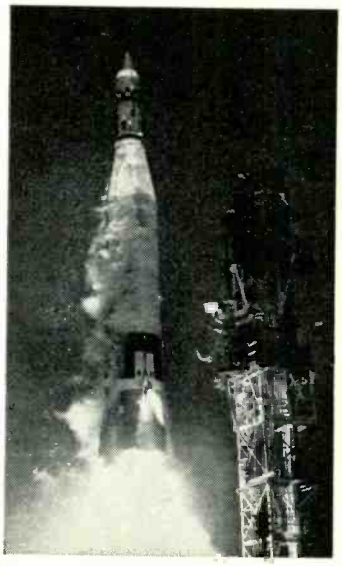

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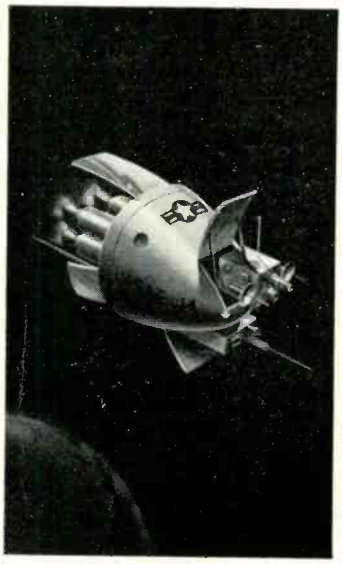

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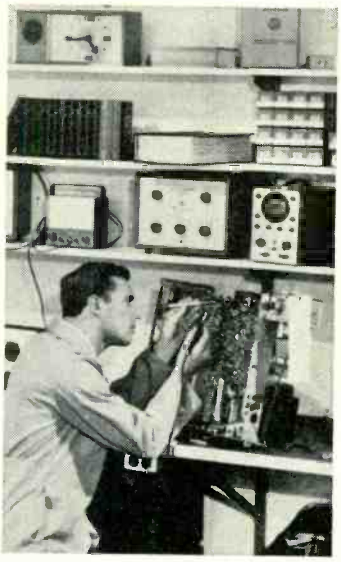

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NEWS BRIEFS

Sonar Doppler Navigates Surface Vessels

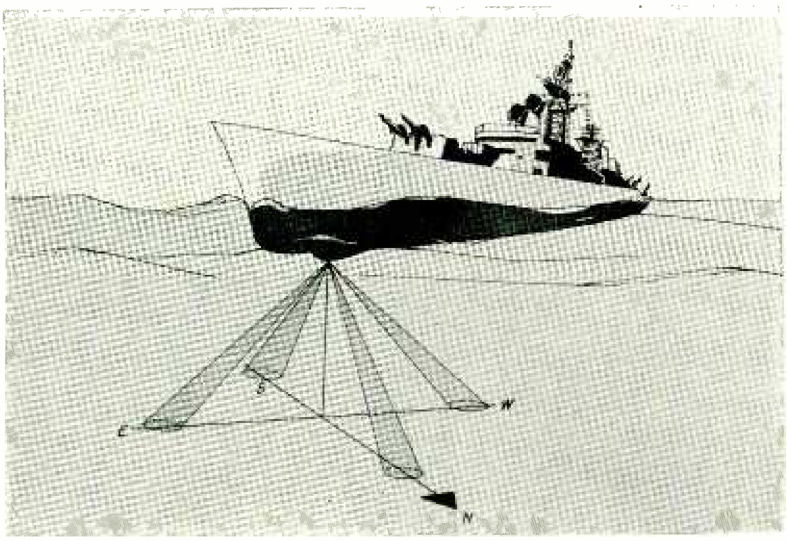
A Doppler navigator that automatically and continually plots a ship's position underway has been developed by Raytheon for the Navy. This works much like the Doppler radar now used to guide airplanes (RADIO-ELECTRONICS, August 1962, p. 42).

As the ship moves forward through the water, sound waves are beamed to the ocean's floor in four directions corresponding to the cardinal points of the compass. The returning echoes, changed slightly in pitch from the frequency of the original beam, are compared with the outgoing sound. The change is called the *Doppler effect* and is a direct measure of the motion of the vessel in the respective directions.

This change occurs only when the ship moves. The bottom echo from the sound signal beamed ahead of the vessel strikes the receiver sooner than it would if the ship were standing still. Therefore, the pitch is slightly higher. Echoes from the beams directed astern and to port and starboard of the ship likewise change in pitch in proportion to the motion of the vessel in these directions.

These differences in frequency are processed and compared electronically. The outputs are fed into step motors which drive the plotting pen over a standard US Coast and Geodetic Survey or Navy Hydrographic Chart. The result is a precise tracing of ink across the face of the chart, the contact point of the pen being the actual position of the vessel with respect to the surface of the earth.

An earlier underwater Doppler radar was mentioned in RADIO-ELECTRONICS, February 1963, on page 16.



New nautical navigator's sonar devices continuously bounce four simultaneous signals off ocean floor. Returning echoes are compared with transmitted signal. Combined results make ink trace on ship's chart, showing ship's exact position.

Child Bites Cheater Cord, Lives, But Loses Two Teeth

Joyce Ellen Cartwright, age 2, of Old Hickory, Tenn., pulled the cord out of the family TV set, put it in her mouth and bit it. Her mother reports that she saw her about 2 feet off the floor, coming down. "I thought she had climbed up on something and fallen off," Mrs. Cartwright said.

At the hospital, it was discovered that the child had third-degree burns at the corner of her mouth and partly down her throat. She had swallowed two of her teeth and a fragment of the TV cord.

Apparently the back of the set had been removed for some reason (possibly amateur troubleshooting) and the set was being operated with a simple cheater cord.

Precision Holes Bored With Laser Guidance

A system in which a beam of laser light acts as a "radar" to show the position of a boring-tool spindle is described by Sperry Gyroscope Co. of Canada. The device would be used to bore holes as small as 1/20 inch—about the size of a pinhead—in tungsten and molybdenum steels. Tolerance would be 20 times finer than at present, about 5 millionths of an inch, or a quarter of the wavelength of red light.

To achieve these tolerances, a beam of laser light from the boring-tool spindle strikes the wall of the hole and is reflected to the spindle. Checking the elapsed time indicates the precise time the light has traveled, and thus can be used to show the radius of the hole. The radius indicated is compared with the desired radius and, if necessary, the spindle repositioned automatically to make the necessary corrections. The operation occurs on each revolution of the borer—up to 6,000 times a minute.

Miniature Gas Laser Emits Visible Light

A helium-neon gas laser only 5 cm long and 1 mm in diameter has been developed by Eugene I. Gordon and Alan D. White of Bell Telephone Labs. Due to its shortness, the new laser oscillates at only one frequency. Larger gas lasers tend to operate at several frequencies simultaneously and are hard to stabilize against frequency fluctuation. The smaller lasers are much less susceptible to vibration and thus more stable.

The combination of stability and single-frequency oscillation makes it possible to use the laser as a very precise measuring instrument. If one of the end mirrors is connected to a positioning device, very slight changes in position will cause the laser to shift frequency. Displacements considerably less than one-millionth of an inch can be detected and, with an oscilloscope, readily measured.

Changing the spacing between the end mirrors varies the frequency

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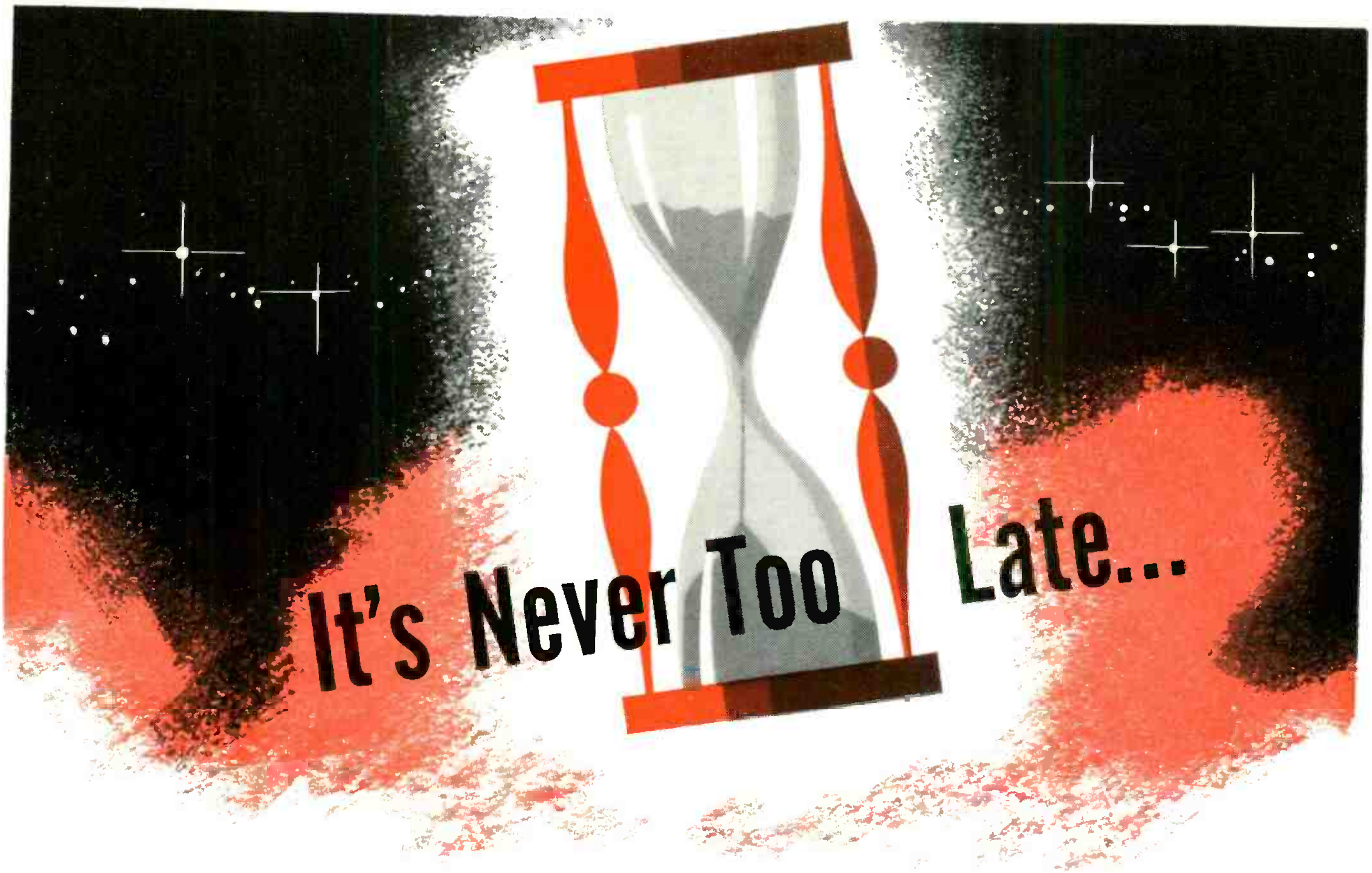

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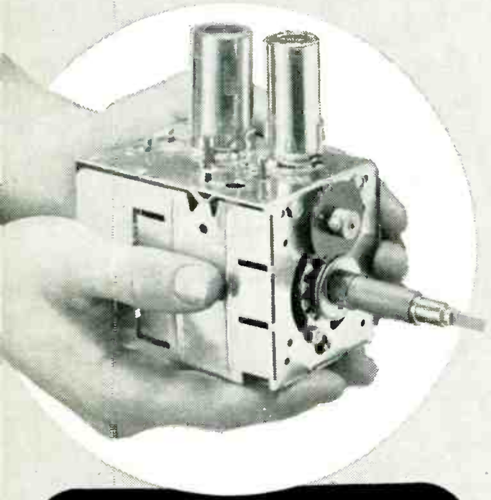

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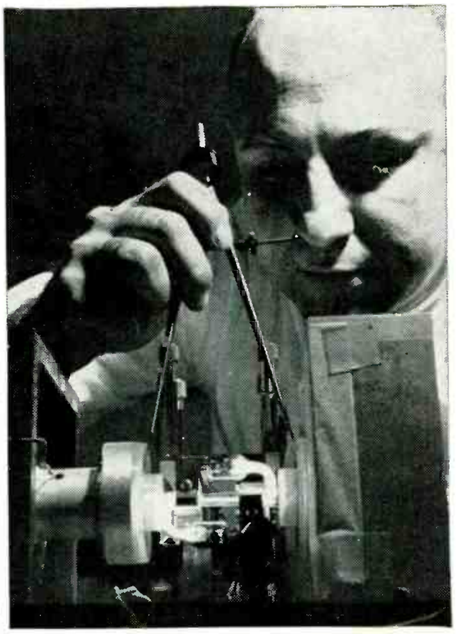
of laser oscillation within a 1,500 mc range centered at 473,000 gigacycles. To tune the laser over this frequency range, one of the end mirrors must move less than 12-millionths of an inch.



Dr. Eugene I. Gordon demonstrates the new laser. Spacing between end mirrors shown by dividers is 4 inches; length of active discharge tube is 2 inches. The mirror at Dr. Gordon's right is attached to a piezoelectric crystal. A voltage applied to the crystal changes its length, moves the mirror slightly, tuning the laser.

To increase laser gain so that the very short lasers could be made to oscillate, the helium 4 gas used in earlier lasers was replaced with the lighter helium 3 isotope, and the diameter of the laser discharge tube was reduced to 1 mm.

Mysterious Marine Sounds Traced Back to Whales

Ten years ago, Bell Laboratory oceanographers detected underwater sounds at 20 cycles or less, so strong as to rise 30 or 40 decibels above the level of background noise. These subsonic pulses, heard in pairs at the rate of about 3 a minute, moved about randomly at speeds varying between 2 and 8 knots.

Recent observations with hydrophones lead some scientists to believe that they may be the heartbeats of whales. According to Dr. Richard A. Walker of Bell Laboratories, the blue whale has a heart which weighs ½ ton, pumps 8 tons of blood and develops a useful output of about 10 horsepower. Such a heart could produce the powerful acoustical pulse that has puzzled the oceanographers.

Walker believes the sound may occur only when the whale's mouth is open to scoop up the tiny marine animals on which it lives. When its mouth is closed, its tons of flesh muffle the heartbeat.

Trucking Company Saves With Mobile Radio

Savings of as much as 70% in driver-to-office communication expenses have been reported by trucking companies after installing two-way radios, according to Outercom Electronics Corp., manufacturers of mobile radio equipment.

According to one trucking company, a telephone call by a driver used to occupy an average of 12 minutes, much of which was spent parking the vehicle. Four drivers earning $2.90 per hour and making only 3 calls per day each, would cost the company $174 per month. To this must be added the actual cost of the calls and the extra mileage added driving to the nearest telephone. These expenses totaled $312 monthly.

Installing mobile radios saved $222 of that and added the extra profits from deliveries made in the time during which the trucks would otherwise be tied up making phone calls.

CALENDAR OF EVENTS

Annual Computer Applications Symposium, Jan. 30–31; LaSalle Hotel, Chicago.
International Exhibition of Electronic Components, Feb. 7–12; Porte de Versailles, Paris, France.
International High Fidelity Show, Mar. 12–19; Paris, France.
Los Angeles High Fidelity Music Show, Mar. 10-15; Ambassador Hotel, Los Angeles, Calif.
IEEE International Convention, Mar. 23–26; Coliseum & N.Y. Hilton Hotel, New York, N.Y.

World's First Computer Becomes An Antique

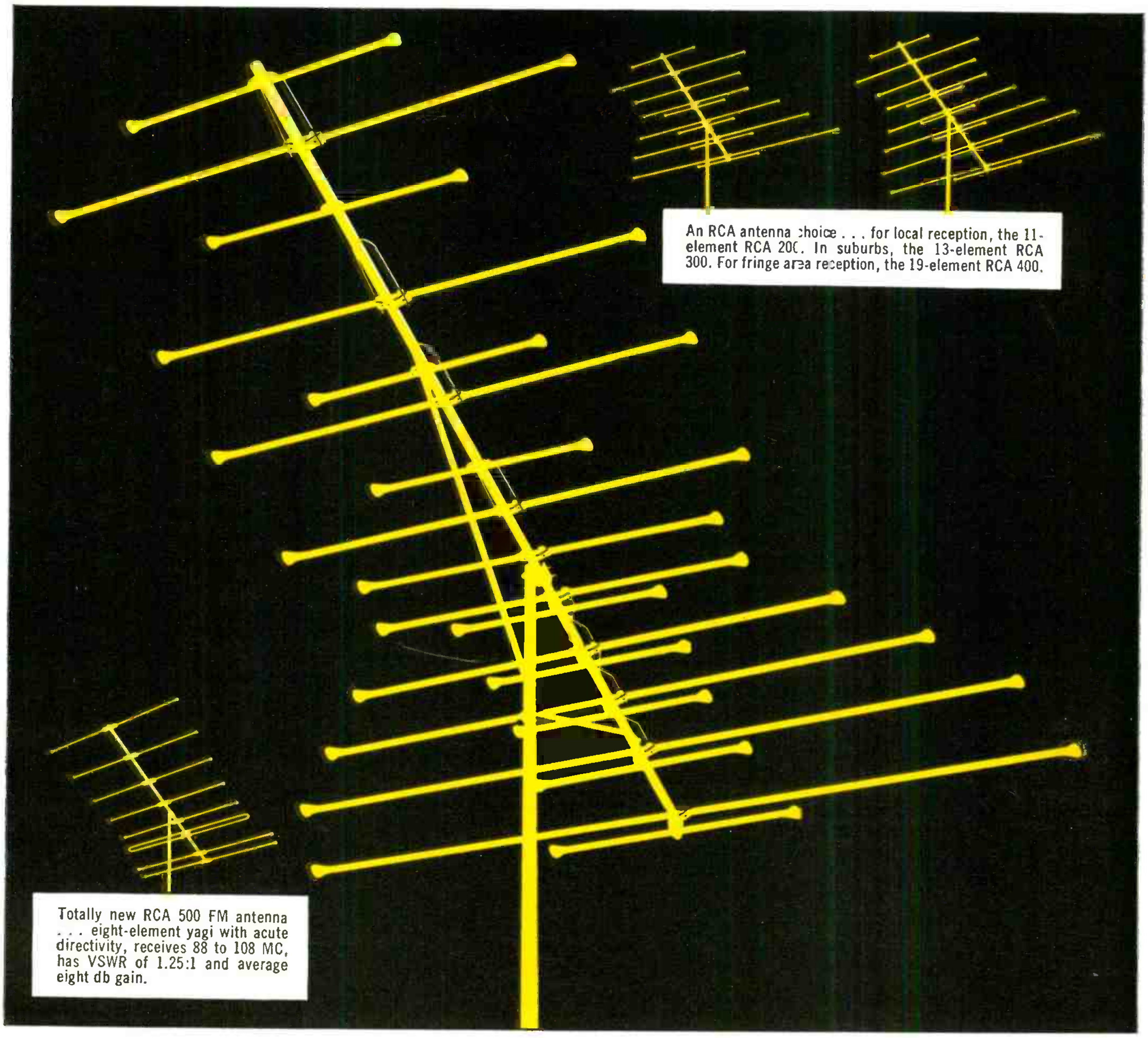
UNIVAC I, Serial No. 1, which went into operation for the Bureau of the Census in March 1951, has been retired and presented to the Smithsonian Institution.

UNIVAC I was developed by J. Presper Eckert and Dr. J. W. Mauchly of the University of Pennsylvania, following work they had done with electronic devices to compute trajectories of artillery missiles during World War II. The Eckert-Mauchly Co. had affiliated with Remington Rand before UNIVAC was completed.

The computer was operated first in the Remington Rand plant in Philadelphia, processing data from the 1950 census. In 1952 it was transferred to the Census building at Suitland, Md., from which date it operated practically continuously 24 hours a day, 7 days a week until its final run.

Electronics Editor Dies; Worked on Radio News

G. C. Baxter Rowe, who was associated with Gernsback Publications



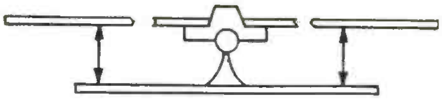
An RCA antenna choice . . . for local reception, the 11-element RCA 200. In suburbs, the 13-element RCA 300. For fringe area reception, the 19-element RCA 400.

Totally new RCA 500 FM antenna . . . eight-element yagi with acute directivity, receives 88 to 108 MC, has VSWR of 1.25:1 and average eight db gain.

RCA...Pioneer and developer of Color TV... Announces a new concept in outdoor antennas

Now the most trusted name in color TV brings you and your customers a whole new outdoor antenna line packed with top-value features. RCA puts together in a single line the best of all-channel yagi and multiple cross-driven element antenna types. You'll satisfy every customer's demand for sharpest color or black-and-white TV reception with this new RCA Series 200, 300 and 400 antennas.

RCA's electro-lens director system absorbs maximum incoming signal power, gives extremely high gain across the VHF band, offers excellent forward gain on the front end.



CAPACITIVELY COUPLED

In addition to phasing low and high band directors for best high band performance, RCA and only RCA positions high band driven elements, *directly below* low band driven elements. Through capacitance thus existing, RCA antennas feed energy *directly* into the transmission line from high band driven elements. An RCA exclusive!

A permanent gold *anodized* finish defends every RCA antenna's glossy finish from weather corrosion. Wrap-around mast clamp aligns antenna on mast, prevents boom crushing.

Just call your RCA Victor distributor. He'll tell you and show you all about new RCA 200, 300, 400 antennas—and that's *plenty!* Call now—sell soon!

RCA PARTS AND ACCESSORIES, CAMDEN, N.J.

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in the '20's, died in Port Chester, N.Y., at the age of 66. During the period with Gernsback, he was associate editor on *Radio News*. Later, he was an editor with the firm of John F. Rider, and from 1949 till his retirement in 1962, was associate editor of *Electrical Engineering*, the magazine of the American Institute of Electrical Engineers.

Europe Heard on Broadcast Band

Low sunspot activity has made trans-Atlantic broadcast-band dx again possible this winter. Among European stations heard in the New York area in December were Monte Carlo on 1466 and Rome 1 on 845 kc. Best reception time was from 1 to 2 am EST, although reception was also possible sometimes around 5 pm. Most stations sign off at 6 or 7 pm but Rome and several others operate 24 hours a day.

European broadcasters in the 150–260-kc long-wave band have also been received. Best heard station is Paris on 164 kc, which operates on a 24-hour schedule.

Trans-Atlantic dx in these bands should be possible till late February and again next fall and winter. A very selective receiver is necessary.

The *World Radio Handbook* lists European broadcasters and their schedules.

GI's Get Commands Via New Lightweight Radio

A new signal system devised by the Army Electronics Research & Development Laboratories in Fort Monmouth, N.J., will make it possible to

Sgt. First Class Taro R. Shimomura, of Honolulu, speaking into the 15-ounce transmitter, while wearing the army's new small receiver on his helmet.

supply receivers to every infantryman in certain combat groups. Transmitters would be supplied to the sergeants, who would thereby be able to keep in touch with their squads, even

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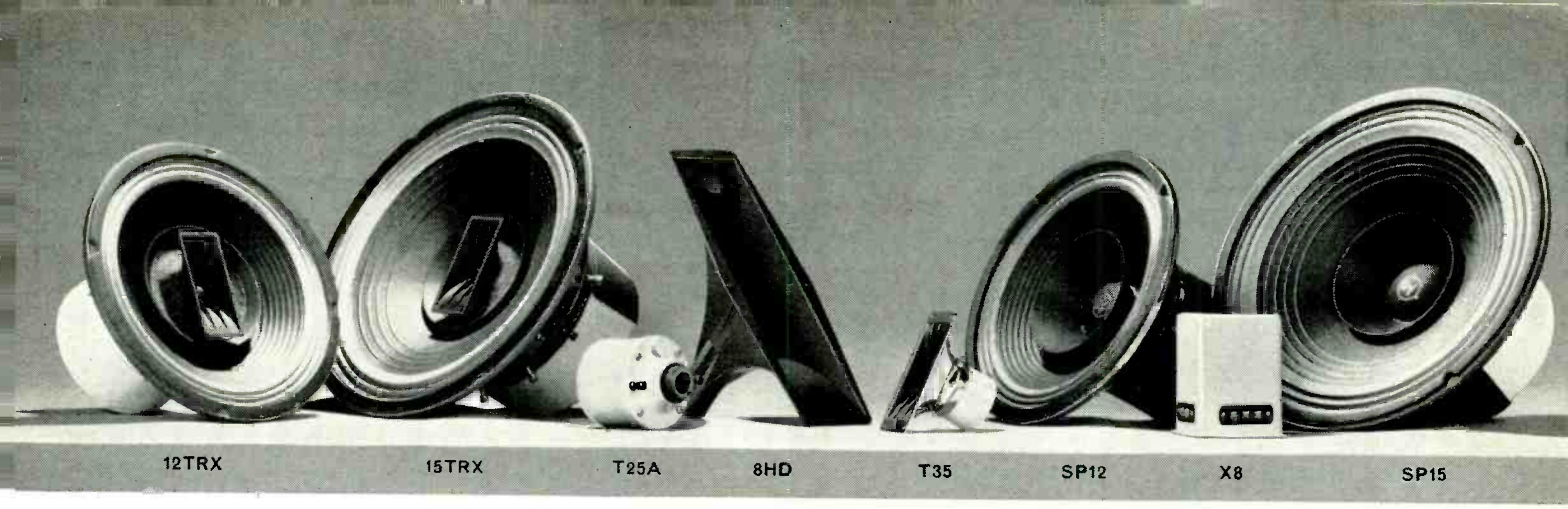


A Return to the Fundamental Concept of High Fidelity: SOUND OF UNCOMPROMISING QUALITY!

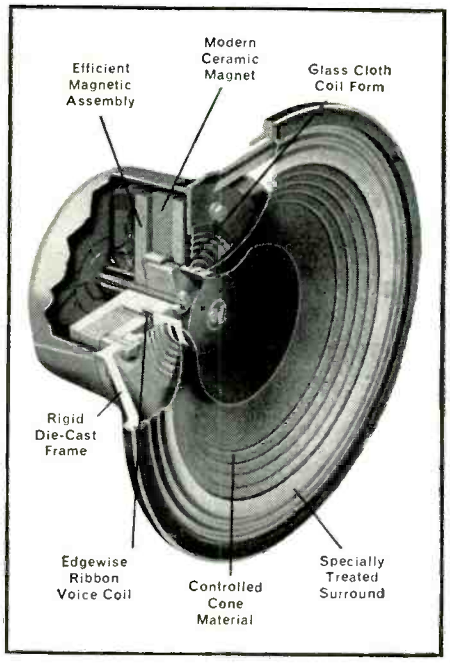
Before you make the final choice of speakers for your high fidelity system, take a moment to review your goals. What comes first—size, cost, or performance? If performance is of prime importance, then you owe it to yourself to look at—and listen to—Electro-Voice Deluxe component speakers. Granted, they are not the smallest or the least expensive speakers you can buy, but their design is predicated on the need for quality reproduction above all other considerations.

Your ear is the final arbiter of speaker system quality, but it may help you to know what's behind the unequalled popularity of E-V in the component speaker field. It begins with the finest engineering laboratory in the industry, finest not only in equipment, but also in the size of its staff and in its creative approach to electro-acoustics.

The basic design for E-V Deluxe components was laid down over a decade ago, and, despite numerous detail improvements, this approach is just as valid today. It begins on a firm foundation: the rigid die-cast frame that provides a stable basis on which this precision instrument can be assembled. It is this frame that assures that each E-V Deluxe speaker will forever maintain its high standard of performance by maintaining perfect alignment of all moving parts.

Added to this is a magnetic assembly of generous proportions that provides the "muscle" needed for effortless reproduction of every range at every sound level. In the case of the SP15, for example, four pounds, ten ounces of modern ceramic magnet (mounted in an efficient magnetic assembly weighing even more) provides the force needed for perfect damping of the 15-inch cone.

Within the gap of this magnetic system rides the unique E-V machine-wound edgewise-ribbon voice coil. This unusual structure adds up to 18% more sensitivity than conventional designs. Production tolerances on this coil and gap are held to ±.001 inch! The voice coil is wound on a form of polyester-impregnated glass cloth, chosen because it will not fatigue like aluminum and will not dry out (or pick up excess moisture) like paper. In addition, the entire voice coil assembly can be made unusually light and rigid for extended high frequency response.



In like manner, the cone material for E-V Deluxe components is chosen carefully, and every specification rigidly maintained with a battery of quality control tests from raw material to finished speaker. A specially-treated "surround" supports the moving system accurately for predictably low resonance, year after year, without danger of eventual fatigue. There's no breaking-in or breaking down!

Now listen—not to the speaker, but to the music—as you put an E-V Deluxe component speaker through its paces. Note that bass notes are neither mushy nor missing. They are heard full strength, yet in proper perspective, because of the optimum damping inherent in the E-V heavy-magnet design.

And whether listening to 12-inch or 15-inch, full-range or three-way models, you'll hear mid-range and high frequency response exactly matched to outstanding bass characteristics. In short, the sound of every E-V Deluxe component speaker is uniquely musical in character.

The full potential of E-V Deluxe component speakers can be realized within remarkably small enclosure dimensions due to their low-resonance design. With ingenuity almost any wall or closet can become a likely spot to mount an E-V Deluxe speaker. Unused space such as a stairwell can be converted to an ideal enclosure. Or you may create custom cabinetry that makes a unique contribution to your decor while housing these remarkable instruments. The point is, the choice is up to you.

With E-V Deluxe component speakers you can fit superlative sound to available space, while still observing reasonable budget limits. For example, a full-range speaker such as the 12-inch SP12 can be the initial investment in a system that eventually includes a T25A/8HD mid-range assembly, and a T35 very-high-frequency driver. Thus the cost can range from $70.00 up to $220.00, as you prefer—and every cent goes for pure performance!

Write today for your free Electro-Voice high fidelity catalog and list of the E-V audio specialists nearest you. They will be happy to show you how E-V Deluxe component speakers fulfill the fundamental concept of high fidelity with sound of uncompromising quality!

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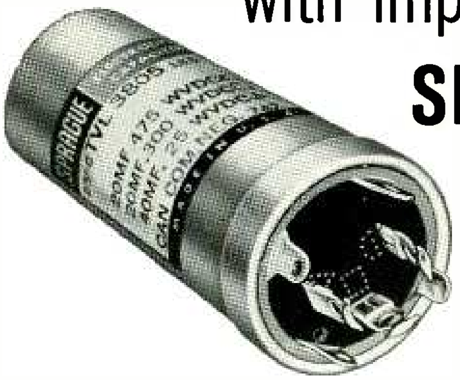
When you substitute capacitor sizes and ratings, you leave yourself wide open for criticism of your work . . . you risk your reputation . . . you stand to lose customers. It just doesn't pay to use makeshifts when it's so easy to get the *exact* replacement from your Sprague distributor!

Get the right SIZE, right RATING every time with improved SPRAGUE TWIST-LOK® CAPACITORS!



Over 1,690 different capacitors to choose from!

The industry's most complete selection of twist-prong capacitors, bar none. Greater reliability, too. Exclusive Sprague cover design provides a leak-proof seal which permits capacitors to withstand higher ripple currents.

GET YOUR COPY of Sprague's comprehensive Electrolytic Capacitor Replacement Manual K-106 from your Sprague Distributor, or write Sprague Products Co., 81 Marshall Street, North Adams, Mass.

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6S-126-63

though the men were widely scattered.

The receivers weigh 9 ounces, and the transmitter 15 ounces. The 9-ounce receiver has 13 transistors and 7 diodes together with batteries good for 24 hours.

With the receiver clipped on his helmet or in his pocket, each member of the squad, even though in a relatively remote location, can be as closely in touch with the leader as in the past, when it was often necessary to remain so close that a single enemy shell could wipe out an entire squad.

Rise In Engineering PhD's And MS's While BS's Decrease

The number of doctor's and master's degrees in engineering continues to increase, as it has been doing for the past 6 years, but the number of bachelor's degrees continues to decline.

A report released by the US Office of Education and announced jointly by the American Society for Engineering Education and the Engineering Manpower Commission of the Engineers Joint Council, stated that during the past 6 years engineering doctorates increased in number at least three times as fast as the total number of doctorates in all of the major academic fields.

Degrees have increased on the master's level also, at twice the rate of increase for the total number of master's degrees awarded in the US.

Bachelor's degrees, however, continue to decline in number, but preliminary figures indicate that the total engineering enrollment rose slightly this fall. Thus, a reversal of this trend is hoped for.

New Phone Cable Links Canada, South Pacific

A 9,400-mile, 72.8-million-dollar trans-Pacific telephone cable linking Canada with British dominions in the Pacific was opened early in December 1963.

The new route, the first telephone cable to be laid across the Pacific, includes more than 300 deep-sea repeaters, laid in depths up to 3 miles, to amplify the signal as it travels. Besides the telephone circuits, the new cable (known as COMPAC) includes facilities for telegraph, telex and phototelegraph services, as well as a music circuit capable of carrying broadcast programs.

It provides for 76 two-way speech channels (80 later), any one of which could be used for 22 teleprinter channels. The route of the line is from Vancouver to Keawaula,

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We train you – prepare you to pass the FCC exam for your first class FCC license. The leading course of its kind, Grantham FCC License Preparation is available in resident classes in Los Angeles, Calif.; South Gate, Calif.; Seattle, Wash.; Kansas City, Mo.; and Washington, D.C. Or, if you prefer, our specialized training is available *in your own home* from our Home Study Department, Kansas City, Mo. Regardless of where or how you study with Grantham, you are taught *right* and prepared *quickly* for your first class FCC license.

Grantham Students Get Their Licenses

Following is a list of *a few* of the many students who have completed our FCC license preparation recently and obtained their *first class* FCC licenses:

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Herbert Braswell, 416 E. Bellefonte Ave., Alexandria, Va.
Floyd R. Henderson, 3219 Andrita St., Los Angeles, Calif.
Gerald D. Herbert, Route 6, Bloomfield, Iowa
William Seymour, 6924 - 32nd St., N.W., Washington, D.C.
Nelson H. Crumling, 92 N. Second St., Mt. Wolf, Pa.
Irvin Griffin, 2421 W. Lexington St., Baltimore, Md.
Denis Christopherson, 4402 Waite Lane, Madison, Wisc.
David H. Klempel, Lambert, Montana
Armand E. Pinard, P.O. Box 3193, Washington, D.C.
Wayne A. Taylor, 4111 Nicholson St., Hyattsville, Md.
William I. Brink, 12 Meade Ave., Babylon, L.I., N.Y.
John Ponchock, Box 88, Coupon, Pa.
John A. Cork, 3535 N. Utah, Arlington, Va.
Charles Bartchy, 1222 S. Park Ave., Canton, Ohio
Gene M. Walker, 1400 S. Wilcox Ave., Monterey Park, Calif.
David Kaus, 5218 Canterbury Way S.E., Washington, D.C.
Wm. S. Bullock, P.O. Box 1133, Atlantic City, N.J.
James W. Logan, 464 DeLeon Dr., Miami Springs, Fla.
Emory R. Valla, Box 616, Imperial, Pa.
Hall Blankenship, Route 2, Rockwood, Tenn.
Charles D. Summers, 451 Hillcrest Dr., Statesville, N.C.
William H. Ames, CMR 2, Box 2112, Travis AFB, Calif.
Alexander Mikalaski, 4510 Rittenhouse St., Riverdale, Md.
Wayne F. Murphy, 317 Jefferson St., Roanoke Rapids, N.C.
Ralph Munday, 417 W. Pecan, Rogers, Ark.
John L. Marlow, Box 384, Umatilla, Ore.
Allen Lee Park, 3024 S. Buchanan St., Arlington, Va.
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Garland Hadley, 205 E. Washington St., Shepherdstown, W. Va.
George L. Heable, 214 N. Main St., Attica, Ohio
Robert J. Maickel, 520 Market St., Havre De Grace, Md.
Harold F. DeBruin, 1621 N. Morrison St., Appleton, Wisc.
James Lee Winde, 805 Princeton Rd., Wilmington, Del.
Thomas J. Bailey, 1005 Penn St., Hollidaysburg, Pa.
Charles G. Suit, 8016 - 14th Ave., Hyattsville, Md.
James R. Reese, Jr., Station WCFV, Clifton Forge, Va.
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Earl J. Mahoney, Box 296, Newport, Vt.
Joseph J. Hytovick, 260 Poplar St., Dickson City, Pa.
Charles H. Hayden, 2607 Kirkwood Pl., Hyattsville, Md.
James D. Neidermyer, R.D. 1, Leola, Pa.
John D. Borin, 5356 Franklin Ave., Hollywood, Calif.
Arthur C. McGuire, 1510 Mahiole Pl., Honolulu, Hawaii
Roy Coleman, 769 Yale Ave., Baltimore, Md.
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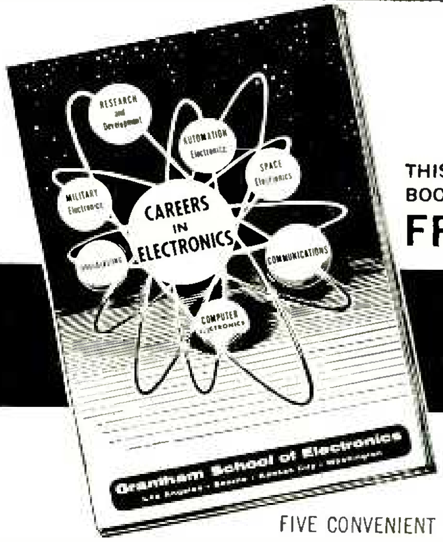

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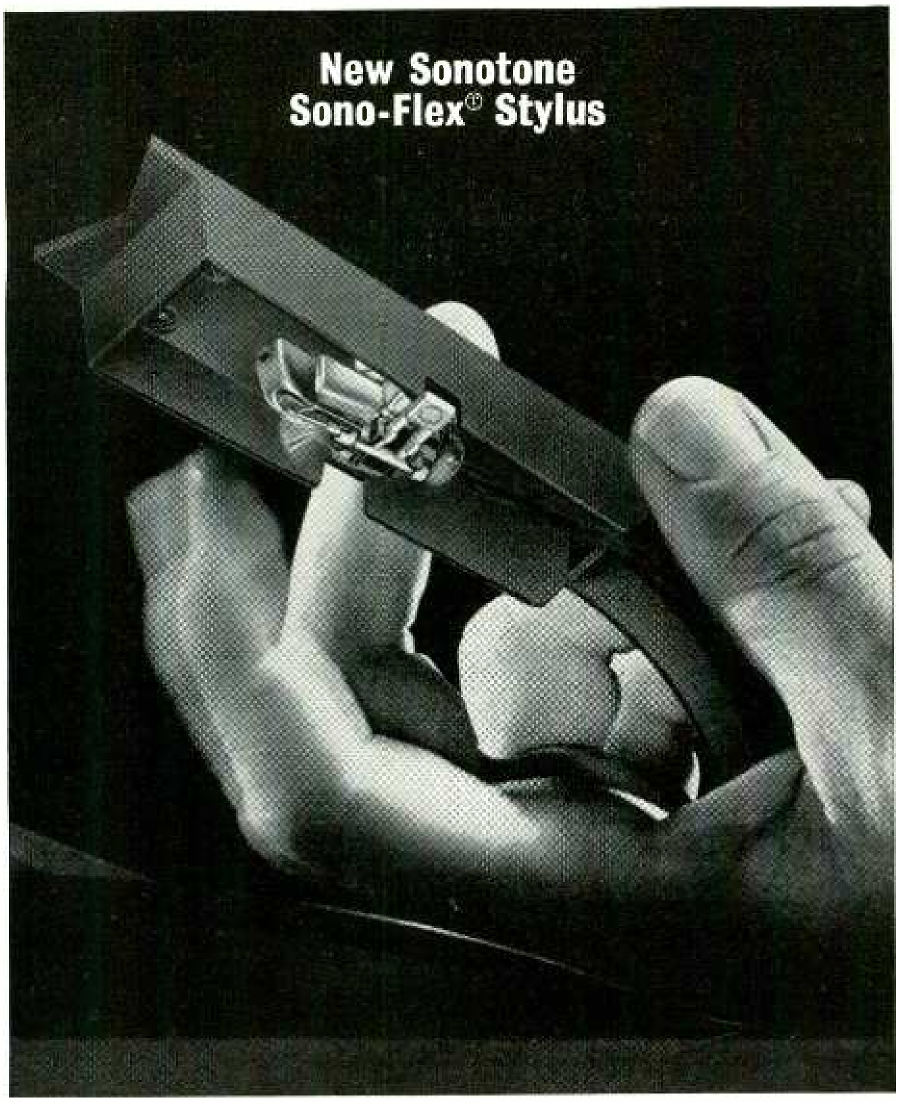

try this with any other cartridge

(at your own risk)

No way to treat a cartridge, for sure—That is, any cartridge except the Sonotone models featuring the new Sono-Flex® needle. No more bent or broken needle shanks caused by flicking off some lint, dropping the arm, or scraping it across the record.

The newly developed Sonotone Sono-Flex® needle to the rescue! Gripped in a resilient butyl rubber mount, you can flex this needle shank in a 360-degree orbit without breaking. Pluck it—flick it—bend it—bump it—it will continue to perform as good as new.

Moreover, the Sono-Flex brings advantages in performance never before offered by any replacement cartridge: Higher compliance, wider and flatter frequency response, lower IM distortion, and longer needle and record life.

Sonotone Sono-Flex® increases your profits two ways

☐ Sonotone cartridges are better than ever, easier to sell, because they're better performers. Further, you eliminate callbacks because of broken needle shanks. Sono-Flex needles are standard right now in these Sonotone cartridges models: 9TAF, 16TAF, 916TAF and the Velocitone Mark IV.

☐ Sono-Flex opens up lucrative needle replacement business for upgrading these Sonotone cartridges models: 9T, 9TA, 9TV, 9TAV, 16T, 16TA, 16TAF and 916TA, original equipment in over a million phonographs. Replacement is fast, simple—requires no tools—assembly snaps into position easily, and gives immediate proof of better performance plus abuse-proof, longer needle life.

See your distributor today and ask for Sonotone cartridges with the Sono-Flex® needle.

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Hawaii (thus including the US), and then to Suva, Auckland and Sydney, Australia.

With the Atlantic link, laid in 1961, operators in London will be able to dial directly into the inland phone system of Australia, and eventually into Montreal, Vancouver and Auckland, as automatic exchanges are set up.

Acoustics of Large Halls Simulated by Ultrasonics

Program material recorded on tape and played back at 10 times its normal speed through ultrasonic equipment makes it possible to build models of concert halls one-tenth size and modify them for the best acoustics. The method was devised by Professor Spandock of Technological University in Munich, Germany.

A similar system, using water and ordinary soundwaves, has been used before, but since sound travels only five times as fast in water as in air, the models could not be scaled down as far as these new ones can.

Alaskan Court Stenos Are All-Electronic

Tape recorders are taking over from the ancient court stenographer in several Alaskan courts, reports Soundscriber Corp., manufacturer of special "tamper-proof" recording equipment.

The Alaskan system uses five microphones, one each for the judge, the clerk, the witness and each attorney. The mikes are monitored so that all are taped at the same level. A written record can be typed off by a typist. This eliminates the necessity for a highly skilled court reporter, and also eliminates the possibility of mistake or misinterpretation by the reporter. If there is any doubt about what was said, the original record can be played again.

Alaskan officials believe that the system saves nearly $250,000 annually and cuts appeal time by 75%.

Brief Briefs

"Whistlers," those low-frequency noises produced by thunderstorms and traveling along the earth's magnetic lines of force, can produce variations in the strength of very low frequency (vlf) radio signals.

This discovery was made by Michael Trimpi of Stanford U. at a vlf Research Station in Antarctica.

Beginning April 19, 1964, the Restricted Radiotelephone Operator permit, now valid for limited operation of certain standard and FM broadcast stations, will no longer be valid. Limited operators will have to hold, as a minimum, a Third-Class Radiotelephone Operator permit, endorsed for broadcast operation. END

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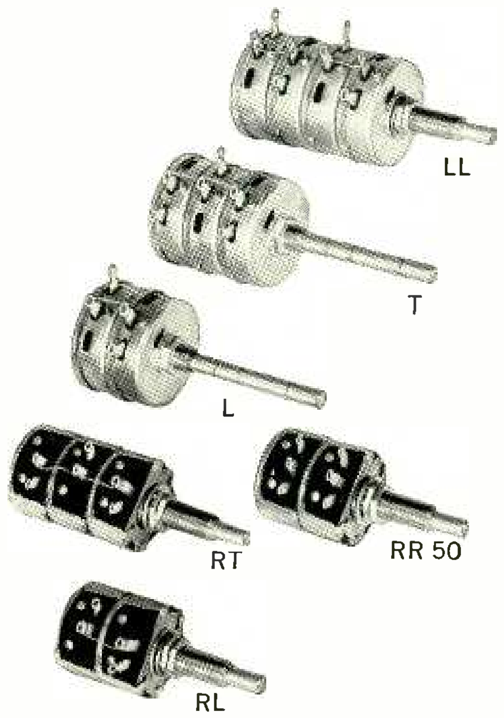
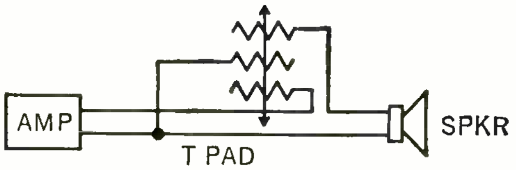
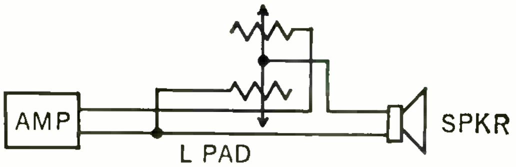
Choosing and using audio attenuators

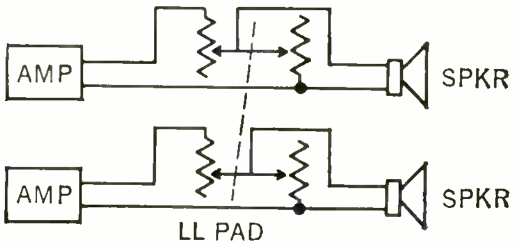




T PAD



L PAD



LL PAD

Ever notice that a hi-fi rig sounds *best* about mid-range on the level (volume) control? Man, those drums, fifes, bugles and train whistles sound GREAT! But, oh, those grouchy neighbors. Somehow they fail to appreciate three or four solid hours of this "pure" sound.

Fear not! There's a simple way to keep true hi-fi sound as well as your neighbors. All you need is an audio attenuator (a fancy name for audio control). There are two basic types of audio attenuators: T pads and L pads.

If yours is the *ultimate* in hi-fi rigs you need a T pad. It maintains a constant impedance between the amplifier and the speaker. You simply turn the amplifier up to optimum performance (somewhere around mid-range) (pretty doggone *loud*) and control *listening* level with the T pad. The "fi" is very "hi" but the level is reasonable and so are the neighbors.

Not all of us can afford the "ultimate". Budgets being what they are, we make a few compromises. Not that our hi-fi doesn't sound great—it does. It's just that it won't break the picture window. We may be able to get by with an L pad. This presents a constant impedance only to the amplifier. Strangely enough, an L pad often seems to *improve* the performance of an inexpensive speaker. Try it—you'll see!

If you have stereo, try an LL pad. That's a pair of L pads with a common shaft. You can balance your rig at the amplifiers and control level at the speakers with only one knob.

How about money? Mallory T, L, and LL pads will handle an "ear-busting" 15 watts of audio power! But if yours is the usual 10 watt system you'll need only an RT or RL pad . . . same extreme quality—only smaller and more economical.

Speaking of economy, try the new Mallory RR 50 Stereo Control. It does a terrific job on most popular stereo outfits. Just what you need for the recreation room or patio.

The whole point of this "tip" is to let you know that your Mallory Distributor has exactly the audio attenuator you need. All kinds of values and several price ranges. He's your "one stop" source for *all* of your electronic requirements. Stop in soon.

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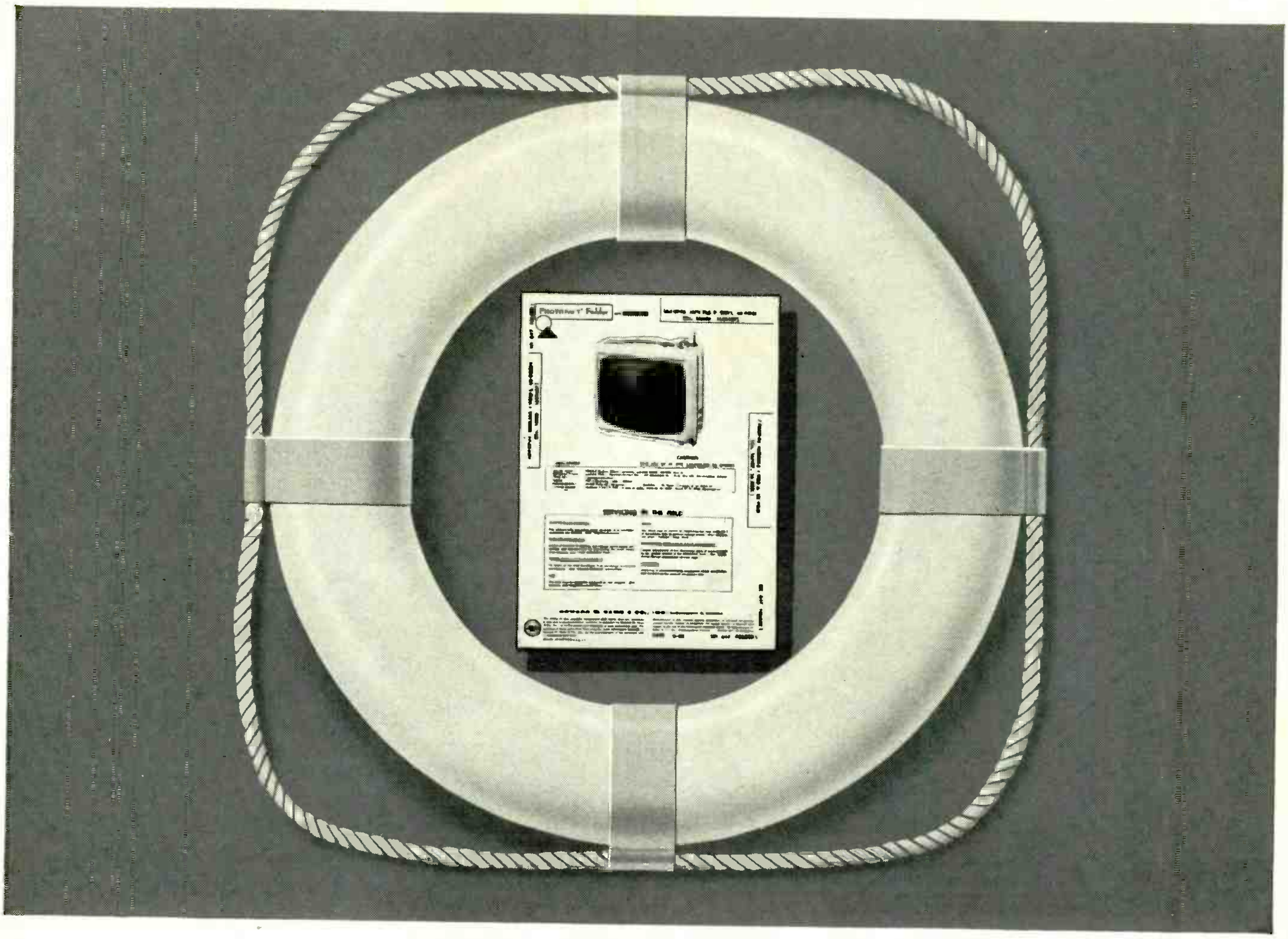

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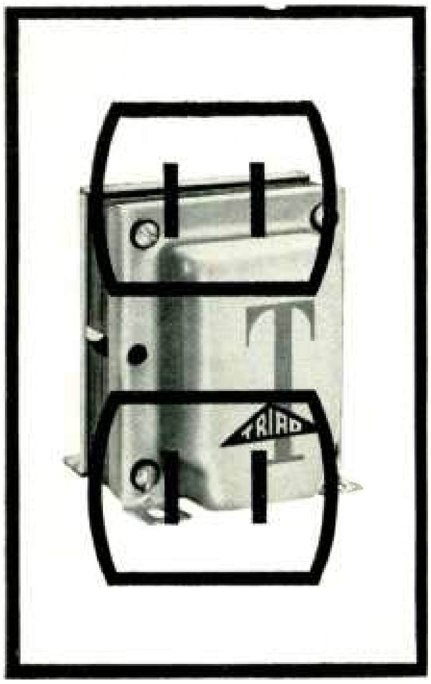

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In auto, boat or plane, Triad's rugged DC-to-AC transistor power supply transformers make it possible for you to plug in a variety of handy household devices—television sets, radios, shavers, record players, dictating machines and heating pads. Two which operate with 12-volt inputs, for example, are the TY-75A which puts out 115 watts at 60 cps and the TY-76A which delivers 60 watts at 60 cps. With a little imagination and either of these units, you can quickly make mobile life far more pleasant and comfortable. Triad also makes a complete line of DC-to-DC transistor power transformers for use with 6, 12 and 28-volt battery-driven sources.

For Engineering Bulletin TY-63 and full details, including basic data, circuit diagrams, specifications and application notes, write to 305 North Briant Street, Huntington, Indiana.

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Correspondence

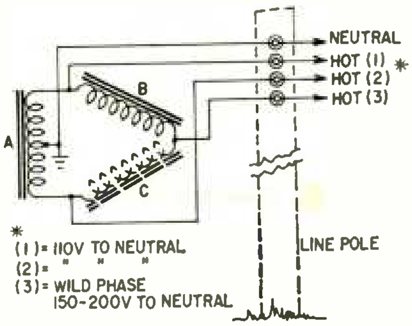
Darr's 3-Phase Problem

[We have received more than two dozen letters on the 3-phase power problem, published in the October issue. All of them feel that Darr was as buffaloed by the problem as the local "industrial technician." But only two have tried to guess what the difficulty was. The rest content themselves with pointing out that it is possible to get 230 or 115 volts single-phase, from a 3-phase line. Some of them simplify the matter by assuming a 4-wire line, or even a transformer with a secondary Y-connected.

Jack Darr is now "reconstructing the crime" with the help of the original photocell unit, and will (in an early issue, we hope) give a full report on the situation by a local electrical authority. Meanwhile, Mr. Austin's guess, below, appears to be the most reasonable solution we have received to date.—*Editor*]

Dear Editor:

Jack Darr's 3-phase problem ("What's your EQ?", October 1963) can be encountered in every detail in one—and only one—type of 3-phase distribution system. At one time, the grounded-delta circuit shown in the drawing was very common in small towns and out-



Transformer secondary connections for 220-volt, grounded-delta, "wild-phase" distribution system. Transformer A is usually much larger than B. Transformer C may or may not be present. If present, system is "closed delta"; if not, "open delta." (Primaries have been omitted for clarity.)

lying city areas where the 3-phase load was small compared to the lighting load.

It was used principally because 3-phase motors were commonly wound for 220 volts at that time, while lighting and appliances were strictly 110-volt. Because this is the only configuration that will give a 2-to-1 voltage ratio on a 3-phase system, it was used in the interests of customer and power-company economy. It also came into play as a stopgap measure when a small customer demanded 3-phase service in an area with predominantly single-phase users.

This hookup can still be found, principally in farm towns where population and electrical load are declining, forcing power companies to make do with long-outmoded distribution systems.

Considering the speed with which Mr. Darr's "3-Phase Club" formed, perhaps it is only fair to say that his basic *problem* was technically accurate, and a situation that does occur when an inexperienced technician encounters this system. I have had to correct similar installations myself, including a few for the old hands!

Since the neutral is very rarely carried through to a 3-phase motor, the technician would probably have encountered a 3-wire line. If so, he made two basic mistakes. First, he should have tried a different phase. Second, it would be a violation of industry practice and electrical codes to pick up a current-carrying ground from the frame of the motor or a conduit. At best, it would be a noisy and erratic current path. At worst, the conduit may open up and put 110 volts on the whole frame of the motor, setting up a highly dangerous situation.

It would seem, then, that Mr. Darr's solution was the practical one, even though his explanation is technically inaccurate.

EUGENE AUSTIN
Lincoln, Neb.

A Man Who Got the Best

Dear Editor:

After reading Herman Burstein's "Get the Best from Those Ceramic Cartridges" (June, page 28), I tried his suggestions. I ran my cartridge as an "amplitude device" to the tuner input of my amplifier. I had been using it as a "velocity device" across a low-value resistor, feeding the magnetic input. It wasn't bad.

But loading the cartridge with 1,800 pf and using the tuner input gives me as good bass and better treble, with a couple of bonuses. The amplifier no longer "blocks up" on heavy signals,

(Continued on page 23)

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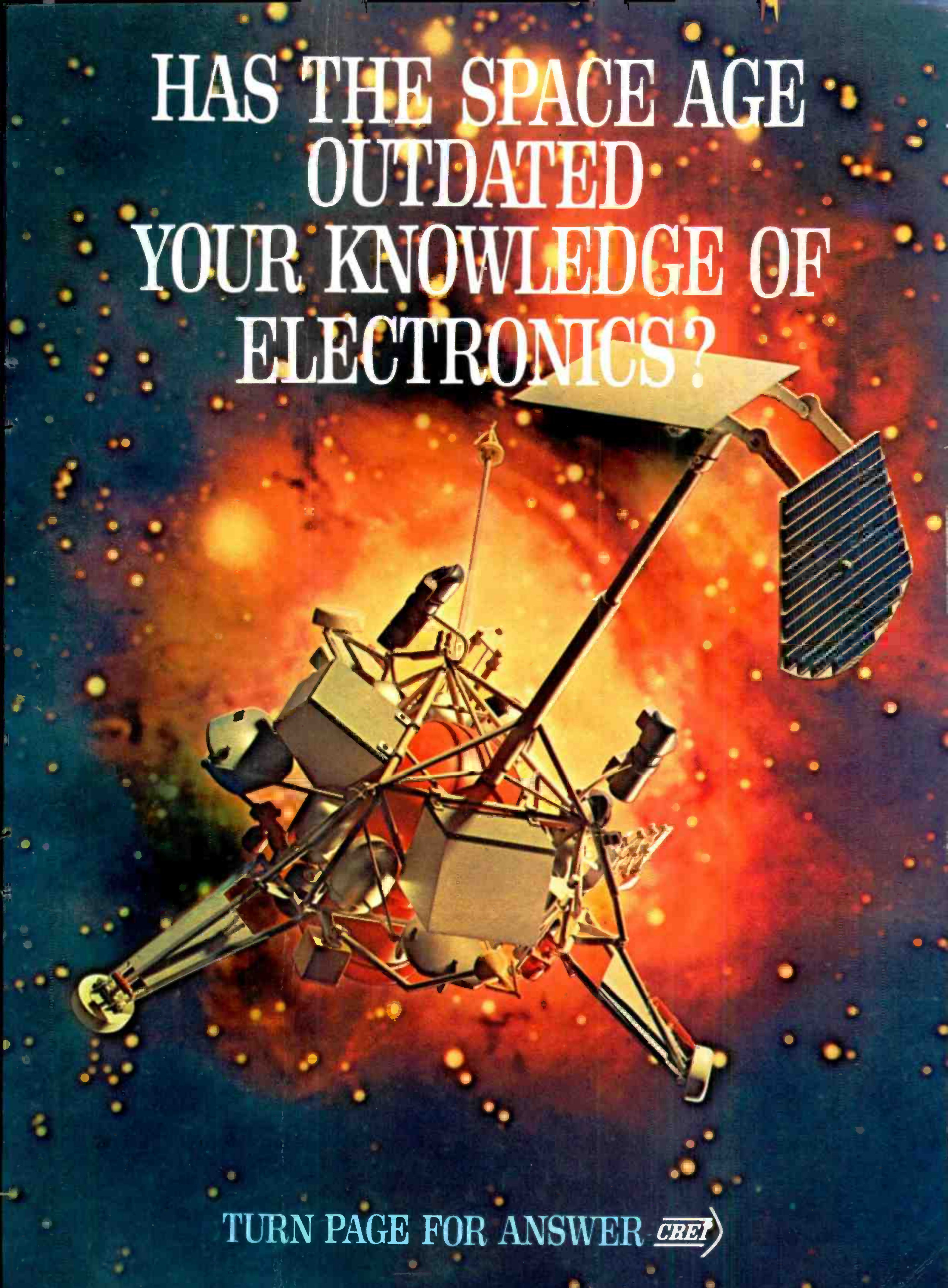

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WHAT HAPPENS TO TRANSISTORS IN THE VAN ALLEN BELT? HOW ARE VACUUM TUBES USED IN SPACE? WHY CAN'T REGULAR LUBRICANTS BE USED ON MOVING PARTS IN A SPACECRAFT? TO WHAT EXTENT HAS THE SPACE EFFORT CHANGED RELIABILITY STANDARDS?

The answers to these questions reflect the changes taking place with space applications of electronics. For space electronics involves new and different uses of electronic principles. Conventional systems and components are frequently outdated. Technical breakthroughs come almost daily. Space electronics is as different from the electronics you know as the superheterodyne receiver is from the crystal set.

WHAT DOES THIS CHANGE MEAN TO YOU?

It means specialized knowledge of space electronics is essential for a career in this field. Nearly every major electronics organization and a good many of the smaller companies have become part of the space program. Guiding space vehicles, communicating with them through space and processing the vital information they gather demands knowledge that did not exist when you studied electronics. And this knowledge can't be acquired on the job, unless you are one of the few men privileged to work for a key space engineer or scientist.

Developments in space electronics are affecting almost every area of electronics. For instance, the same techniques used in the space program are used in electronic packaging to reduce computers and television sets to a much smaller size. So knowledge of space electronics is an asset to a man in any field of electronics.

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(Continued from page 18)

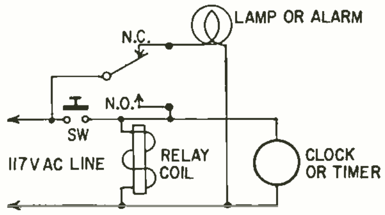
and there's no more tendency to start rumbling on low bass. My thanks to Mr. Burstein and RADIO-ELECTRONICS.

J. E. CARTER
Jacksonville, Fla.

Safer Clock Relay

Dear Editor:

Reference article "Relay Prevents Clock Confusion" in "Try This One" (page 107, October 1963): Wouldn't a momentary contact spst switch connected from the armature to the top of



the relay coil in parallel with the N.O. contacts be a safer and more convenient way to energize the relay than "depressing the armature . . . manually"?

MSGT. CYRUS N. WELLS, JR.
Novato, Calif.

[Sure would. We thank you, Sgt. Wells, and Mr. Allen A. Gault of Baltimore who also came up with this solution.—*Editor*]

. . . But the Meaning Depends on the Viewer

Dear Editor:

"The Pattern Depends on the Probe" by Cunningham in the November issue was quite interesting. But it all depends on how a man gets used to his scope.

The smear shown in picture "a" is what I trace for—I use that direct probe. If I can pick up that smear at the tuner but lose it somewhere in the video circuit, there's the trouble.

How many TV service technicians who own a high-voltage probe really take the time to use it with their meters? The insulated screwdriver has taken over the job quite well.

PETER LEGON
Malden, Mass.

Long-Time Reader

Dear Editor:

My career in wireless began when I subscribed to *Modern Electrics* back in 1912 when I was 12. It was the inspiration which Mr. Hugo Gernsback's magazine afforded me which triggered my interest. I have been professionally in "wireless" since 1918. I wonder how many others were so affected by Mr. Gernsback's magazines and stories?

E. B. REDDINGTON
Staff Engineer
EIA
Washington, D.C.

END

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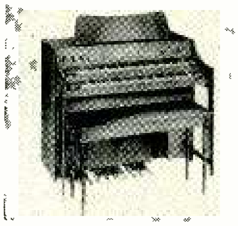

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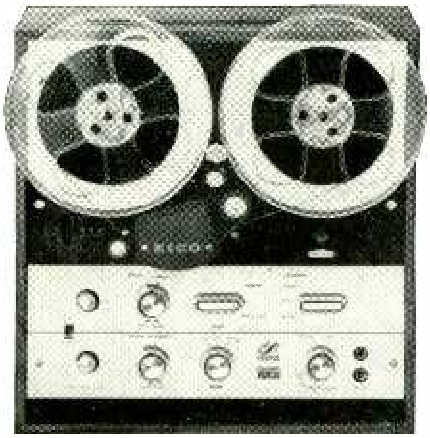

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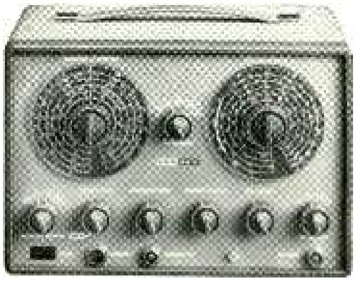

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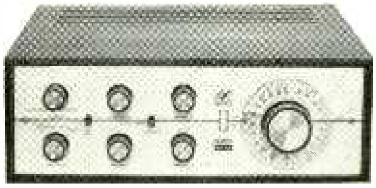

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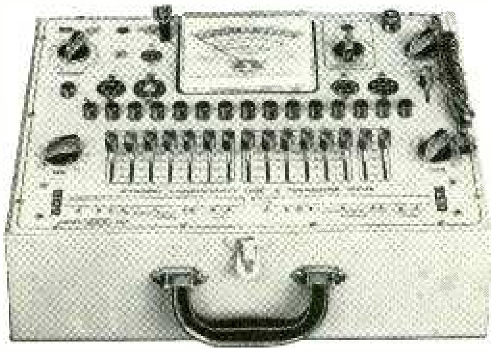

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SPACE HANDICAPS

...To Remain Alive In Space Is Difficult...

Humans, who all their lives have lived in the protective blanket of the earth's atmosphere, find it difficult to dissociate themselves from it entirely; that is, to live in a perfect vacuum.

An entirely new environment, as well as new physical laws, which will always be full of surprises for man, exist in space or on the moon.

Once he leaves his comfortable, pressurized space cabin and ventures out into the harsh vacuum of space in his clumsy space suit, he must learn all over again how to live.

In this article we do not wish to go into too great detail about the weightlessness and dangerous, often deadly, radiation from the sun, such as ultraviolet, infrared, X-rays and others not too well understood as yet. (There are still other, nonsolar forms of radiation, such as cosmic rays and neutrons, all more or less deadly if humans are not insulated against them or are exposed to them too long.)

On the moon, the direct heat from the sun can reach a temperature higher than 200°F and a low during the lunar night of —250°F! On top of all this, a man in a space suit gives out as much heat as does a 150-watt lamp and it is continuous! This calls for portable air conditioning if one is to survive.

However, even if there is no air in space or on the moon, a man in a space suit need not necessarily broil or freeze to death. His white space suit will, first of all, reflect a large percent of the solar radiation. He can simply turn his back to the sun periodically. This then heats his freezing back and cools his front. Remember, too, that the inside of the space suit must contain a layer of pressurized air without which a human cannot live. Indeed, if an accidental puncture of the pressurized space suit occurs and if that puncture is not closed immediately, the man must perish within minutes in the lowered air pressure. He will literally blow up, because his body interior air puffs up his body like a balloon. A similar phenomenon occurs when we bring a deep-sea fish to the surface. Robbed of the tons of ocean pressure, the fish dies quickly from internal organ injuries.

We shall now speak of another hazard, too often forgotten: the *invisibility of man in space.* Space is practically dead black. The sun shines harshly in an inky-black sky. Starlight does not appreciably change that sky. Without air to diffuse the light rays, any object not directly in the sun becomes invisible.

Thus men walking in single file cannot see the men ahead. They would have to walk abreast. A man entering into the shadow of a large rock or cave becomes totally invisible from all sides—he just seems to disappear. The effect will be the same when spacemen must work outside a space ship to make repairs. If a man is in the shadow of the ship, as he often must be, his co-workers cannot see him. Two-way radios do not always help to find the missing man quickly, particularly if he has floated some distance and his companions are behind him. Remember, he is now invisible and today's two-way radios are not too directional.

This calls for (1) illuminated spacemen, and (2) highly directional two-way radios usually built into the space suit.

Both these points have been neglected so far. In the matter of illumination, a high-intensity pulsing light should be affixed to the top of the spaceman's helmet as well as to his back. It would be operated by a simple lightweight electronic pulser and a few batteries. To keep them recharged one could attach solar cells to the front and back of the spaceman. In the vacuum of space, solar cells receive more radiation; there may be an increase of up to 20% in output. These can then be used instead of batteries for constant electrical energy output. As one moves away from the sun in interplanetary space, the solar cells are no longer efficient. Thus, near the planet Neptune the output of a solar cell is less than one tenth of one percent of that on the earth.

The solar cells could furnish electricity directly as long as the spaceman is in the sun. But when he is in shadow, he will have to rely on the batteries for power.

As a safety standby in case of flasher failure, the spaceman should be provided front and back with high-efficiency luminous markers as well. *—H.G.*

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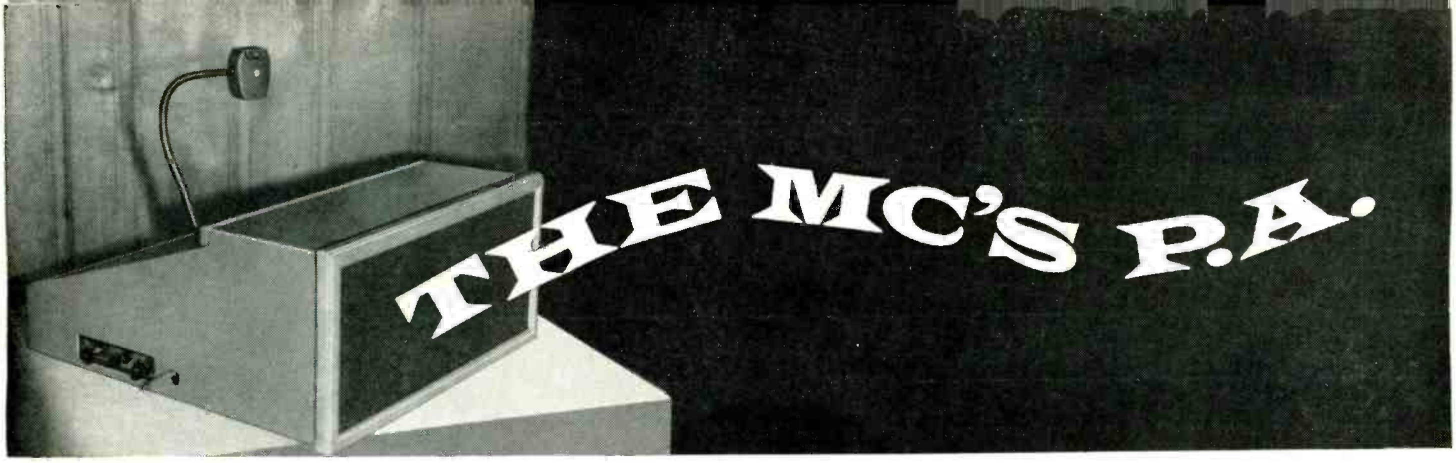

THE MC'S P.A.

Meeting-hall voice booster is all-transistor

By LEON A. WORTMAN

A MASTER OF CEREMONIES USUALLY needs two things: a good story and a PA system. I don't have a good story at the moment but I do have a good PA system to offer. It's complete in one package, compact and economical. All-transistor, it includes preamplifier, power amplifier, loudspeaker, microphone, choice of ac power supply or long-life battery pack, and a lectern. Because of the exceptional portability, setup speed and built-in choices of power source, a system like this appeals to those who feel the lack of manpower, electric power or money power.

The chassis measures 5 x 7 x 2 inches. It contains a three-stage preamplifier transformer-coupled to a push-pull 6-watt amplifier and a 117-volt ac power supply for operation from house current. One 12-volt "lantern" battery provides power when ac power lines are not accessible. For mobile work, a car battery can power the system. An accessory cord with a plug for the cigarette lighter is a convenient way to obtain power.

The three-stage preamp can be built from scratch, or a ready-made unit purchased from a mail-order house. For those who prefer to "roll their own" all the way, a wiring diagram for an equivalent circuit is shown in Fig. 1. Fig. 2 shows the simple modifications made to the ready-made amplifier to adapt it for preamplifier use. The commercial "preamplifier" was made to be used as a small power amplifier. Therefore, it is equipped with an output transformer to match a speaker voice coil. However, in this application it must match the push-pull input of the large-signal power output stage. Either replace the transformer provided with the ready-made

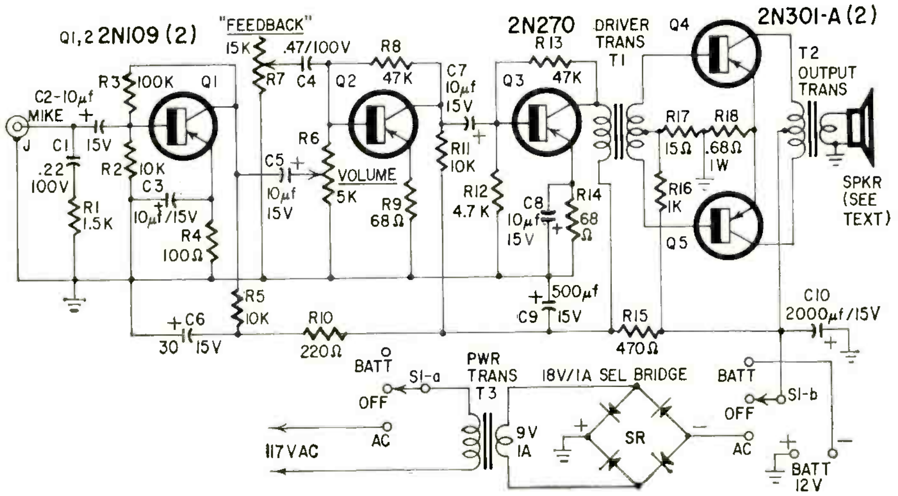

Fig. 1—Amplifier circuit works from 12-volt battery or ac line.

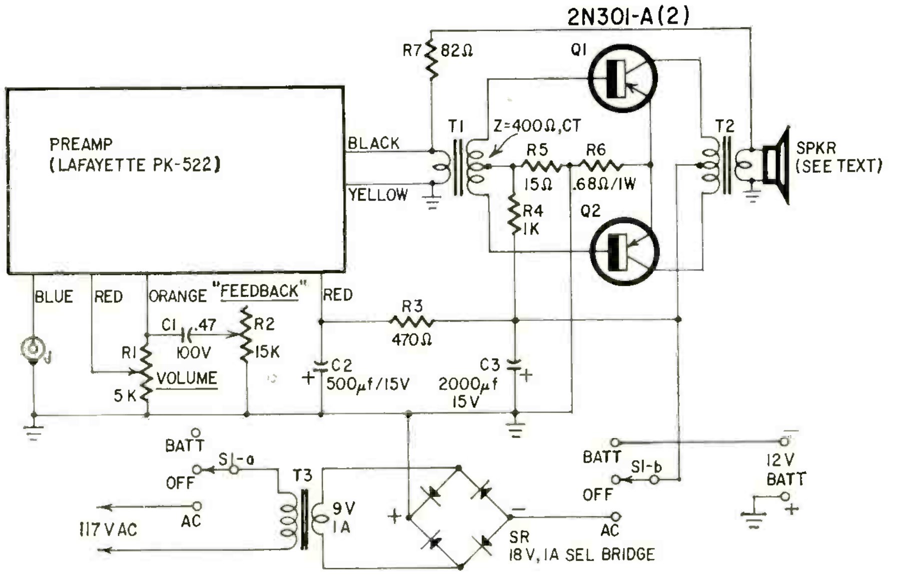

Fig. 2—Same output stage and power supply, but Q1, Q2, Q3 and associated components of Fig. 1 are replaced with prepackaged 3-stage amplifier.

PARTS LIST, Fig. 1

C1—.22 μf, 100 v
C2, C3, C5, C7, C8—10 μf, 15 v, electrolytic
C4—.47 μf, 100 v
C6—30 μf, 15 v, electrolytic
C9—500 μf, 15 v, electrolytic
C10—2,000 μf, 15 v, electrolytic
J—phono jack
Q1, Q2—2N109
Q3—2N270
Q4, Q5—2N301-A
R1—1,500 ohms
R2, R5, R11—10,000 ohms
R3—100,000 ohms
R4—100 ohms
R6—pot, 5,000 ohms, audio taper
R7—pot, 15,000 ohms, audio taper
R8, R13—47,000 ohms
R9, R14—68 ohms
R10—220 ohms
R12—4,700 ohms
R15—470 ohms
R16—1,000 ohms
R17—15 ohms
R18—0.68 ohm, 1 watt
All resistors ½ watt, 10% except as noted
S—2-pole 3-position rotary switch
SR—rectifier, full-wave bridge, 18 v, 1 amp (International Rectifier Corp. M1B or equivalent)
T1—interstage transformer: 500-ohm pri, 150-ohm ct sec (Stancor TA-38—use full primary)
T2—output transformer: 48-ohm ct pri, voice-coil sec; 6 watts (Argonne AR-503)
T3—selenium rectifier transformer (Stancor RT-201 or equivalent)
Chassis—aluminum, 5 x 7 x 2 in.
Case, speaker, microphone—see text
Miscellaneous hardware

PARTS LIST, Fig. 2

C1—.47 μf, 100 v
C2—500 μf, 15 v, electrolytic
C3—2,000 μf, 15 v, electrolytic
J—phono jack
Q1, Q2—2N301-A
R1—pot, 5,000 ohms, audio taper
R2—pot, 15,000 ohms, audio taper
R3—470 ohms
R4—1,000 ohms
R5—15 ohms
R6—.68 ohm, 1 watt
R7—82 ohms
All resistors ½ watt, 10% except as noted
S—2-pole 3-position rotary switch
SR—rectifier, full-wave bridge, 18 v, 1 amp
T1—output transformer, used in reverse: 400-ohm ct pri to voice coil (Stancor TA-41)
T2, T3—same as in Fig. 1
Chassis, case, speaker, mike—same as in Fig. 1
Miscellaneous hardware

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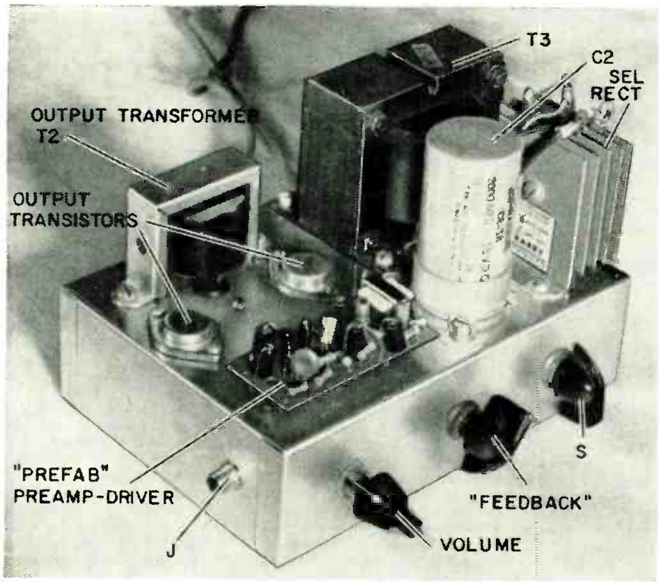
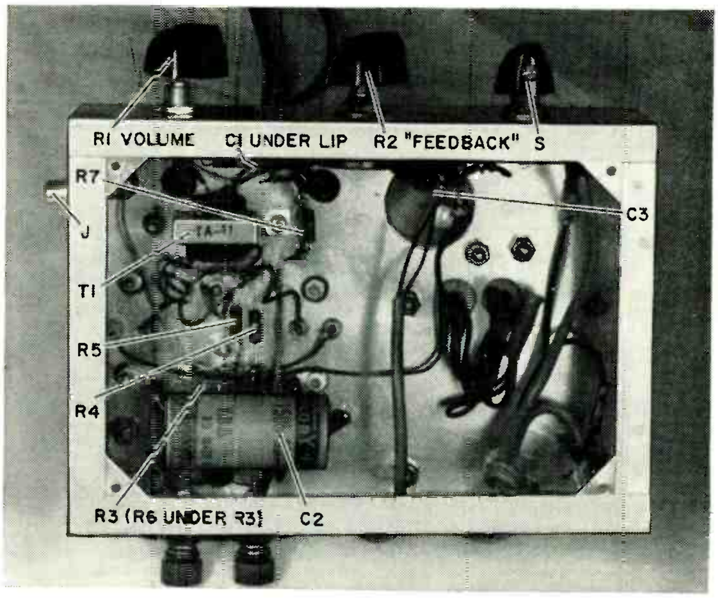


Close up of amplifier–power supply chassis. This version uses prewired amplifier as preamp and driver.



Underneath the chassis. Prepackaged amplifier saves many parts and connections. Components shown are those of Fig. 2.

unit, or add another in cascade. I chose to *add* rather than *replace*. This simplified construction and provided a convenient way of introducing negative feedback. Either approach involves the same investment: one transformer.

Construction of the lectern or podium is, of course, up to you. My unit is shown simply as a guide. The speaker is an 8-inch unit rated at 10 watts. A mid-range speaker was selected for maximum efficiency at voice frequencies. A wide-range speaker with extended high-frequency response is not desirable because of its tendency to produce excessive "spill" or feedback.

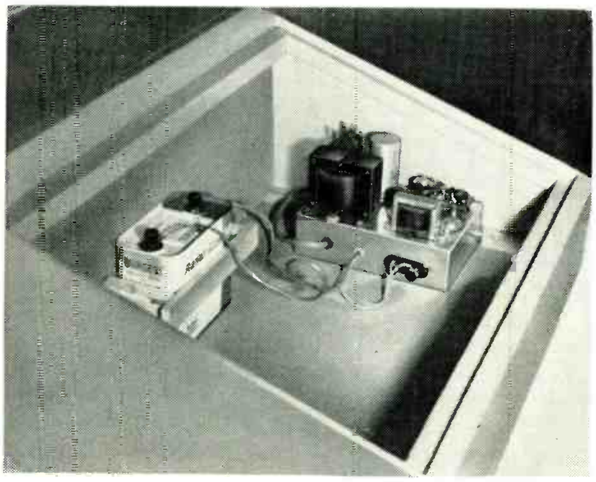
Cut and assemble the compartment first. Use ¾-inch plywood to keep cabinet vibration down. The outside dimensions of this section are 10x22x6 inches. Make the cutout for the speaker with a sabre or coping saw. Placement of the cutout is not critical. Acoustic isolation between the speaker and the microphone is essential for high audio output without feedback howl problems. Insulating materials (glass wool, rockwool, etc.) should be attached to the interior surfaces of the speaker compartment. The "feedback" control (basically a tone control designed to attenuate treble) is vital in eliminating "howl" at high volume settings.

After the speaker compartment is completed, add the side extensions. Cut two side pieces from ¼-inch plywood. Glue and nail these to the sides of the speaker compartment. The back piece is ¾-inch plywood, glued and nailed in position. Cut the bottom piece from ¼-inch plywood or masonite. Strips of wood approximately ¾ x ¾ x 10 inches add bracing at the joints formed by the sides and the bottom. They are important.

The sloping board on which the speaker rests his manuscript is made of ¼-inch plywood. Braces of ¾ x ¾ stock are glued and nailed inside the lectern to support the sloping board. Install the braces so that the sloping board recesses ¼-inch to provide a stop for the user's papers.

The amplifier chassis and the lantern battery are installed and secured inside the lectern, beneath the sloping board. A rectangular cutout in one side of the lecturn provides easy access to the controls while the equipment is in use. Note that switch S1 has three positions. All power is off when the switch is at its center position. The clockwise position connects the amplifier to the ac power supply. The counter-clockwise position disconnects the power supply from the circuit and connects the amplifier to the batteries.

Filter capacitor C10 is in the circuit regardless of the power connection. It filters ripple when the amplifier is ac-operated and helps prevent the howl that can develop as the batteries age and their internal impedance rises.



Inside the lectern. Amplifier and ac power supply are against far wall. Battery is secured on back wall of speaker compartment.

The microphone must be a high-output type (crystal, ceramic or reluctance). A "boom" for the microphone is easily constructed from lighting fixture components. I used a gooseneck extension with male threading at both ends. A ⅜-inch hole was drilled in the center of a 2 x 2-inch piece of metal to accommodate one end of the threaded gooseneck. That assembly is then bolted to the sloping board. The microphone is attached to the free end of the gooseneck in any convenient way (depends on the case of the specific mike). The result is a very neat, professional-looking flexible boom.

Sanding, sealing and painting or staining give the final commercial touch. Screw-in 6-inch legs can be installed to raise the lectern to the proper height above the conventional dining table. They can be removed quickly without tools should the user find the added height incorrect. Portability can be improved with a hinged cover. My capabilities as a carpenter ran out at this point! END

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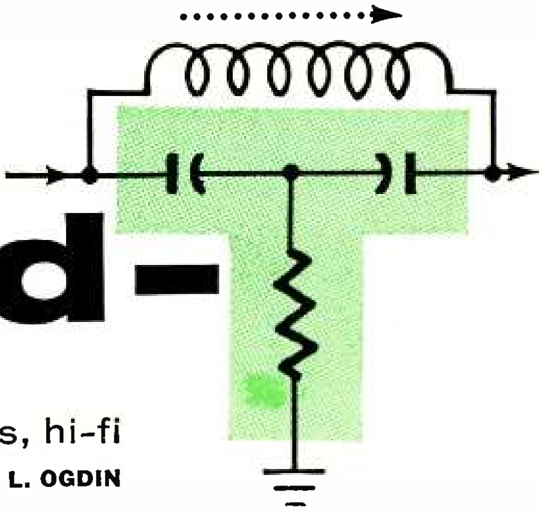
the bridged-T



Use it in communications receivers, hi-fi tuners and test equipment. By JERRY L. OGDIN

LITTLE HAS BEEN PUBLISHED ON BRIDGED-T (or T-notch) filters. This useful breed of circuit can attenuate or "notch out" an undesired frequency, as in harmonic-distortion analyzers and communications receivers. Used in a feedback amplifier, it can also select a "peak" or a desired frequency while rejecting all others.

A few years ago, the bridged-T filter gained new popularity in several amateur and communication receivers. There, the purpose was to attenuate an interfering carrier. (The bridged-T works from audio to higher radio frequencies.)

Fig. 1-a shows a typical bridged-T filter, designed for 455 kc. The inductor and capacitors resonate at the frequency to be notched out. Shunt resistor R has a unique function: it determines the amount of attenuation in the notch. Usually, with the optimum value of R, the notch depth is about 45 db. (That is, the output at the notch frequency is about 45 db down from the input voltage.) R has an optimum value for maximum rejection, and any other value will give less notch depth and more bandwidth.

The bandwidth of the bridged-T filter depends also on the Q of the inductor. Fig. 1-b shows typical bandwidth curves for two inductors, one having a Q of 1, the other a Q of 100. The higher the Q, the narrower the bandwidth and the tighter the skirt selectivity.

Fig. 1-c is the same circuit as Fig. 1-a, drawn in equivalent-circuit form. Resistor R_s is *not* an actual resistor; it represents the ac resistance of the coil. Once this is known, the value of the shunt resistor of the network can be calculated.

The formula for resonance in this circuit is

$$f_o = \frac{1}{2\pi}\sqrt{\frac{2}{LC}}$$

and, for maximum null at the frequency of interest,

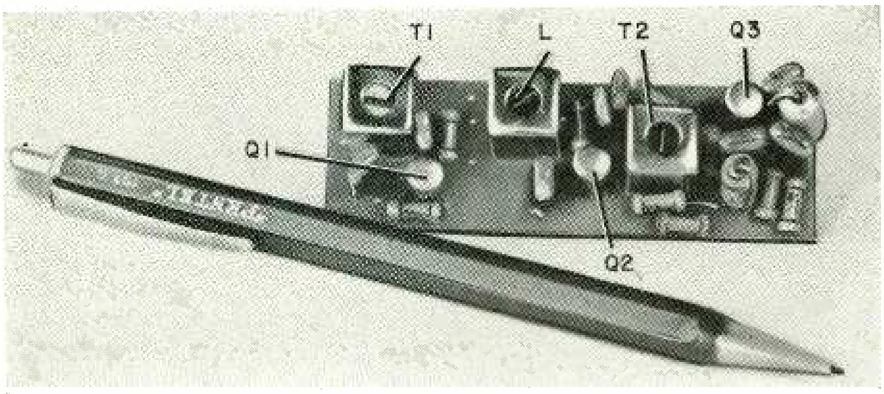
$$R = \frac{X_c^2}{R_s}$$

where $R_s = X_L/Q$.

The nomogram was developed to simplify the calculation of bridged-T filters. Easy to use, it makes the task of "turning the mathematical crank" to get an answer a lot simpler. First select a coil. Either calculate, measure, read out of a catalog or guess the inductance, and enter this information on the L scale. Next, set the frequency of operation on the f scale. Using a straightedge, connect the two points just marked, and read out the value of the capacitors required for resonance on the C scale.

If the Q of the coil is known, calculate the value of R_s according to the formula given above. Enter this on the R_s scale. Connect the point on the R_s scale and the point last crossed on the unmarked line between the L and R scales. After connecting these two points, read the R column to find the *approximate* value of the shunt resistor.

It's rare that the junkbox will yield a coil of known Q. In this case, construct the filter, insert a potentiometer, and "tune" for a null. It is good to do this even when the resistor value has been calculated, because according to Murphy's law, "if any error can possibly creep into any calculation, it will invariably do so."



The i.f. amplifier of Fig. 7. It's 3⅞ inches long by ⅞ inch wide.

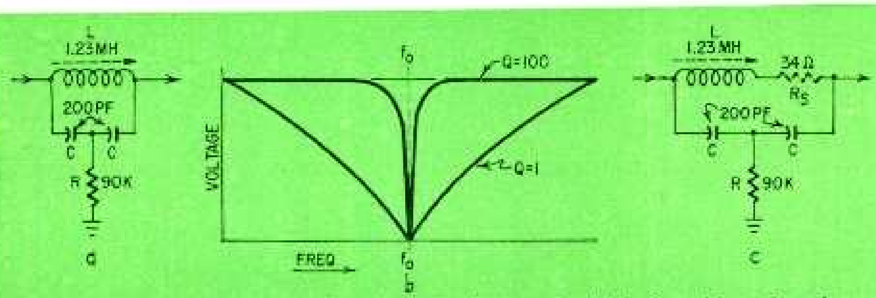


Fig. 1—Bridged-T for 455 kc. (b) Typical curve for high-Q and low-Q coils. (c) Equivalent circuit of (a) showing R_s, coil's resistive component.

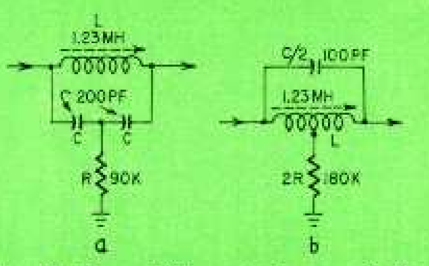


Fig. 2—Two different forms of the bridged-T filter.

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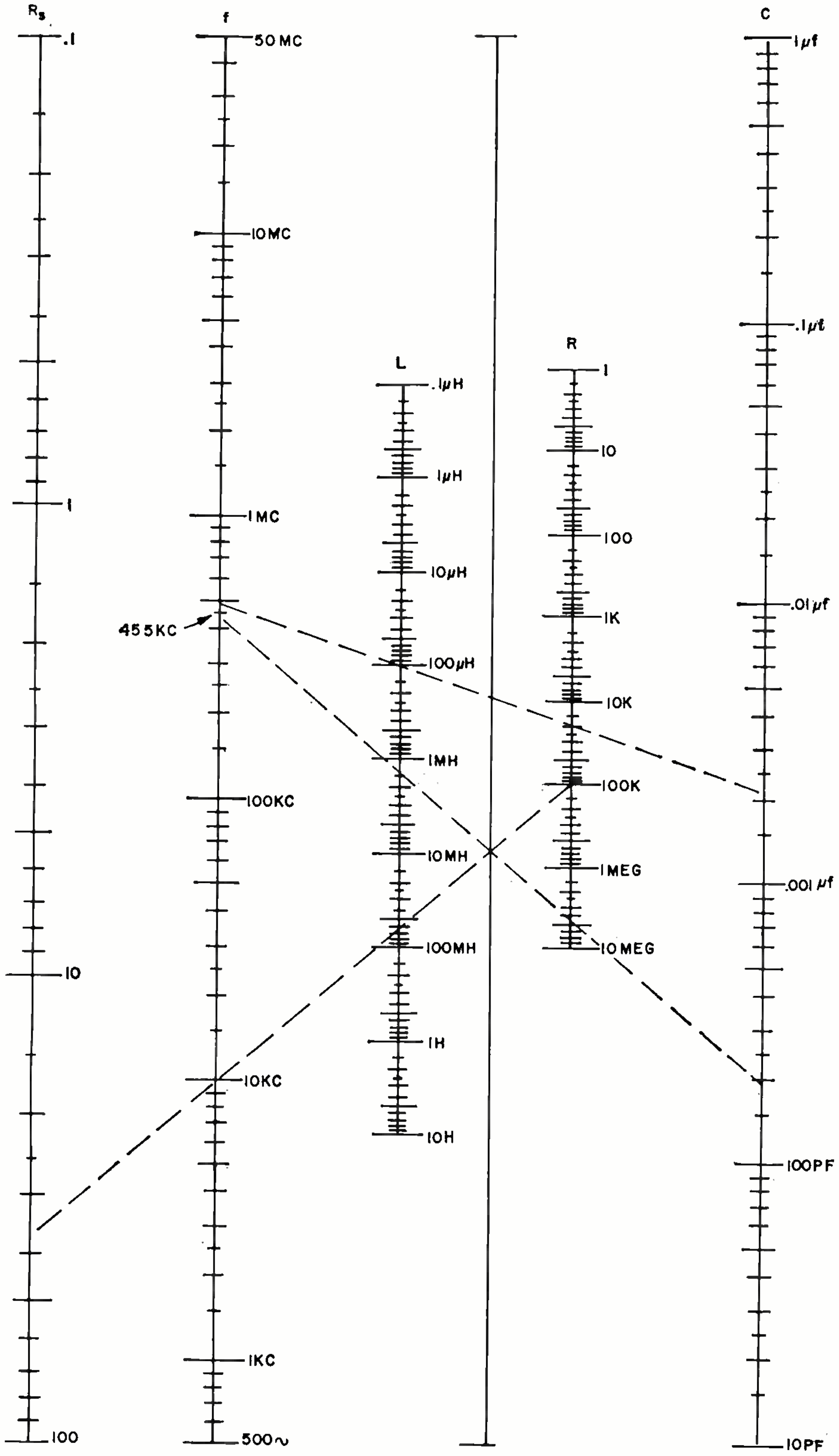

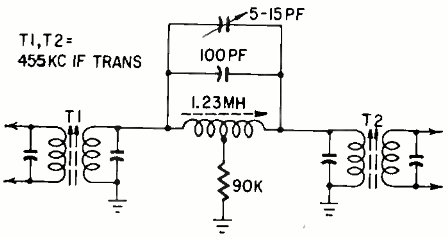

Fig. 3—A simple i.f. filter for notching out interference. The whole circuit should be substituted for one i.f. transformer. If only one side of each transformer in receiver is tuned, T1 and T2 should both have tuned side as primary.

To Use The Bridged-T Nomo

Mark off the inductance of the coil on the L scale, and set the intended frequency of operation on the f scale. With a straightedge, connect those two points. The line will intersect the C scale at the capacitance required to resonate with the inductor at f.

Knowing the frequency and selecting a suitable capacitance, you can find the proper inductance value in the same way.

If you know the Q of the coil, calculate R_s according to the formula $R_s = X_L/Q$. Mark this value on the R_s scale, and now draw a line from this point to the point where the line you drew to find L or C intersects the ungraduated line between the L and R scales. Extend the R_s line beyond that point and into the R scale. Read off the approximate value of shunt resistor R from the R scale.

The example shown on the nomogram is for the filter of Fig. 1-a.

The filters of Fig. 2-a and 2-b are electrically identical. If the inductor chosen has a center tap, use it. In that case, the single capacitor has one-half the value determined in the nomogram, and the value of the shunt resistor is doubled (assuming no change in the value of the inductor).

Using the filter

A bridged-T filter may be connected with either side as an input. The shunt resistor is connected to a point which is at ac ground. The impedance of the filter presented to an input source is approximately equal to the shunt resistor, and the source should have an impedance of less than that value. The output should be loaded lightly—that is, look into a high impedance.

A simple filter system that can be used with nearly any 455-kc i.f. amplifier is shown in Fig. 3. The variable capacitor is used to tune the notch over a small range to an interfering carrier. The 90,000-ohm resistor may be replaced with one of 22,000 ohms in series with a 75,000-ohm potentiometer. This provides variable notch depth and selectivity.

Another use for the T-notch is in high-fidelity AM tuners, where 10-kc heterodyne whistles are often disconcerting. The circuit of Fig. 4 can be used to attenuate 10 kc. Of course, the values shown on the schematic are only examples, and may be changed to suit the junkbox by using the nomogram.

Reversing the notch

Although the bridged-T is very good for rejection filtering, it cannot be

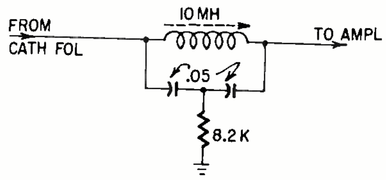

Fig. 4—A 10-kc "whistle filter" for hi-fi AM tuners. Use it from low impedance to high impedance.

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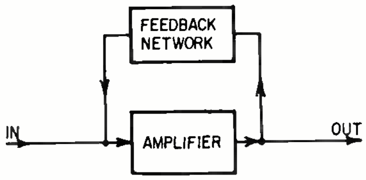

Fig. 5—"Classical" functional diagram of feedback amplifier. Here, amplifier has 180°-phase shift, feedback network 0°.

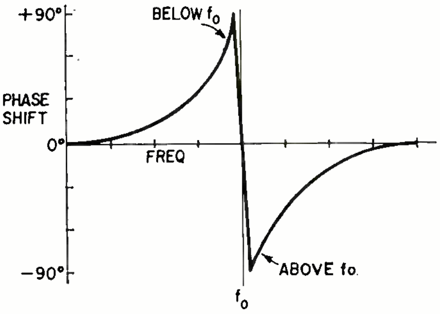

Fig. 6—Phase shift diagram for bridged-T. Note sudden, rapid change from +90° through 0 to −90°, which makes filter very selective.

directly wired for use in bandpass circuits. However, consider the basic voltage amplifier with negative feedback (Fig. 5). If, classical theory has it, we want to eliminate some frequency, we feed back that same frequency 180° out of phase with the input and the frequency cancels out. Conversely, if we want to amplify only one frequency, we feed back all *except* the desired frequency.

However, we must know the phase shift through the filter itself. Fig. 6 shows it at various frequencies. Near the center (resonant) frequency, the phase shifts rather violently from +90° to −90°, passing through the point of zero phase shift *at* the resonant frequency. Therefore, for a tuned bridged-T, the phase shift can be assumed to be zero.

Practical circuitry

The circuit of Fig. 7 is the result of research into an inexpensive selective i.f. amplifier. The bandwidth of the amplifier at various levels is shown in the table, but can be spread by reducing the value of filter resistor R1.

BANDWIDTH OF FIG. 7 AMPLIFIER

Level	*Bandwidth*
−6db	800 cycles
−20db	1.8 kc
−40db	9.5 kc

The amplifier is normally fed from a mixer circuit through the input transformer T1. (If you cannot get double-tuned transformers for transistors, use the scheme of Fig. 8.) The amplifier may also be fed from a converter or another i.f. amplifier. The first two transistors, Q1 and Q2, are connected in a form of the Darlington circuit (super-alpha pair). Usually, the Darlington circuit has both collectors tied together, but here it is more stable when the collector of the first transistor is decoupled for ac.

The secondary windings of the two i.f. transformers are returned to ground. If the bias were fed in series with the windings to the base of the transistors, the low dc resistance of the filter would change the operating points erratically. This is because, for dc, the bases of Q1 and Q3 would be connected together. The same components are used in either biasing scheme.

The phase difference between the two points to which the filter is connected must be 180°. The secondary of T1 is assumed to have zero phase shift. The coupling capacitor to the base of Q1, and transformer T2, each have equal and opposite phase shifts, which cancel out. The first transistor is an emitter follower (no phase shift) and the second transistor has a phase shift of 180°. Therefore, the total phase shift of the circuit with feedback is 180°, which is correct.

If, by accident, the secondary of T2 is reversed, the amplifier will oscillate.

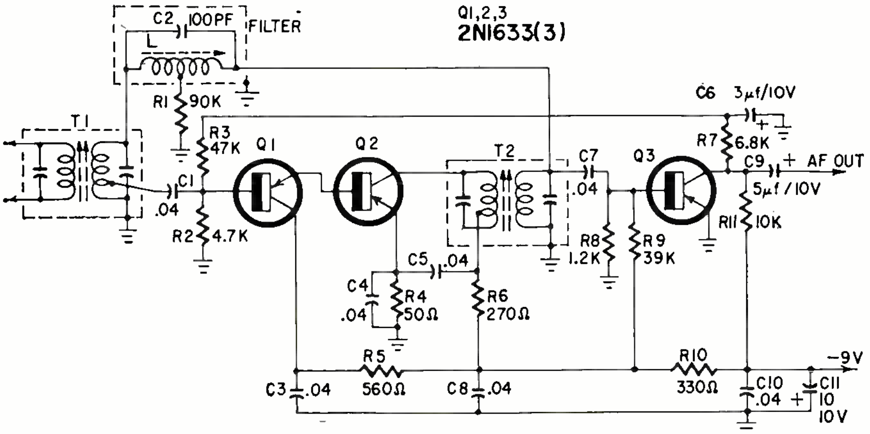

Fig. 7—Practical high-selectivity i.f. amplifier. Bridged-T network provides 100% negative feedback at all frequencies except 455 kc.

Parts List

R1—90,000 ohms (see text)
R2—4,700 ohms
R3—47,000 ohms
R4—50 ohms (use 47- or 51-ohm resistor)
R5—560 ohms
R6—270 ohms
R7—6,800 ohms
R8—1,200 ohms
R9—39,000 ohms
R10—330 ohms
R11—10,000 ohms
All resistors ½ watt, 10%
C1, C3, C4, C5, C7, C8, C10—.04 µf disc ceramic
C2—100 pf ceramic or silver mica
C6—3 µf, 10-volt electrolytic
C9—5 µf, 10-volt electrolytic
C11—10 µf, 10-volt electrolytic
L—1.23 mh slug-tuned coil, center-tapped. (If center-tapped coil not available, use two 200-pf capacitors instead of C4, as per Fig. 2-a.)
Q1, Q2, Q3—2N1633 or similar
T1—455-kc double-tuned transistor i.f. transformer. Secondary tap 1,500 ohms
T2—455-kc transistor i.f. transformer, 5,000-ohm secondary.
[The author states that these double-tuned i.f. transformers are not widely advertised or listed in catalogs but many distributors stock them as a kit of replacement transformers for Japanese radios. Check your dealer's counter display cards or bargain counter. If they are not available, use two Stancor RTC-8671 or J. W. Miller 9-C1 transformers connected back to back for T1 and T2. See text and Fig. 8.—*Editor*]

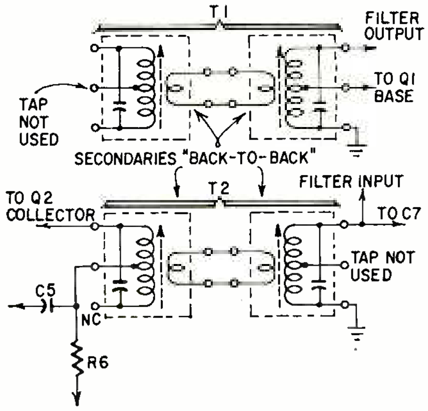

Fig. 8—How to wire four single-tuned i.f. transformers for use as T1 and T2. See parts list.

The last transistor (Q3) is a class-B detector, and gives an additional 10 db gain. This transistor also functions as an agc amplifier, with the agc voltage taken from the collector. The 6,800-ohm resistor and the 3-µf electrolytic decouple the agc and determine the time constant. The dc is then fed through the 47,000-ohm resistor to the base of Q1. If agc is not desired, these three components may be eliminated, and a 62,000-ohm resistor connected from the base of Q1 to the −9-volt line.

A 50-µv input gives an audio output of 0.2 volt, peak to peak. Just at the point where the detector begins to saturate, the audio output reaches 1.5 volts peak to peak.

No attempt has been made to apply this circuit to vacuum tubes, but there is no reason it shouldn't work equally well. END

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1. Markus and Zeluff, *Electronics for Communication Engineers*, McGraw-Hill.
2. *Selected Semiconductor Circuits*. NAVSHIPS 93484

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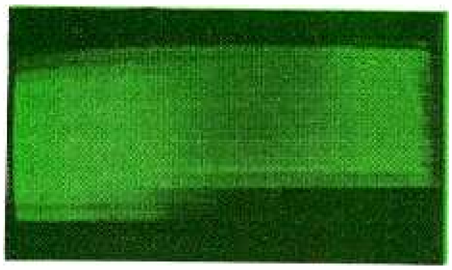
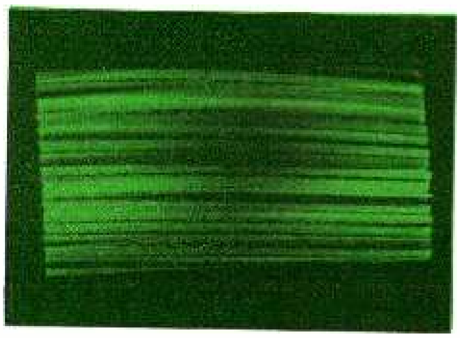
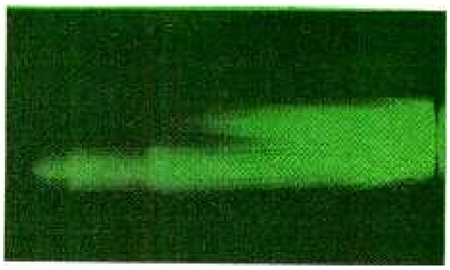


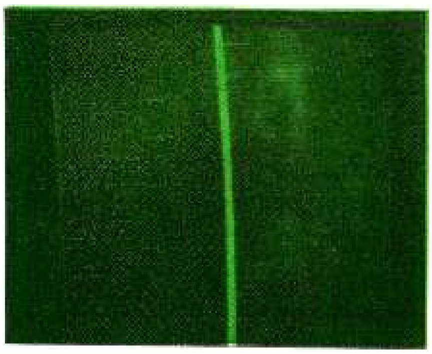
Horizontal oscillator way off?



Horizontal oscillator? Output?



Shorted yoke? Arcing damper?



A drive line?

They're all caused by power supply troubles!

Bad vertical output stage?

TV Power Supply TROUBLES

Simple? Not always! The photos here show some strange but perfectly possible symptoms

By JACK DARR
SERVICE EDITOR

LOW B-PLUS: EASY TO DISCOVER—A QUICK jab with a voltmeter. What causes it, though? The answer, as usual in TV service, is plural. Low B-plus voltage can be due to a weak rectifier, either tube or "dry". But it can also be due to an overload, heavy leakage or short somewhere in the distribution network. How can we find out which—quickly?

First, of course, replace the rectifier. Easy with a tube, not so easy with others, unless they're plug-ins. If the rectifiers aren't easy to get at, we can use other shortcut tests. Let's take the tube types first.

Replace the tube. If this doesn't cure the trouble, check the input filter capacitor. This acts as a reservoir for the charge fed into it by the rectifier. So, if we lose capacitance here (C1 in Fig. 1), down goes the output voltage. For a quick check, to save pulling a chassis, put a tube-base test adapter under the rectifier tube. Now we can read the voltage at the cathode (or filament, on 5U4's, etc.). Also, we can shunt a good capacitor across the input of the filter. If we leave the voltmeter hooked to the cathode while this is done, we can see the voltage jump back to normal if the old capacitor is open. Be sure to use test capacitors with *at least* a 450-volt rating! (About 40–60 μf is the right size.)

If the input capacitor is OK, then our low B-plus must be due to an overload. Something is drawing too much current. What's causing this? One of three things: a shorted tube (not the rectifier—we've already changed that), capacitor leakage, or—we'll get to the third in a minute. Let's try the more common troubles first.

A shorted tube should be caught in tube testing. We can break the B-plus circuit at the rectifier cathode and insert a 0–500 dc milliammeter, as in Fig. 2. Now we can pull tubes, one at a time, watching for the current to drop back to normal. We can also disconnect the various branches of the B-plus network, watching the drain on the meter. If the overload suddenly disappears, you've found the villain. You can also "ohmmeter" this trouble out, by checking resistance along that particular line.

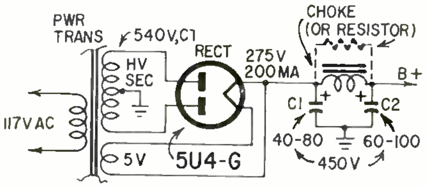


Fig. 1—Basic circuit of typical transformer type power supply.

Voltage readings will help pin down shorts and leakage. Look for overheated resistors—a sure clue!

Final word on this process: be *sure* to check *all* tubes before you start disconnecting wires! I remember one set that blew two big 5U4's very rapidly. Dead short in the B-plus. After hauling the thing 5 miles to town, I found the trouble: a dead-shorted 6BQ7 in the *tuner!* This makes one feel very intelligent! So now I check *all* tubes before I make any diagnoses of "shorted filter capacitors"! Quick check: connect an ohmmeter across B-plus to show the short, then lift tubes from the sockets, one at a time.

Now for the third cause: incorrect grid bias on one of the high-current tubes—the horizontal output, vertical output and audio output tubes. The rest will not draw enough current, unless they are shorted, to drop voltage much.

However, the 6BQ6 draws 100 ma; the 6CM7, 70 ma, and the 6AQ5 (audio or vertical), 100 ma. If these tubes lose drive or bias, they can pull enough cur-

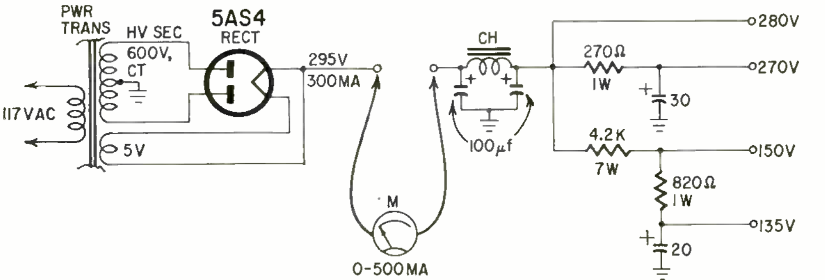


Fig. 2—Where to hook a milliammeter to read total *B-plus drain.*

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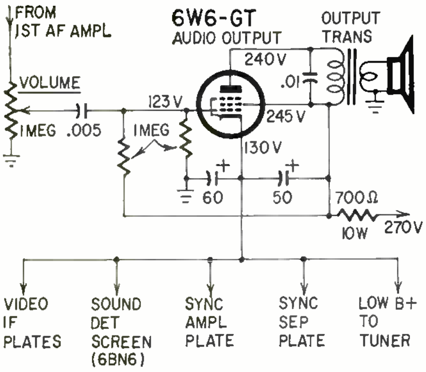

Fig. 3—Stacked B-plus circuits have troubles all their own. Audio output tube here is part of voltage divider, drops about half of 270 volt B-plus. Tube bias affects plate voltage in most other sections of set.

rent to cause trouble. In the mysterious cases where everything's all right but nothing works, try checking the bias on all of these tubes. A drop of 5 volts grid bias can cause a *100-ma change* in plate current on some types.

Stacked-B circuits can cause some obscure troubles, too. Look at Fig. 3. Here, the audio output tube cathode is the source of the 130-volt line. Note how many other stages are fed from this. A defect in the audio stage can show up as sync trouble, sound trouble, video i.f. overload, looking exactly like agc trouble, and even cause the CRT to black out if that 130 volts happens to be used for its bias!

Watch out for grid voltages on the audio tube. Notice the two 1-megohm resistors in the 6W6 grid? These form a voltage divider across the 270-volt line. The voltage at the junction is the grid bias of the audio output tube. If one of these drifts in value, away goes the grid bias, and off goes the 130-volt line! Leakage in the coupling capacitor can be responsible for this, too. You'll get the "volume control affects the picture" symptom: the leakage will put the 1-megohm control into the audio grid dc circuit, and its setting will change the bias, thus changing the 130-volt line again!

Transformerless circuits

Voltage-doubler circuits are used in "transformerless" TV sets. They give higher dc voltages without a power transformer. The full-wave circuit of Fig. 4 is not found too often any more. The ac line must "float," and the circuit requires extra parts.

Low output voltage can be due to weak rectifiers or partly open (weak) capacitors. To check, measure the dc voltage across each rectifier, also across the doubler capacitors C1 and C2 in Fig. 4. You should get about 135 volts across each. Less than 100 volts each means trouble. You can shunt capacitors across suspected units, or even shunt rectifiers across suspected weak ones, watching the polarity, of course. If this brings the voltage up, the original is below standard. Replace it.

In this circuit, an open filter capacitor, C3, will not cause much voltage drop. All it will do is increase the ripple. Partly open capacitors in the *doublers* drop the B-plus; "weak" rectifiers are usually seleniums. Silicon types tend to short out abruptly and completely, instead of losing voltage output.

The half-wave doubler circuit of Fig. 5 is one that puzzles novices (and a few old heads, too). When they see the electrolytic capacitor connected "direct to the ac line," they wonder if their instructors knew what they were talking about! However, the "shunt rectifier" on the other side takes care of that. There

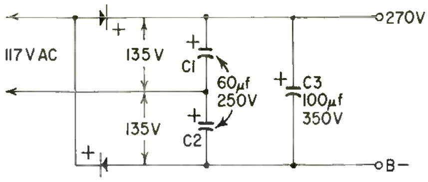

Fig. 4—Typical full-wave voltage doubler. Not too often used any more without transformer.

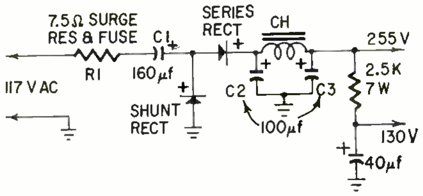

*Fig. 5—Common half-wave doubler. **C1** charges on positive half-cycle of ac line voltage, then discharges through series rectifier on negative half-cycle, adding its charge to the voltage rectified in normal half-wave fashion.*

is never any actual ac across this capacitor (unless, of course, the shunt rectifier is shorted). Then, rectifier and capacitor must be replaced. (Along with the fuse!)

Low voltage in this circuit is most often due to loss of capacitance in C1, the doubler capacitor. C2 and C3 will not affect the dc output. If they weaken or open, they increase the ripple.

Overloads react differently on both doubler circuits. If heavy, they should burn out the fuse. Many circuits combine fusing with the surge resistor in the "fusible-resistor" types (R1 in Fig. 5). Because of the "direct-to-line" connection, the current-carrying ability of this circuit is limited only by the size of the rectifiers and capacitors used. In making replacements, if the original rectifier seems a bit close, that is, a 300-ma rectifier in a circuit drawing 260 ma, use the next larger size—say, a 500-ma. This will increase the service life considerably. If silicon rectifiers replace seleniums, the B-plus voltage will be higher, because of the lower rectifier drop. Be careful. Don't wind up with too much voltage on your filter capacitors!

Check the surge voltage, the peak dc voltage when the set is turned on, cold. If this exceeds the working voltage rating of the capacitors, increase the value of the surge resistor. If capacitors are replaced in such circuits, always use new ones with higher voltage ratings.

Obscure troubles

Now let's look at some more obscure troubles. The real cause for these is usually too much *impedance* in the power supply. The ideal supply would have zero impedance between B-plus and ground. There could then be no coupling of circuits in the supply, and no feedback. Practical circuits can have impedances as low as 1 ohm or even less. Main cause of too much impedance is loss of capacitance in filter capacitors, or a high power factor, which reduces the filtering efficiency.

The scope is the best way to check for this. If the power supply has a low impedance, it won't develop much "signal" across it. Checking at the rectifier cathode in a good B-plus supply, we see, as in Fig. 6, a ripple of about 20 volts peak to peak. At the output, after filtering, the ripple is down to less than 2 volts p–p (Fig. 7). This is a transformer supply with full-wave rectifier; ripple frequency, 120 cycles. Notice that every

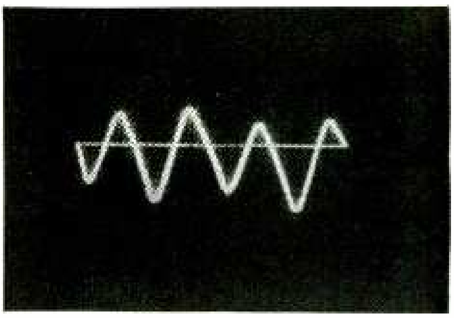

Fig. 6—Normal 120-cycle ripple pattern at cathode of full-wave rectifier. About 20 volts peak to peak.

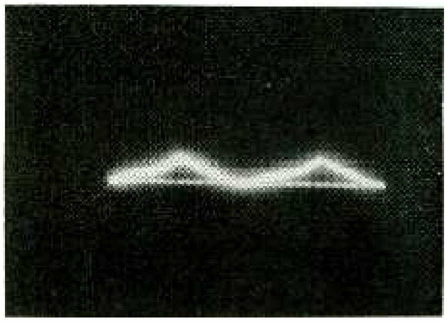

Fig. 7—Normal ripple at output of same power supply. Peak-to-peak voltage is down to about 1.9.

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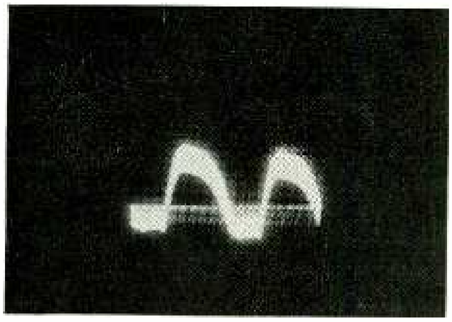

Fig. 8—Ripple at output with weak output filter capacitor (capacitance below normal). Peak-to-peak voltage up to about 24. Thickening of trace due to horizontal-frequency "hash" developed across impedance of weak output filter.

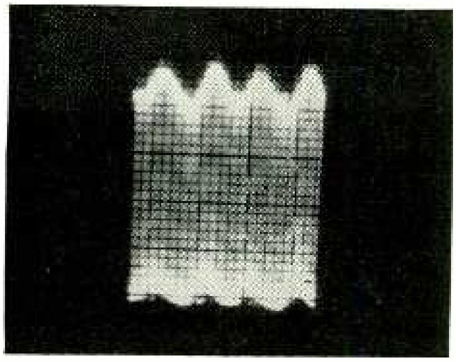

Fig. 9—Same power supply, output filter completely removed (or open). Scope sweep set at 30 cycles. Blurring caused by continual motion of scope trace. Peak-to-peak voltage now about 120.

other cycle is low? This is due to heavy loading on the B-plus by the vertical output stage. Since this is 120-cycle ripple, and the loading is 60-cycle, we see a drop in every other cycle. This, if severe, could mean poor B-plus regulation.

If the output filter capacitor has lost capacitance, the impedance of the power supply rises. Look at Fig. 8, which shows the ripple at the filter output, as in Fig. 7, but with a too-small electrolytic capacitor. This waveform is 24 volts p–p. Note the "thickening" of some parts; this is due to horizontal sweep frequencies developing across the increased impedance. This much ripple can cause instability, hum and other troubles.

If the output filter capacitor opens completely, we can see some *real* troubles! Fig. 9 shows this waveform, at the same point. "Ripple" is now a whopping 120 volts p–p, and the waveform itself is so jittery that it was hard to photograph. This was taken at 30-cycle sweep.

The same waveform, at 7,875-cycle sweep, shows the reason for the failure of the set's horizontal circuits, which went into violent "squegging" as soon as this capacitor failed. Feedback, through the increased impedance of the power supply, was so high that the whole sweep circuit was disrupted. This is the horizontal-frequency component in the waveform of Fig. 9. Fig. 10 expands the sweep so that the horizontal pulses can be seen.

The moral is simple. The B-plus circuit is a basic part of the set, as basic as the 117-volt ac line! Unless it's in good shape, nothing is going to work right! Take the very small amount of time necessary to be sure that it's in good shape. One jab with a voltmeter and another with a scope and you've got it made! END

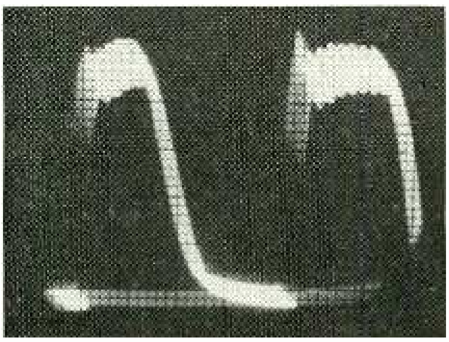

Fig. 10—Same conditions as Fig. 9, with scope sweep at half horizontal scanning frequency (7,875 cycles). This is a horizontal-frequency component of ripple. Feedback through power supply impedance threw horizontal oscillator off completely, and raster disappeared!

reactance tables

By ERNEST T. THIERSCH

I USE INDUCTIVE AND CAPACITIVE REACTANCES quite often and have gotten tired of calculating out a particular value each time I need it. This goes for using nomographs or slide rules too. To avoid this I drew up the two charts shown here. I use them so often that I thought others would find them useful too.

My original calculations were carried to many more digits, but three are accurate enough for my needs and better than much of my test equipment.

INDUCTIVE REACTANCE

$X_L = 2\pi fL = 6.28fL$

When X_L is in	ohms	megohms
L is in	henries	microhenries

f is always cycles per second

L → (henries) / f (kc) ↓	1.00	2.00	3.00	4.00	5.00	6.00	7.00	8.00	9.00
10	62.8 kΩ	126 kΩ	188 kΩ	251 kΩ	314 kΩ	377 kΩ	440 kΩ	503 kΩ	565 kΩ
11	69.1	138	207	267	346	414	484	553	622
12	75.4	151	226	302	378	452	528	603	679
13	81.7	163	245	327	408	490	572	653	735
14	88.0	176	264	352	440	528	616	704	792
15	94.2	188	283	377	471	565	660	754	848
16	101	201	302	402	503	603	704	804	905
17	107	214	320	427	534	641	748	855	961
18	113	226	339	452	565	679	792	905	1.02 meg
19	119	239	358	476	597	716	836	955	1.07
20	126	251	377	503	628	754	880	1.01meg	1.13
30	188	377	565	754	942	1.13meg	1.32meg	1.51	1.70
40	251	503	754	1.01meg	1.26meg	1.51	1.76	2.01	2.26
50	314	628	942	1.26	1.57	1.88	2.20	2.51	2.83
60	377	754	1.13meg	1.51	1.88	2.26	2.64	3.02	3.39
70	440	880	1.32	1.76	2.20	2.64	3.08	3.52	3.96
80	503	1.01 meg	1.51	2.01	2.51	3.02	3.52	4.02	4.52
90	565	1.13	1.70	2.26	2.83	3.39	3.96	4.52	5.09

When multiplying f or L by 10, multiply X_L by 10.

CAPACITIVE REACTANCE

$X_C = \frac{1}{2\pi fC} = \frac{.159}{fC}$

When X_C is in	ohms	megohms
C is in	farads	microfarads

f is always cycles per second

f Kc	C = 100 pf	200 pf	300 pf	400 pf	500 pf	600 pf	700 pf	800 pf	900 pf
10	159 kΩ	79.5 kΩ	53.1 kΩ	39.8 kΩ	31.8 kΩ	26.5 kΩ	22.7 kΩ	19.9 kΩ	17.7 kΩ
11	144	69.1	48.2	36.2	28.9	24.1	20.7	18.1	16.1
12	133	63.3	44.2	31.6	26.5	22.1	18.9	16.6	14.7
13	122	58.4	40.8	30.6	24.5	20.4	17.5	15.3	13.6
14	114	56.8	37.9	28.4	22.7	18.9	16.2	14.2	12.6
15	106	53.1	35.4	26.5	21.2	17.7	15.2	13.3	11.8
16	99.5	49.7	33.2	24.9	19.9	16.6	14.2	12.4	11.1
17	93.6	46.8	31.2	23.4	18.7	15.6	13.4	11.7	10.4
18	88.4	44.2	29.5	22.1	17.7	14.7	12.6	11.1	9.83
19	83.8	41.9	27.9	20.9	16.8	14.0	12.0	10.5	9.31
20	79.5	39.8	26.5	19.9	15.9	13.3	11.4	9.95	8.84
30	53.1	26.5	17.7	13.3	10.6	8.84	7.58	6.63	5.89
40	39.8	19.9	21.2	9.95	7.96	6.63	5.68	4.97	4.42
50	31.8	15.9	10.6	7.96	6.37	5.31	4.55	3.98	3.54
60	26.5	13.3	8.84	6.63	5.31	4.42	3.79	3.32	2.95
70	22.7	11.4	7.58	5.69	4.55	3.79	3.23	2.84	2.53
80	19.9	9.95	6.63	4.97	3.98	3.32	2.84	2.49	2.21
90	17.7	8.84	5.89	4.42	3.54	2.95	2.53	2.21	1.96

When multiplying f or C by 10, divide X_C by 10.

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Simplest direct-reading frequency meter

Read audio frequencies from 200 to 20,000 cycles right off the meter

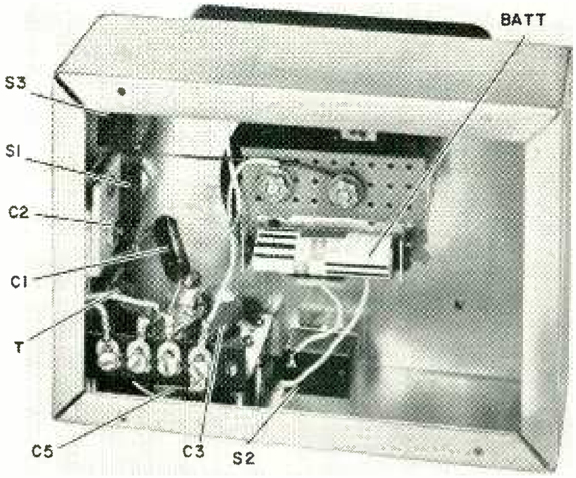
By I. QUEEN EDITORIAL ASSOCIATE

HAVE YOU EVER OWNED A DIRECT-READING frequency meter? Very handy thing. This instrument can be read to about 1% or better, except near zero. It uses a single transistor powered by a small mercury or dry cell. A 4½-inch meter indicates frequency to three decimals.

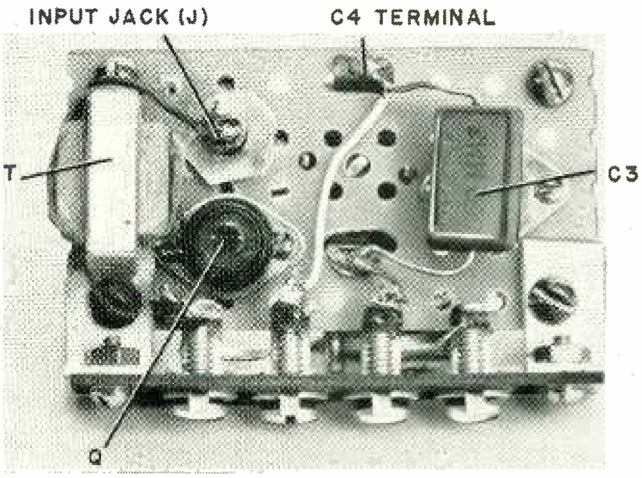
Many technicians rely on their scope to compare the ac line (or other standard) with the unknown frequency. This method is precise on certain related frequencies. For example, you can easily recognize a frequency of exactly 300 cycles, but how about 320 or 340? (If the unknown is not stable, you may even have difficulty measuring 300 cycles.) With a direct-reading frequency meter, you have only to read the result from a meter scale.

Transistor Q flattens the peaks of the incoming signal to produce a square wave. This is differentiated by C1–C4 and the low shunt resistance of the meter (an R-C network), and the resulting pulses are rectified. The charge on C5 (and hence the voltage across it) is proportional to the pulse rate, which is the same as the input frequency. Meter M, connected across C5, reads the voltage there. Thus M's reading is directly proportional to frequency over a wide range.

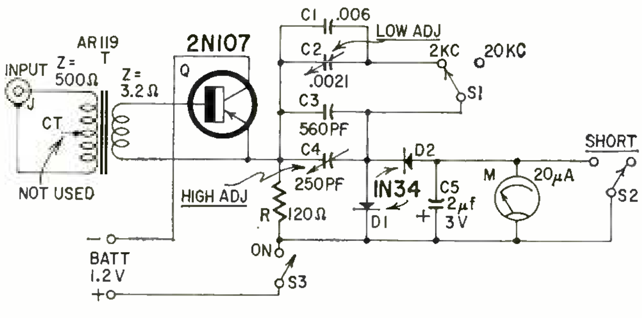
The input signal amplitude must be sufficiently high. The instrument saturates at about 5 volts input. Before you make a measurement, be sure you are applying about 5 volts. The input im-



Rear view (upside down, to show the subchassis). Plenty of room—big meter fixes size of case.



Tiny subchassis is a 1½ x 3-inch piece of perforated phenolic board.



Circuit of the frequency meter.

R—120 ohms
C1—.006-μf paper
C2—.0021-μf mica trimmer
C3—560-pf mica
C4—250-pf mica trimmer
C5—2 μf at 3 volts, electrolytic
Q—2N107
T—miniature output transformer: 500-ohm primary, 3.2-ohm secondary (Argonne AR-119 or equivalent)
M—20-μa dc meter
D1, D2—1N34
J—phono jack
S1, S2—spdt toggle switch
S3—spst toggle switch
BATT—1.2- or 1.5-volt mercury or dry cell
Transistor socket
Aluminum chassis, 2 x 5 x 7 in.
Miscellaneous hardware

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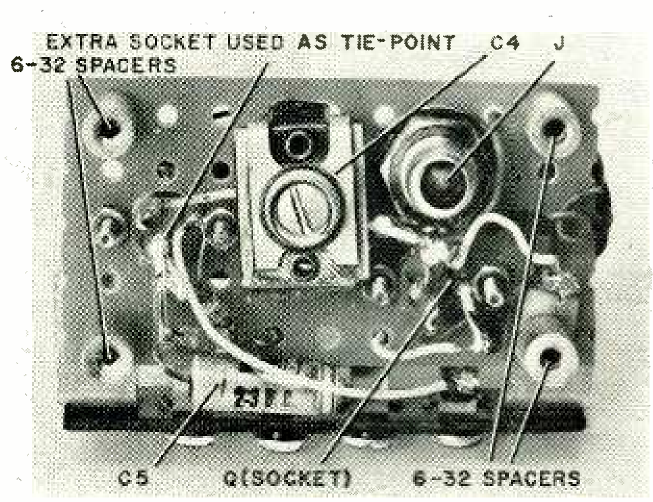

Other side of subchassis shows most of the remaining parts.

BENCH TESTED

This device was given to a member of the editorial staff for testing. This is what he reported:

"Unit is accurate and easy to read from 200 to 2,000 cycles on its lower range, and from 1,500 to 20,000 cycles on the higher. Below 200 cycles there was no direct relationship to frequency . . . meter needs about 4.5 volts rms to read accurately . . . at 4 volts rms the reading is still usable.

"This device can take over where 60-cycle Lissajous patterns get too hard to read."

pedance of the frequency meter is approximately 3,000 ohms.

Use known signal frequencies to calibrate the frequency meter. Switch to the 20-kc range first and apply a frequency under 20 kc. Adjust C4 to make the meter reading correspond to the frequency (i.e. 18 μa for 18 kc). Now check other settings in this range· You will probably find, as I did, that small readings are somewhat lower than they should be. I solved the problem by changing the meter's mechanical zero setting to about ¼ μa. With a little juggling between the meter zero and the signal calibration, you will find you can obtain very high accuracy except close to zero.

Now switch to the 2-kc range and again apply known frequencies. Adjust C2 as required, but don't change the zero setting of the meter again.

After careful calibration and zero setting, I obtained exact readings at 16.5, 8.25 and 4.1 kc on the 20-kc range, and 1.65 kc, 960 cycles and 120 cycles on the low range. By "exact," I mean better than 1%.

The 20-μa meter is a very sensitive and delicate instrument and should receive special care. For this reason it is equipped with a "short" switch. When the meter is not in use, keep it shorted. Avoid applying frequencies higher than 20 kc (or 2 kc when you are switched to the low range). When I band-switch some audio oscillators, the needle of the frequency meter tends to swing violently upscale. To be safe, keep the meter shorted while switching bands. Though I did not think of it at the time, it would probably be better to use a momentary-contact, normally closed toggle or push-button switch, and simply "push to read."

The capacitors C1–C4 shown determine the calibration of this instrument. A higher capacitance increases the meter reading. The values shown were suitable for my instrument, but slightly different values may be needed for others.

END

Trimming Resistors and Capacitors

By MARTIN H. PATRICK

WE OFTEN need to trim off a resistor by using another in parallel with it. Then the trial-and-error method starts. A handy time-saving setup to have about the bench is shown in Fig. 1. Used in conjunction with an ohmmeter, you simply adjust the potentiometers until you arrive at the required resistance reading, flick a switch and read the correct parallel value on the same scale.

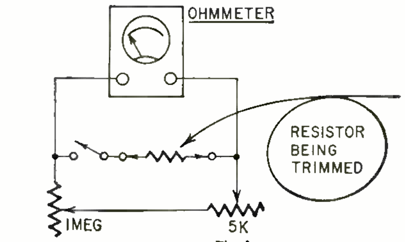

Fig. 1

Another handy device used for the same purpose is the resistor–capacitor chart shown in Fig. 2. To find the correct resistance value of resistors in parallel, place a straightedge on the chart so that one value is covered on the vertical column, R, and the other value on the horizontal column, R. The combined value will be the point where the line crosses the diagonal, R_T–C_T.

Example: what value resistor would I use in parallel with 4 ohms to reduce it to 3 ohms? Placing the straightedge on 4 of the vertical column and on 3 of the diagonal R_T line, we find that the line crosses 12 on the horizontal line, the value to be added. In this case it is 12 ohms.

Other values can be interpolated: 4 ohms can be read 40 ohms and 12 ohms can be read 120 ohms, resulting in an answer of 30 ohms. To prevent error, always bear in mind that the answer will be a number less than the smallest resistance found in the parallel circuit.

When computing more than two resistors in parallel, first find the combined resistance of any two and add this value of the next resistor, and so on. Thus: What is the total resistance of 3, 4 and 12 ohms connected in parallel?

First find the combined resistance of 4 and 12 ohms, which is 3. Now add the remaining resistance, 3 ohms, proceeding as before, to the 3 ohms (combined resistance of 4 and 12 ohms), arriving at an answer of 1.5 ohms.

Any combination of resistances within reason can be used with this chart. For example, 6 becomes 60,000 and 12 becomes 120,000 ohms. Placing the straightedge across 6 and 12, we find the answer 4 which becomes 40,000 ohms. Thus the combined resistance of a 60,000-ohm resistor in parallel with a 120,000-ohm resistor is 40,000 ohms.

The same holds true for capacitors in series. What is the value of capacitance when a 0.3 μf is connected in series with a 0.6 μf? Placing the straightedge across values 3 and 6, we find the line crossing C_T at 2. Thus the answer 0.2 μf.

END

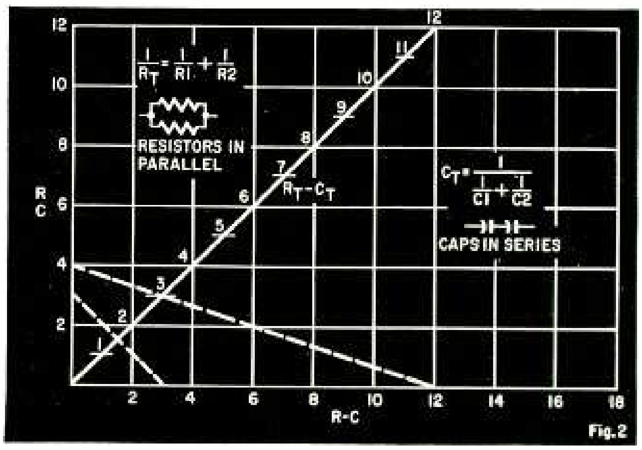

Fig. 2—Simple graph for working with series capacitors and parallel resistors. You can find the resultant of two knowns or the value of an unknown needed to provide a required value of resistance or capacitance. The text describes its use.

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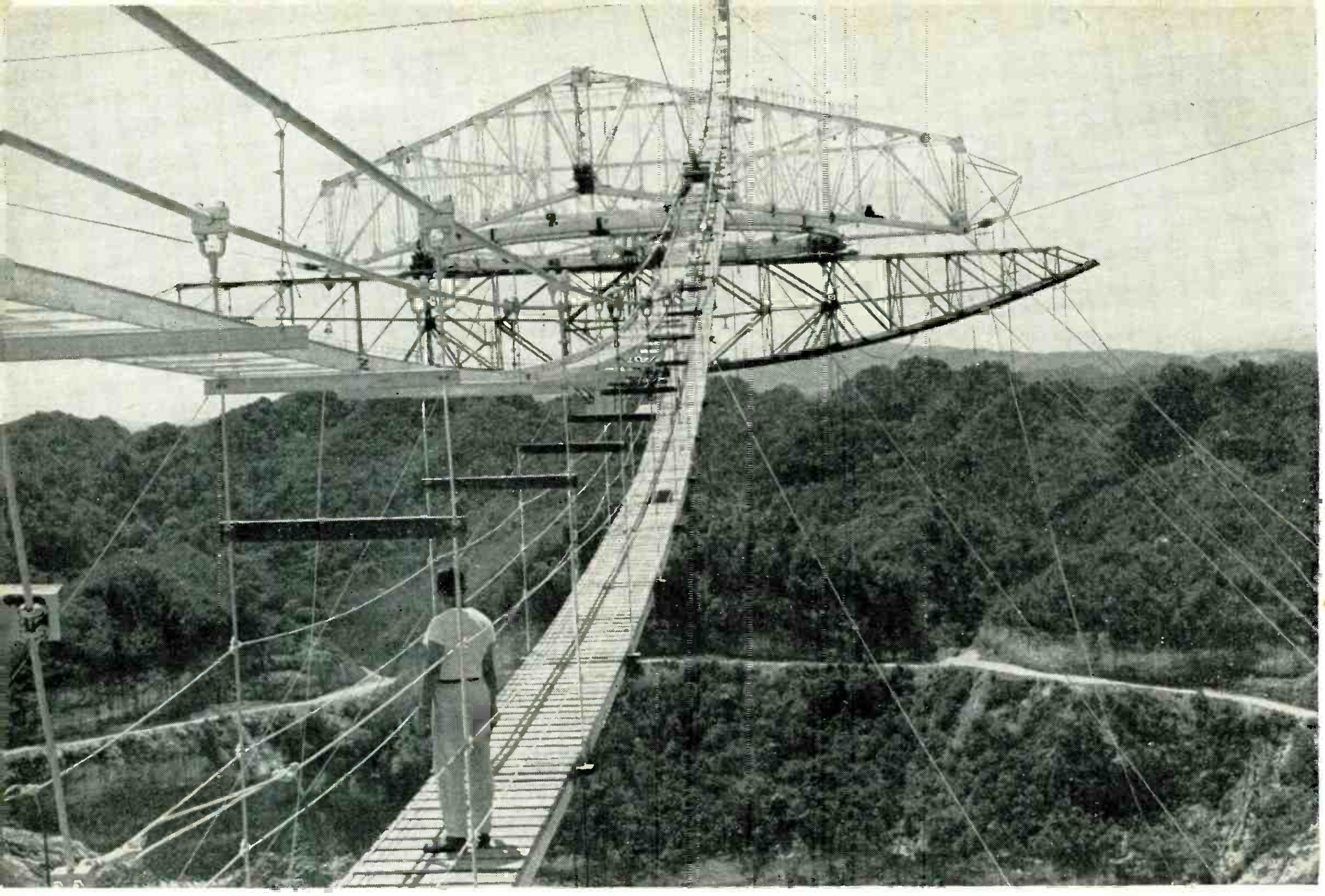

Transmission lines and electrical cabling are carried on this 700-foot catwalk (photographed during construction), which also provides access for personnel. The waveguide and electrical wiring had not been installed when this photograph was taken.

Cover Story

BIGGEST telescope on earth is IN the earth

By ERIC LESLIE

THE WORLD'S BIGGEST RADAR—RADIO telescope, illustrated on our cover, is a partly natural, partly artificial spherical hollow in the hills 12 miles south of Arecibo, Puerto Rico.

Why such a telescope? And why at Arecibo? What is the new instrument expected to accomplish?

Its chief purpose is to study the ionosphere. Satellites and rocket probes as well as radar soundings have given us many new facts about this region whose several layers surround the earth at distances ranging from less than 50 to more than 250 miles. The study has been limited by the small amount of information that could be obtained from existing instruments.

Prof. William Gordon of Cornell University envisioned a system using an extremely powerful transmitter and an antenna of much higher gain than any in existence. He believed that it would be possible to study the changes in the ionosphere by the back-scattering of free electrons from the various layers at uhf. This would make it possible to measure electron density and temperature, determine auroral ionization and detect transient currents in the ionosphere. Prof. Gordon suggested that the antenna would probably have to be a stationary dish in a natural bowl in the earth. It should be near the equator, he said, so that the solar system would be included in the scanning angle.

The Armed Forces are very much interested in all information obtainable about the ionosphere, as an aid in ICBM detection and decoy discrimination. Therefore, funds were supplied by the Advanced Research Projects Agency as part of the Project Defender Program for exploring ICBM defense techniques. The Air Force Cambridge Research Laboratories was assigned to provide technical management. The laboratories immediately suggested that instead of the usual parabolic reflector a spherical one be used, with a phased-line feed. This would make it possible to direct the beam over an angle of 20° from the zenith, a much wider angle than would be possible with a parabolic antenna.

The Arecibo site was selected for several reasons. It is within 18° of the Equator and thus in a favorable position to scan the ecliptic, in which the sun and the planets move. There was a natural bowl of very nearly the correct size and shape.

The temperature varies very little, so structural materials would not be greatly affected by climatic changes. The sheltered area among higher hills is protected from heavy winds, and the location is relatively remote from sources of man-made interference.

Even though the bowl was nearly perfect, 300,000 cubic yards of material had to be blasted from some spots, while 200,000 cubic yards were added in others. The big reflector was then constructed of sheets of ½-inch galvanized steel mesh, placed on a cable grid that

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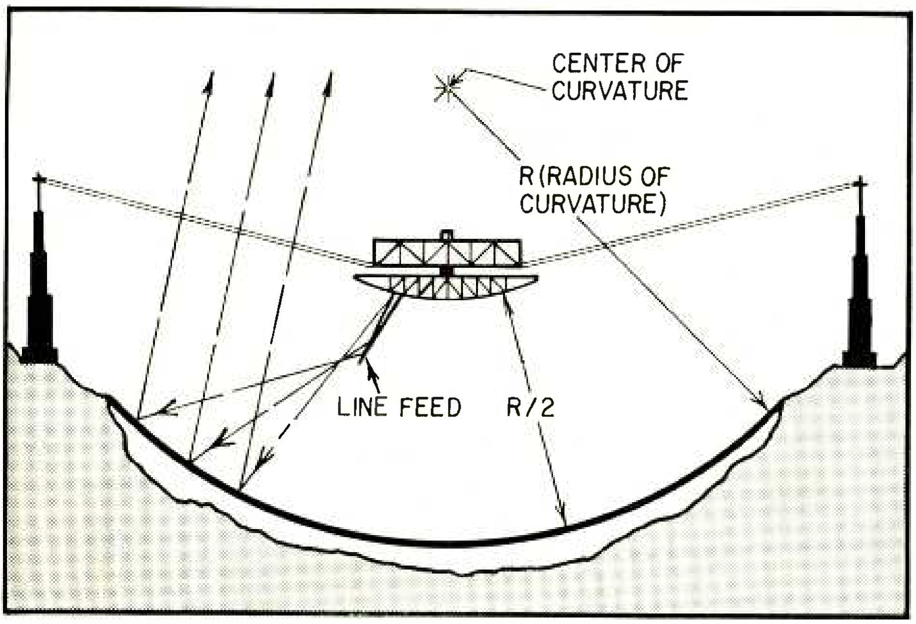

How signals are beamed into the vertical bowl to produce a parallel beam. The shape and slotting of the line feed control the amplitude and the phase of the energy radiated at each point along its length. The vertical angle of the beam can be varied by moving the line feed along the feed arm.

criss-crosses the bowl north–south and east–west. To maintain its shape, the reflector is contoured with vertical tie-down cables every 6 feet, and loaded when necessary with steel ballast rods. The surface forms part of a perfect sphere, with a tolerance of only ±1 inch.

Since the radar beam can be steered only 20° from the zenith, a complete hemisphere is not necessary. The radius of curvature is 870 feet, while the dish is 1,000 feet across (a total of 18.5 acres).

Signals are beamed at this reflector in a special way: from a 96-foot line feed made of aluminum and mounted 435 feet (half the radius) above the reflector. The reflector being spherical rather than parabolic, the signal can be steered 20° in any direction from the zenith. The line feed is so shaped that signals from different parts of it reach the reflector bowl with different intensities. The lengths of its radiating slots are calculated to vary the phase of these signals so that a beam of parallel rays will be reflected from the bowl. The line feed is suspended from a crescent-shaped track called the feed arm, so the vertical angle can be varied. The feed arm in turn is suspended from a circular azimuth track girder, approximately 129 feet in diameter. Thus, the line feed can be positioned in azimuth within 1 minute of arc, and in elevation to within 0.8 minute of arc.

The structure which holds this transmitting and positioning equipment is a triangular platform, 216 feet on a side, suspended from three concrete towers. Each of these is 700 feet from the center of the reflector, and rises 468 feet above its upper edge. The transmission line, 1,300 feet of waveguide, carries power from the transmitter building just outside the bowl to the line feed.

Two ingenious waveguide joints were necessary to get power to the line feed: a rotary joint to take care of antenna rotation, and a crescent-shaped one for the linear joint. This is a piece of waveguide 160 feet long inside the larger curved waveguide on the lower surface of the feed arm.

The transmitter can be operated as a continuous-wave radar at 150 kw or as a pulsed radar with a peak power of 2.5 megawatts. The transmitter is now operating at 430 mc, although it is expected to operate later at 40 mc, and probably also at a frequency of 900 mc or higher.

Though most of its time will be spent studying the ionosphere, the new telescope will have other uses. With 40,000 times the power of the Millstone Hill radar in Massachusetts, which first detected reflected signals from the planet Venus, it should be able to contact Venus, Mars or Mercury whenever any one of them is in the field of view. Millstone Hill had to wait till Venus was near its closest approach to the earth. Moreover, the new telescope will be able to produce directly observable signals, instead of having to sort them out of background noise with the help of a computer. It will probably also be able to make contact with Jupiter and Saturn when they are in favorable positions. It may also improve the accuracy with which we can determine the astronomical unit of distance, and we may even be able to observe the atmosphere of the sun with radar. END

Line Voltage & Amplifier Distortion

EVER HAD DIFFICULTY IN TRACKING down the cause of high distortion in an audio system? This story is based on actual experience.

In an installation that included a pair of 20-watt power amplifiers using 5881 tubes, I found the distortion at the 20-watt level to be 3.6% at 1,000 cycles. The amplifiers had a rated 20-watt distortion figure of 0.5% or less. This was a justifiable complaint.

Operating the system at full 20-watt output, I made a stage-by-stage check with an oscilloscope. The waveform was good up to the input of the voltage amplifier before the phase-inverter–driver for the output tubes. At the output of this stage, waveform distortion was noticeable. Here, it seemed, was the point to troubleshoot the circuit!

But that assumption was misleading. The distortion from this stage on was not due to a circuit defect, but was caused by overdriving the stage to obtain full output from the power tubes. But why was this overdriving necessary?

I took dc voltage readings in the various stages. Deviations from normal seemed reasonable until I got to the 5881 output tubes. There, the plate and screen voltages were almost 50 volts below that required for 20-watt output. The power supply rectifier circuit tested OK.

Then I checked the 117-volt power line. It measured 95 volts! The reason? It was heavily loaded with electrical and electronic gear and ran a good distance back to the main power distribution box.

I was able to boost the supply to the audio system to a scant 112 volts with a Variac. The distortion in the 20-watters dropped to 0.55% at full output.

In this case it is obvious that at least another 115-volt circuit was needed to handle some of the load. But in some parts of the country where the supply-line voltage is normally low, a variable transformer to boost the supply voltage may be used to advantage if the low supply is causing audio amplifier distortion.

Incidentally, there was another undesirable condition attributable to this low voltage. The tape recorder used with the equipment was very slow in starting and in reaching normal speed, sometimes requiring a little manual assistance. This also was remedied by the 17-volt boost provided by the power control.

—Harold Reed

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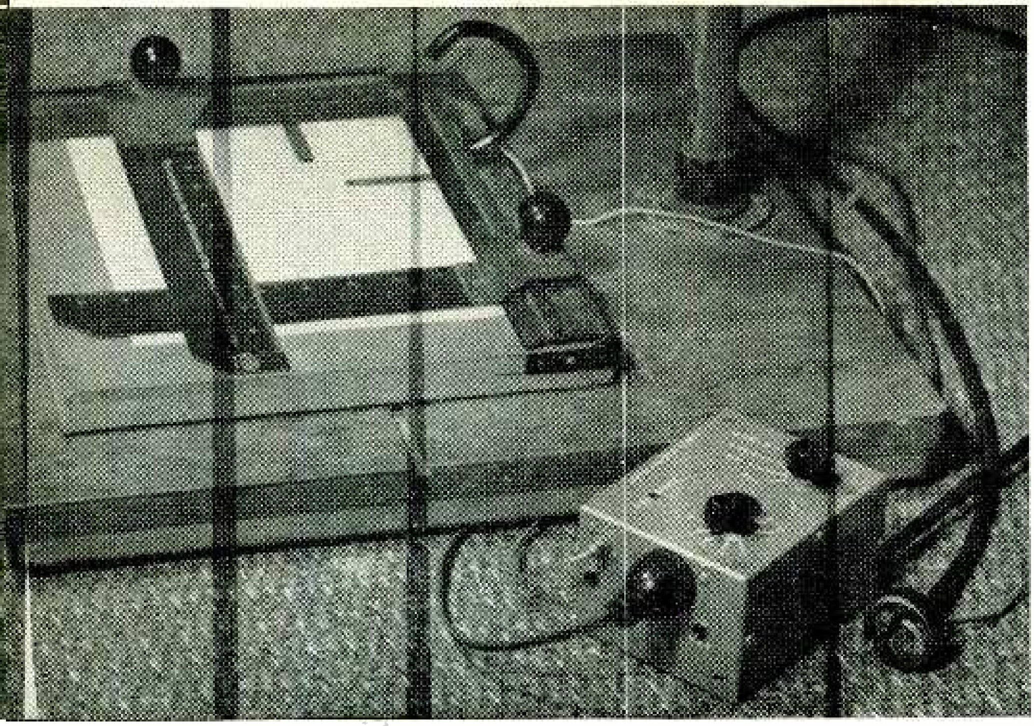

This picture (unretouched) was made by exposing the same paper six times, through a movable mask, from the same negative. The left-most strip was made with the enlarger diaphragm wide open; exposure turned out to be about ½ second. Each successive strip to the right was made with smaller and smaller aperture and correspondingly longer exposure. The rightmost one took 45 seconds. But the exposure time was "figured" automatically by the Auto-Photo Timer: notice the uniformity of contrast and tone.

AUTO-PHOTOTIMER

Perfectly exposed enlargements every time—even with changes in paper, diaphragm setting and negative densities

By JOSEPH GIANNELLI

THOSE OF YOU WHO MIX PHOTOGRAPHY and electronics have very likely run into one of the biggest headaches in making good enlargements: correct exposure. This timer will expose your paper correctly even with changes in diaphragm setting. And it compensates for different papers and negative densities.

The Auto-photo uses a kind of photoelectric feedback, utilizing the light reflected from the paper on the enlarger easel to control the length of the exposure. Fig. 1 is the circuit diagram.

PC is a photoresistive element so placed that it "sees" the photographic paper. Its resistance varies from a few thousand ohms in bright light to a few megohms in darkness. PC and R17 act as a voltage divider to vary the voltage on the grid of V1-a. V1 is arranged as two cathode followers with a diode and a relay coil between them. When S1 is set to EXPOSE, the enlarger lamp is on. The photocell picks up the light and establishes a dc voltage on V1-a's grid. Because of the shape of the photocell and the way it's mounted, it integrates the light over the paper surface quite well.

As long as V1-a's cathode is more positive than V1-b's, D1 cannot conduct and RY1 remains unenergized (lamp on). C2 is now charging to the voltage set by R7 through R9–R10. This rising voltage is compared with that at the cathode of V1-a, and when the cathode of V1-b becomes 5 volts more positive than V1-a's cathode, D1 conducts. RY1 is energized and the enlarger lamp extinguished. RY2 then shorts out the cell

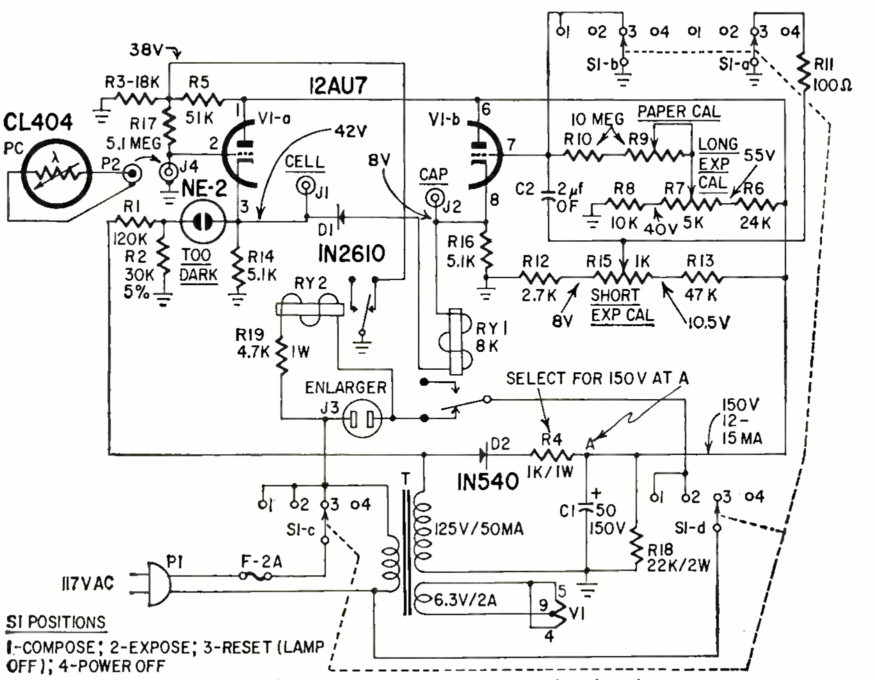

Fig. 1—The Auto-Photo Timer's circuit.

C1—electrolytic, 50 μf, 150 volts
C2—oil-filled, 2 μf, 200 volts
D1—1N2610
D2—1N540
F—fuse, 2 amperes, 125 volts
1—NE-2
J1, J2—pin jacks
J3—ac receptacle (Amphenol 61-F1 or equivalent)
J4—phono jack
P1—polarized ac line plug
P2—phono plug
PC—photocell (Clairex CL4 or CL604)
R1—120,000 ohms
R2—30,000 ohms
R3—18,000 ohms
R4—1,000 ohms, 1 watt
R5—51,000 ohms
R6—24,000 ohms
R7—pot, 5,000 ohms, linear (author used miniature ⅝-in. diameter unit)
R8—10,000 ohms
R9—pot, 10 megohms, linear
R10—10 megohms
R11—100 ohms
R12—2,700 ohms
R13—47,000 ohms
R14, R16—5,100 ohms
R15—pot, 1,000 ohms, linear (author used miniature ⅝-in. diameter unit)
R17—5.1 megohms
R18—22,000 ohms, 2 watts
R19—4,700 ohms, 1 watt
All resistors ½ watt, 10% except as noted
S1—rotary shorting switch, 4 poles, 4 positions (3 positions plus off), 1-amp, 300-v contacts (Mallory 1225L or equivalent)
T—power transformer, 125 v (half-wave) 50 ma; 6.3 v, 2 amps (Stancor PA-8421 or equivalent)
RY1—sensitive plate circuit relay, spdt, 8,000-ohm coil (Sigma 4F-8000-S/SIL or equivalent)
RY2—miniature 75-volt ac relay, spdt, 9,000-ohm coil (Sigma 11FZ-9000-ACS/SIL or equivalent)
V1—12AU7
Case—aluminum, 5 x 4 x 3 inches (Bud Minibox CU-2105-A or equivalent. See text)
Tube socket, fuse holder, metal tubing and miscellaneous hardware

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voltage, to prevent V1-a's cathode from going to its high dark voltage and de-energizing RY1 and causing it to oscillate. Since the cathode of V1-b has to be 5 volts above the cathode of V1-a to energize RY1, zero time must be considered from this 5-volt level, and not from zero volts. R15 sets up the proper level for this purpose – important at low cell voltages (high light levels and short exposures).

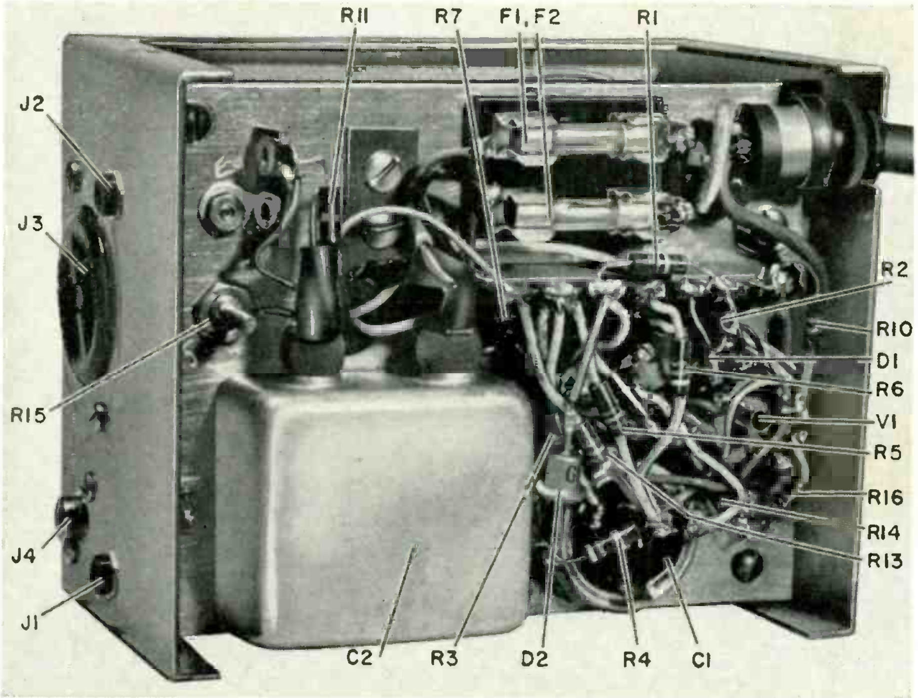
The voltage drop across the cell is not linear with varying light values. This is partly due to the cell itself and the value of R17. To make sure that the charge voltage across C2 tracks perfectly with the cell voltage at various light values, a plot of cell voltage vs incident light was made. This plot shows correct exposure for each increment of light, and was made from many trial exposures at various light levels.

R17 was chosen empirically, until it gave a curve that could easily be duplicated ("tracked") with a capacitor's charge curve (see Fig. 2). The charge voltage on C2 was then made to agree with the plot of Fig. 2. The voltage across R7 is used to calibrate the top end of the charge curve near 95% of the applied voltage. This is the region where the longer exposures are made. Remember that decreasing light causes an increase in cell voltage.

When the enlarger lamp is automatically extinguished, put S1 in the RESET position, which shunts 100 ohms across C2, discharges it, opens the lamp circuit and de-engerizes RY1. You are now ready for your next exposure.

A COMPOSE position is provided on S1 to turn on the enlarger lamp for setting up, focusing and diaphragm adjustments. Returning S1 to RESET will extinguish the lamp so that you can put photographic paper in the easel. Switch to EXPOSE, and you will have another correct exposure.

The neon bulb connected to the cathode of V1-a and the junction of R1 and R2 serves as an indicator which ignites when light value falls beyond the reliable range of the unit. A 1-minute exposure requires a surprisingly small amount of light (much less than .01 foot-candle), and this seems more than adequate for even the most severe enlarging conditions.



The open back of the Timer. Layout is not critical.

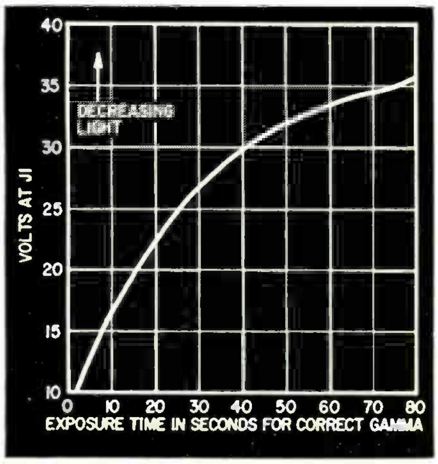
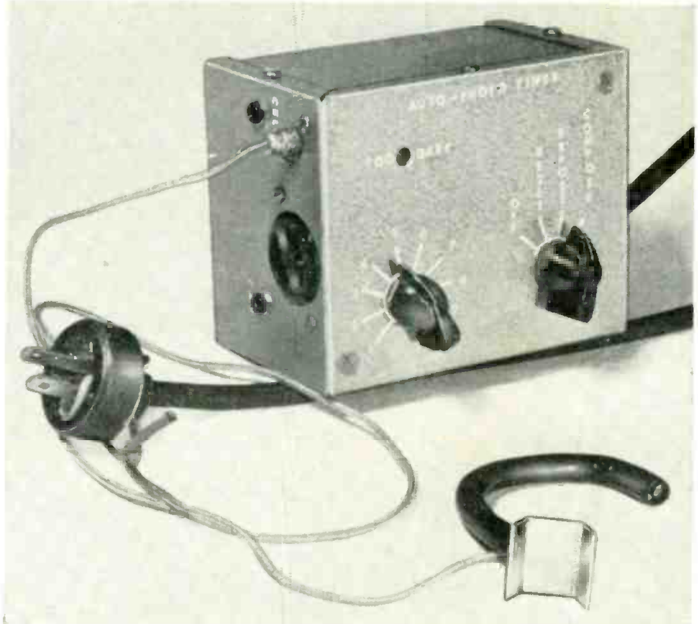


Fig. 2—Plot of cell voltage (measured at J1) vs exposure time, using a 150-watt enlarger lamp and Kodak G2 paper. The charge rate of C2 is adjusted to match this curve as closely as possible.

Construction

The whole unit is housed in a Bud 5 x 4 x 3-inch Minibox, labeled with decals. [This box is very compact and you'll have to be careful with your layout to fit all parts into it. We suggest using a 6 x 5 x 4-inch such as the Bud CU-2107-A or equivalent to simplify parts placement. The two relays, power transformer, 12AU7 are above the subchassis. S1 and R9 are on the front panel. —*Editor*] The photocell is external and plugs into the side of the unit. A 1/16-inch thick, 3¾ x 4⅞-inch plate, mounted on two posts, is used as a subchassis. The jacks and receptacle can be laid out on the side of the box once the other components are mounted. The neon indicator is mounted with cement (Miracle Adhesive) on top of T, directly under the opening at the top of the box. C2 is mounted beneath T.

The Sigma 4F and 11FZ relays must be insulated from the chassis plate. A piece of thin fiber on both sides will do the trick, with the mounting holes drilled oversized. Two pieces of ⅜ x 1 15/16-inch curtain rod are drilled and


The Auto-Photo Timer in its case. Just in front is the tube and bracket that holds the photocell to the enlarger stand. You can see the cell at the opening of the tube.

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tapped for 6-20 screws. Mount the ends to the inside of the box with flat-head screws. The other ends support the chassis plate.

The photocell is mounted inside a ⅜-inch copper tube bent into a half-round so that the seeing end is 3 inches off the photographic paper, and mounted on the easel to look into the center of a 5 x 7 image. The seeing end must be outside the projected image so that it doesn't cast a shadow on the photographic paper. Once this is done, mount the tubing permanently to the easel, solder the cell to 3 feet of shielded phono cable and pull the cable through a hole in the bottom of the tube. Secure the cell in the seeing end with a small wooden wedge and install a 13A Cinch phono plug on the other end of the phono cable. Paint the tube a flat black.

Mount filter capacitor C1 from the bottom of the chassis plate—it would stand too high if mounted on top. Fasten with a makeshift strap soldered to the case of T.

Calibration and test

Before applying power, recheck wiring and diode polarities. Set S1 to RESET and check for the voltages indicated on the schematic. Read the voltages with a vtvm, J4 open-circuited.

To set up Sigma 4F relay RY1 for proper operation, place a .010-inch shim between armature and pole and adjust the normally open contacts so that this circuit is closed when the armature is pressed lightly. Adjust spring tension so that the relay energizes with about 5 volts across the coil (measured with a vtvm). Do this by plugging the photocell into J4, shading the cell so that about 15 volts appears at J1 and switching S1 from RESET to EXPOSE. With the voltmeter across the coil, the relay should click in at 5 volts.

Now you can make adjustments to set the charge curve of C2 so it will track with the plot of Fig. 2.

Attach the photocell to your easel and set R9 to center position. Be sure that your enlarger lamp is 150 watts, and that your safelight illumination does not fall on the easel. All other lights are out. Set S1 to COMPOSE and adjust the enlarger for a 5 x 7 image, with no negative in place. Adjust the enlarger diaphragm until 10 volts appears at J1. Set S1 to RESET, then to EXPOSE. The enlarger lamp should go out in 2 seconds. If you do not have a stopwatch, find a windup clock with a loud tick. Listen to the "tick-tock" and you will find that every "tock" is a ½-second interval—four "tocks" for every 2 seconds. Repeat the RESET and EXPOSE switching, adjusting R15 until the lamp goes out in 2 seconds.

To calibrate the high end, adjust the enlarger diaphragm until 33 volts appears at J1 with S1 in the COMPOSE position. Return S1 to RESET, then to EXPOSE. The lamp should now extinguish in 60 seconds. If not, adjust R7, repeating the test until it does. If you have trouble getting 33 volts at J1 even with the enlarger diaphragm fully closed, put a negative in your enlarger to cut out more light.

To calibrate the mid-range, set S1 to COMPOSE and adjust the enlarger diaphragm for 25 volts at J1. Set S1 to RESET, then to EXPOSE. The lamp should extinguish in 25 seconds—if not, adjust R9.

Since the adjustments of R7, R9 and R15 are interdependent during calibration, repeat the adjustments until they agree within 15% to 20% of the plot in Fig. 2.

The NE-2 should fire when approximately 36 volts appears at J1. Select a different value of R2 if necessary.

Operation

R9, mounted on the front of the box, has its rotation marked off in 10 numbered positions. This serves as a calibration control for various paper types. R9 works independently of R7 and R15 once the unit is calibrated. Just select a position on R9 that gives the correct exposure for a particular paper, and make a note of it. If you change paper grade or manufacturer, place R9 in the correct new position and leave it there.

A 150-watt enlarger lamp has a Kelvin rating of about 2,800. A higher-wattage bulb has a higher Kelvin rating, decreasing the sensitivity of the photocell. You may have to trim resistances R6–R10 if you use another lamp. END

WHAT'S YOUR

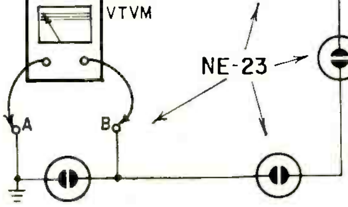
Three puzzlers for the student, theoretician and practical man. Simple? Double-check your answers before you say you've solved them. If you have an interesting or unusual puzzle (with an answer) send it to us. We will pay $10 for each one accepted. We're especialy interested in service stinkers or engineering stumpers on actual electronic equipment. We get so many letters we can't answer individual ones, but we'll print the more interesting solutions—ones the original authors never thought of.

Write EQ Editor, Radio-Electronics, 154 West 14th Street, New York, N. Y.—10011.

Answers to this month's puzzles are on page 62.

Neon-Bulb Circuit

In the circuit shown, one neon lamp requires a minimum of 74 volts for ionization and four in series require a minimum of 296. After ionization, the drop across each lamp is 59 volts and the total current 0.3 ma.



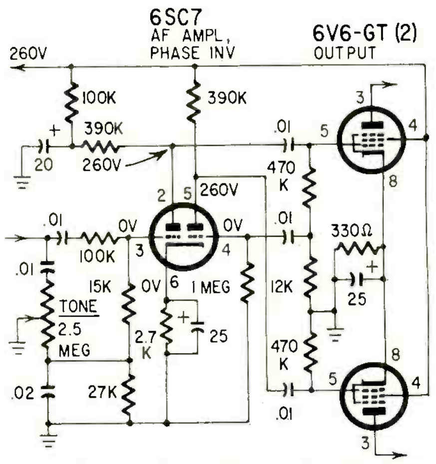
Assuming that the lamps are nonconducting when switch S is closed (because 266 volts is not enough to start conduction), what change will occur when a vtvm with an input resistance of 10 megohms is connected across terminals A and B? Also, what reading will the voltmeter have and what will happen when the voltmeter is disconnected from the circuit?—*Kendall Collins*

The Innocent Black Box

A black box has only two terminals. When I use an ohmmeter to check the resistance in the R × 1 range, the meter reads 25 ohms. When I change the range to R × 10, the meter reads only 10 ohms. The meter has been recently checked for calibration and is good. The black box does not contain any voltage source. What does it contain?—*H. D. Varadarajan*

A No-Signal Stinker

In this old Stromberg-Carlson radio (1210), there is no signal through the 6SC7 stage. The tube is new and good. B-plus voltages are OK, all resistors and capacitors are good, and measure close to rated values. What's wrong? —*Jack Darr*



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By LLOYD VINCENT

improve FM reception with a wide-band detector

Add one to any FM tuner or radio—you'll be amazed at the difference

FM reception today offers the near-ultimate in high-fidelity listening. In many hi-fi tuners, FM as well as AM, the detector is the chief source of distortion. There was a time when this distortion was of little concern but, with today's audio amplifiers virtually distortionless, detector distortion has taken on new importance. Anything that can improve the detector stage is well worth the effort. But what can be done to improve the FM detector?

Basically, the trouble stems from a discriminator or ratio-detector transformer that does not have enough bandwidth to handle the i.f. signal. Fig. 1 shows the response characteristic of a typical discriminator or ratio detector, commonly called the S-curve. Note that the curve is linear up to a certain point (A) on either side of the center frequency, f_c. Beyond this point, the curve is no longer linear and the detector output is not proportional to the frequency deviation. When the if signal swings into this non-linear area, distortion appears in the output.

There are two reasons why the if signal might swing too wide for the existing detector transformer: If the FM station overmodulates on peaks, the signal will exceed the linear portion of the average transformer (Fig. 2-a). Unfortunately, there are FM stations that do overmodulate—some inadvertently, a few deliberately. The second and more frequent cause of excessive signal swing is a detector transformer with a linear portion not wide enough to accept a heavily modulated, but not overmodulated, signal. The effect is essentially the same as that of the overmodulated signal. There, the signal was too wide for a standard transformer. Here, the transformer is not wide enough for a standard signal. There is a fine difference between the two, but the effect is the same. When the signal swings beyond the linear portion, the output is distorted (Fig. 2-a).

Surprisingly enough, the standard FM signal can be wider than it is usually considered to be. An FM signal which is being modulated 100% by a 15-kc tone has significant sidebands as far as 120 kc away from the center frequency. Thus, to hold distortion to a minimum, a transformer with a linear portion at least 240 kc wide is required. Stereo multiplexing places even more stringent demands upon the high-frequency response of both the transmitter and receiver.

Another type of distortion closely related to these two occurs when a signal that could fall entirely within the linear portion of the curve is forced to swing into *one* of the nonlinear areas by the receiver being mistuned, because of human error or oscillator drift. This is shown in Fig. 2-b. Also, music is not a single note but a combination of many. The high-frequency components can "ride" on the stronger low frequencies and combine to overmodulate the transmitter (Fig. 3).

Increasing bandwidth

If we can make the linear portion of the detector curve wide enough, we can eliminate distortion caused by these three conditions. Little can be done to the detector *circuit* to increase its bandwidth, so the obvious solution is to replace the existing detector *transformer* with one that has a wider linear portion and greater peak-to-peak separation.

But just how wide should the *ideal* transformer be? A bandwidth of 240 kc is required for low-distortion detection of a 15-kc note at full deviation.

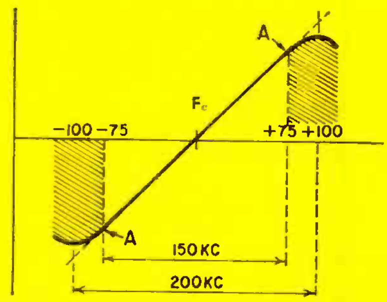

Fig. 1—S-curve of a typical FM detector. Distortion occurs if the FM signal swings past the linear portion into the shaded areas.

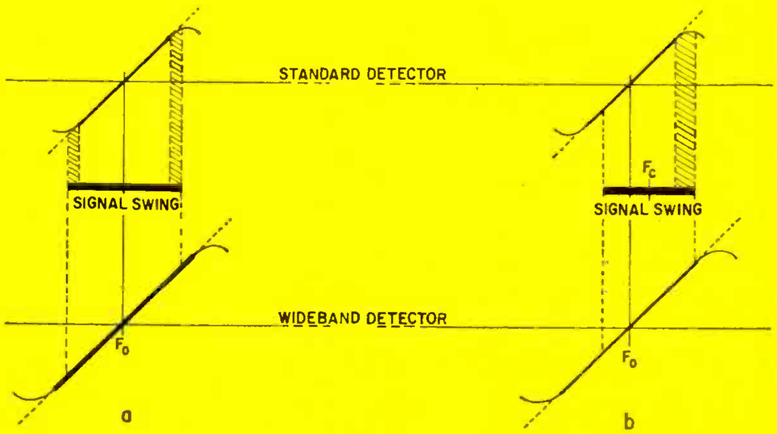

Fig. 2—S-curve of a wide-band transformer compared with a standard one. The heavy part of each curve represents its linear portion. In (a), the swing, represented by the horizontal bar, is too great for the standard transformer and distortion occurs on both positive and negative peaks. In (b), the signal is tuned off center and distortion occurs on one peak. In both cases, the output of the wideband transformer is not distorted.

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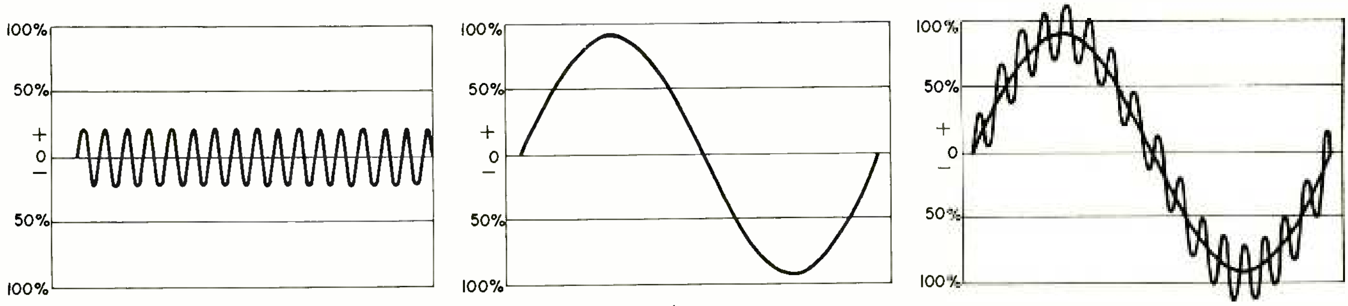

a b c

Fig. 3—A high frequency tone (a) will ride on a strong low-frequency tone (b). Their combined amplitudes (c) can cause the FM transmitter to be overmodulated.

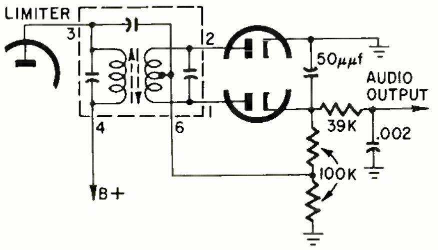

Fig. 4—Typical discriminator type of FM detector.

To this, add 20 kc to allow for oscillator drift, overmodulation, etc. This means we should have a transformer with a linear portion *at least* 260 kc wide.

Discriminator and ratio-detector transformers are usually described in terms of peak-to-peak separation, if any mention of bandwidth is made. The linear portion of a transformer's curve is generally equivalent to 70% to 75% of the peak-to-peak separation. Thus, the greater the peak-to-peak separation, the better the overall performance of the receiver. Not only will the distortion be lower, but the effects of oscillator drift will be lessened. Tuning will be easier and less critical, and the capture ratio of the tuner will be improved. Consequently, there will also be better separation of adjacent signals.

Improved transformers available

In the past the service technician or audiophile has been able to do very little about the bandwidth of his discriminator or ratio-detector transformer. But recently transformers with greater bandwidths have been developed. The Stanwyck Winding Co. has marketed a transformer (S-626) which has a peak-to-peak separation of 325 kc and a linear portion 250 kc wide. Thordarson-Meissner makes a transformer (17-3487) with 400-kc peak-to-peak separation. Eico, in its FM tuner kits, uses a ratio-detector transformer with a 600-kc peak-to-peak spread and a 400-kc linear portion. The Scott FM tuners use a discriminator with a 2-mc bandwidth.

The J. W. Miller Co. is now marketing a wide-band ratio-detector transformer (1465-WB) with 800-kc peak-to-peak separation, and a wide-band discriminator transformer (1464-WB) with 900-kc separation. These two units are readily available and can be used to improve the performance of many FM tuners and radios in use today.

Using the Miller 1465-WB for ratio-detector circuits and the 1464-WB for discriminator circuits (because they offer the greatest bandwidth of any of the replacement transformers presently available), I have replaced many older transformers. The results have proved to be well worth the effort.

Improvement noted

Three hi-fi FM tuners and five FM radios have been improved this way. Two of the radios and one of the tuners were AM–FM combinations. AM circuitry in an FM receiver has no effect upon the FM *detector* stage, even though some sets use *if* stages common to both signals.

The degree of improvement depends largely on the bandwidth of the old transformer. In the Eico HF-90 FM tuner, which already had a transformer with 600-kc peak-to-peak separation, the improvement was rather subtle. It was noticeable only on very loud passages and also on one of the local stations that frequently overmodulates. The improvement in the AM–FM radios was immediately obvious. Even the other two FM tuners showed a marked freedom from high-frequency breakup on the louder passages.

None of the receivers was re-aligned—at least not immediately after the new transformer was installed. Instead, the new wide-band *transformer* was aligned with the frequency to which the if section of each particular receiver was peaked. This was done so that any improvement resulting from realignment would not be credited to the new transformer. (Eventually several of the receivers were completely realigned for optimum performance. But the improvements mentioned were noted before that.)

Installing a new transformer

The existing detector transformer can be replaced with a wide-band transformer by any qualified service technician. The charge should be modest. If the receiver is several years old, check the overall receiver alignment while it is on the bench. With a little care and caution, the replacement can be made by anyone who can read schematics and has had at least a little experience with a soldering iron, such as building a kit.

A word or two of warning: Do not disturb the lead dress of any wires in the set except those going to the detector transformer! Even these should not be moved any more than necessary. Also, while the physical arrangement of the terminals on the bottom of the old and new transformers may appear identical, the internal connections to these terminals can be and often are different. Therefore, the new transformer should be wired according to the schematic and not according to the previous physical connections.

Three basic FM detector circuits are used in hi-fi equipment today. These are the discriminator (Fig. 4), and the balanced and unbalanced ratio detector (Fig. 5). The terminal numbers shown are those of the wide-band transformers. Fig. 6 shows the terminal arrangement on the bottom of the transformer.

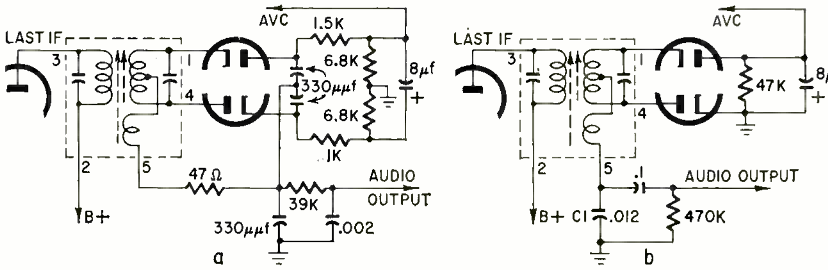

Fig. 5—Two types of ratio detectors: a—balanced, b—unbalanced.

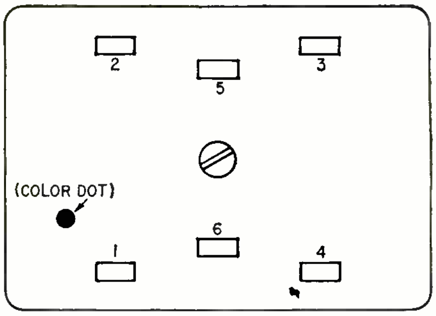

Fig. 6—Base-terminal arrangement of Miller 1464-WB and 1465-WB transformer.

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A ratio-detector transformer should of course, be replaced with a ratio-detector transformer, and a discriminator with a discriminator type. (The one exception might be the discriminator that is preceded by only one limiter stage. The use of a ratio detector, with the required circuit changes, would be an improvement over the original design.) If there is any doubt about which type of detector a set uses, check the connection of the diodes to the *existing* transformer. If the plates of both diodes are connected to the transformer secondary, it is a *discriminator*. If the plate of one diode and the cathode of the other diode are connected to opposite ends of the transformer secondary, it is a ratio detector.

Alignment

Once the new transformer has been installed, all that is left to do is to touch up the alignment of either the new transformer only or the entire receiver. Just which should be done depends on the test equipment available, the experience and ability of the individual and the age and condition of the receiver.

The audiophile whose experience has been limited to kit building probably does not have the equipment or the knowledge to make a complete i.f. alignment. If it is warranted either by the age or condition of the set, or the demand for absolute optimum performance, it can be done by a qualified service technician. On the other hand, if the set is in good condition, a slight touchup of the adjustments of the new transformer can be made fairly easily by the average audiophile, without using test equipment, if the procedure given here is followed carefully.

First, allow the receiver to warm up for 20 or 30 minutes. Then tune in a very weak signal. If there is no weak signal in your area, the same effect can be obtained with a strong signal by substituting a short piece of wire for the antenna or by loosely coupling the antenna lead-in to the receiver. A pad (Fig. 7) could be constructed to attenuate the incoming signal. The signal should be reduced to the point where both noise and the detected audio can be heard, with the audio somewhat the louder of the two.

Disable the afc. Next, rock the receiver tuning control back and forth, stopping at the point where the audio is the loudest. Many receivers have a meter, an "eye" or some other similar tuning indicator. It can be used in the normal way to determine when the receiver is precisely tuned to the incoming signal. For even greater accuracy, hook a vtvm to the limiter grid. You'll find it much easier to spot the peak. To avoid mistuning, it is wise to recheck the setting of the tuning control one or two times during alignment. It will prevent mistuning caused by tuner drift—you'll be sure you're accurately tuned to the station while aligning.

Now adjust the bottom slug (the primary) of the new detector transformer for the loudest audio. Probably no more than one turn in either direction will be required. It is wise to note how far and in which direction the slug has been turned, so that it can be returned to its original setting if necessary. *Do not* rely on the tuning indicator at this point. Instead, adjust for maximum audio.

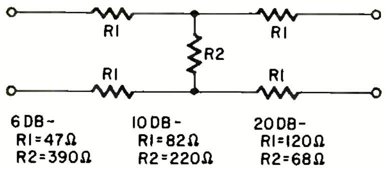

Fig. 7—H-pad for signal attenuation. Values are given for three degrees of attenuation. Two or more pads can be cascaded if necessary.

Next, adjust the top slug for *minimum noise* and *maximum audio*. Particular attention should be given to the "hissing" sound referred to as noise. As the top slug is tuned through the proper point, this *noise* will drop off sharply and will then begin to increase again after the proper point has been passed. The change in *audio* amplitude around this point is not nearly so pronounced as the change in noise level. This sharp null in the noise represents the point at which the transformer secondary is properly tuned. Chances are good that the top slug will not have to be turned more than a quarter turn in either direction.

There is usually some interaction between the two adjustments. It is possible that the slugs will have to be adjusted alternately several times. The final adjustment should be made to the *top* slug. If the receiver does not null and peak as just described, the entire if section probably needs realignment.

Bandwidth of i.f. stages

With the new wideband ratio-detector or discriminator transformer installed and aligned, the question of whether to increase the bandwidth of the *i.f.* transformers might arise. While there are ways to do this, it is doubtful that it is necessary or even advisable.

H. H. Scott while using an extremely wide, 2-mc detector circuit in its FM tuners, still uses the standard 150-kc i.f. bandwidth. This is a good compromise between low distortion and good selectivity. Certainly a 150-kc i.f. bandwidth does not nullify the benefits of a wideband detector or discriminator.

Nothing can be obtained for nothing, of course, and there is one penalty for installing the wideband circuit. Audio output drops appreciably. This is not an important factor in my case, but might be important to listeners in fringe areas.

Installing a wideband ratio detector or discriminator is easy and simple. The improvement in receiver performance, especially in reduced distortion, is more than worth the time and effort for those who desire the best in high-fidelity FM reception. END

Educational Television May Nudge Out Textbooks?

Educational TV may be as commonplace as textbooks by 1970, believes Stanley Lapin of Adler Electronics. Speaking to the Third Annual Educational Television Conference, Mr. Lapin stated that the FCC ruling opening 30 channels in the 2,500-mc band for ETV eliminates two major barriers—high costs and insufficient channels. He told the conference that a two-channel ETV system in the 2,500-mc range can be installed in a large city for as little as $2.25 per student. Student costs would probably run higher in smaller population units, though equipment for 2.500 mc would be substantially cheaper than previously available ETV systems.

Meanwhile, Robert E. Lee, FCC Commissioner, told the same conference that educators are not using the television available to them—neither closed circuit TV nor the present channels now allotted to ETV. "The FCC," he said, "has set aside valuable frequencies and pleaded with educators that they be used."

R-E Abbreviations

RADIO-ELECTRONICS is adopting the modern abbreviation "pf" for "μμf". (The "p" in this case is short for pico, meaning "very small." Both the "p" and the "μμ" represent 10^{-12}.) This abbreviation has been coming into more and more common use in the past year or two, and is especially handy for people who do not have the character "μ" on their typewriter keyboards.

We are also using "Q" instead of "V" to designate transistors. While usage has been split on this, "Q" is now used by the majority of American publications.

Music to Type By

Young stenos who have grown up listening to music while doing their homework can transcribe recorded dictation the same way—if they happen to work for Equitable Life Assurance Society. Built by McGraw-Edison's Voice-writer Division, the firm's system puts a music background on an office network of 43 transcribing machines, so the boss's voice has a canned-music accompaniment.

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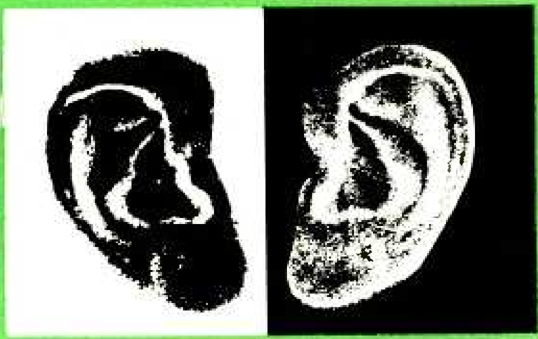
PROFESSIONAL STEREO LINE AMPLIFIER



High-quality unit has continuous bass and treble compensation

By HAROLD REED

MOST PROFESSIONAL AUDIO INSTALLATIONS (and some home systems) use line (intermediate) amplifiers to make up for losses between preamps and power amplifiers, and to insure plenty of drive voltage for the power amplifiers. In broadcast studios these are often called program amplifiers.

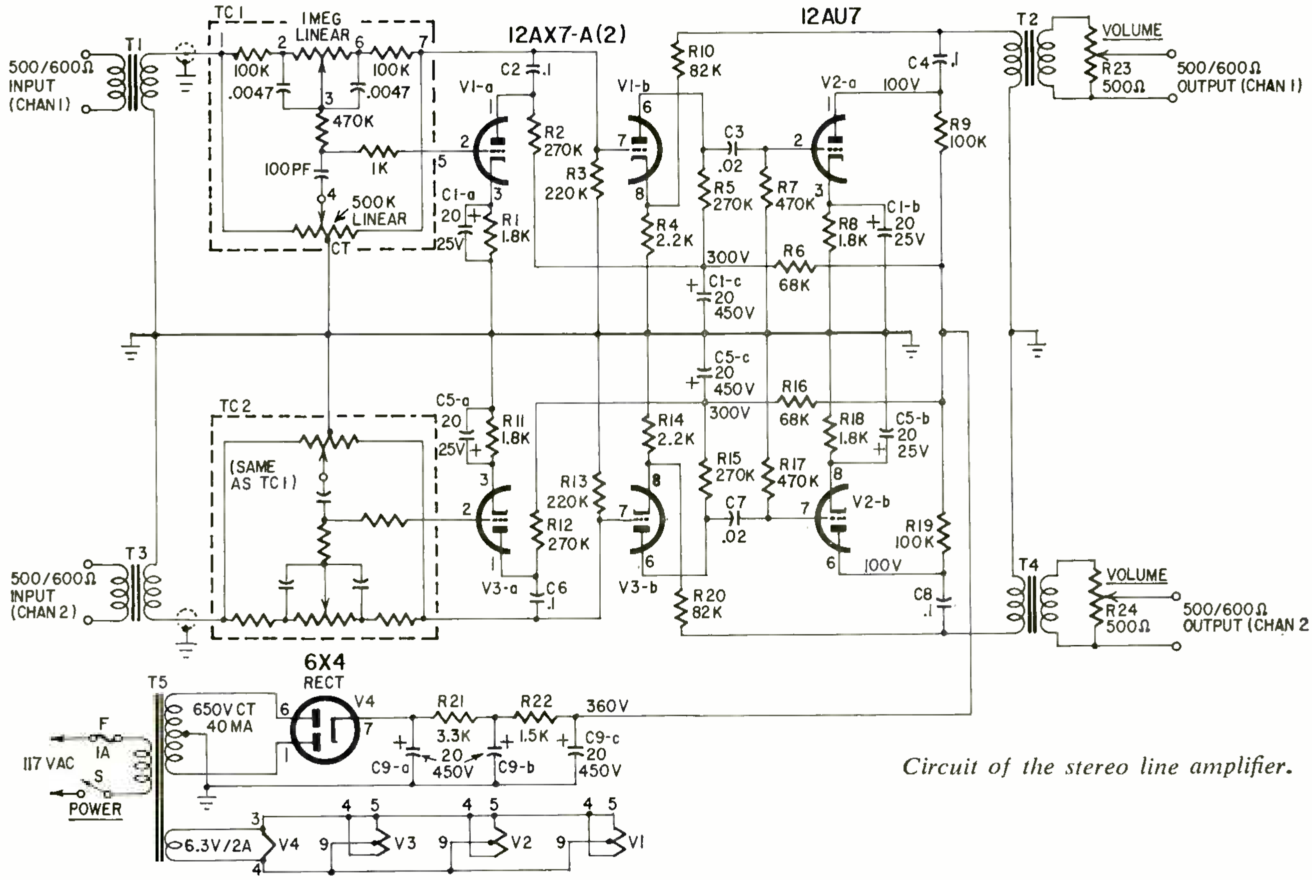
When stereo came in, many outfits simply doubled everything, although this wasted space, power and money. Moreover, the gain of the channels was often unequal and had to be compensated somehow.

The design shows a four-tube professional stereo line amplifier with separate bass and treble tone controls in each channel.

The two channels are identical, part for part, so only one need be described. The input signal enters through T1, a wide-range input transformer that steps up the 500/600-ohm line impedance to about 50,000 ohms. It passes on to V1-a through the Baxandall type tone control network (which can be bought complete and prewired as Centralab C3-300). Part of V1-a's output is fed back to the input of the network, since the Baxandall circuit is a feedback system. V1-b is a straight "gain" stage, and V2-a drives the output line (again 500/600 ohms) through T2, a stepdown transformer. R10 provides a feedback loop around V1-b and V2-a. R23 serves as an output level control, and also terminates the output properly.

Construction details

The original amplifier, built for the Navy, was on a 2 x 13 x 7-inch aluminum chassis fastened to a 10½ x 19-inch rack-mount panel. This allowed room for the VU meter and switch, which appear in the photos but are not part of



Circuit of the stereo line amplifier.

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the amplifier and are not in the schematic. If you build the amplifier, you can use a much smaller chassis. While layout is not especially critical, you are dealing with relatively low-level audio, and since this is a stereo amplifier, there may be crosstalk problems if you take gross liberties in layout and wiring. Use the usual precautions in building the amplifier. Particularly, keep the signal transformers well away from the power transformer. In the original, shielded leads were used between input transformer secondaries and tone controls.

All external connections except ac power are made to the barrier terminal strip on the back of the chassis.

Performance

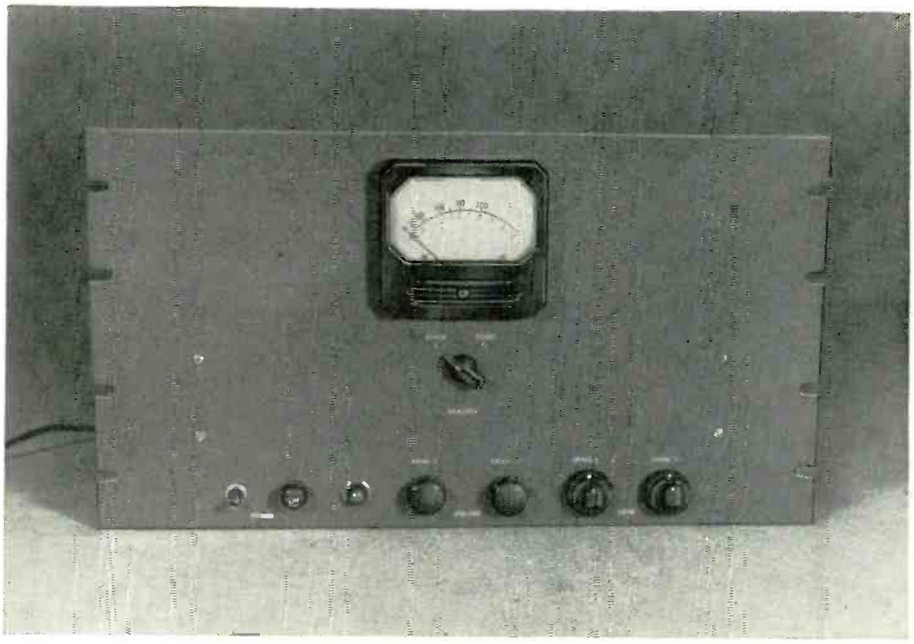
Each channel has a voltage gain of 42, or 32.5 db. Used with a G-E VR-22 stereo cartridge and a G-E stereo preamp with 32 db gain, the line amplifier delivers about 2 volts output across 500 ohms. A 50,000-ohm to line transformer was used at each preamp output, giving a voltage stepdown of 20 db.

Hum and noise are 75 db below 2 volts out. Distortion was 0.5% at 50 and 1,000 cycles, and 0.8% at 15,000 cycles. Frequency response is down 1.3 db at 50 cycles, 0.5 db at 15,000 cycles, taking 1,000 cycles as 0-db reference. The tone controls give bass boost and cut of 11 db at 100 cycles. Treble boost and cut are 10 db and 12 db, respectively, at 10,000 cycles. Negative feedback in each channel is 13 db.

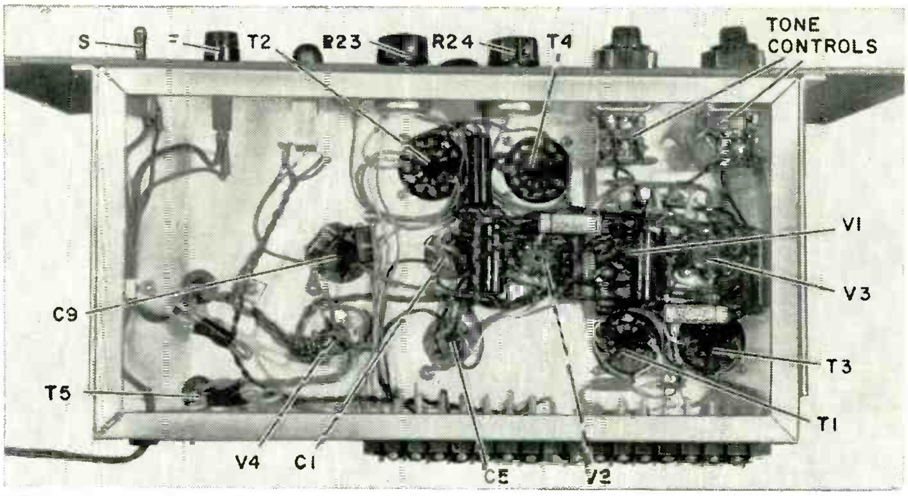
The amplifier also works well with Fisher PR-6 preamplifiers, which give a gain of 40 db in this service. Using the PR-6's, the line amplifier will drive low-sensitivity amplifiers—ones that require 1.5 volt or more input—to full output with R23 and R24 turned only about a third of the way up.

The stereo line amplifier, though useful almost anywhere, is especially suited for stereo PA systems. END

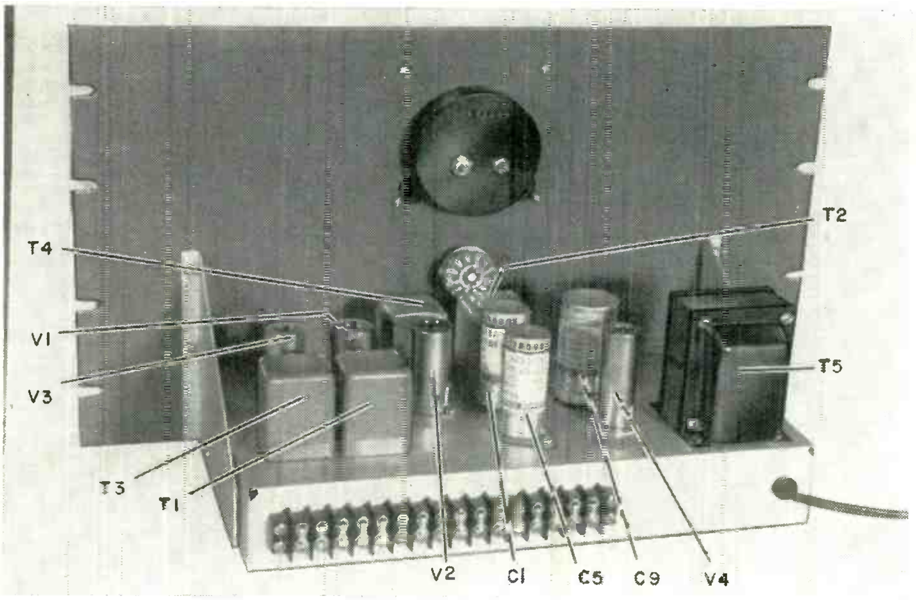
R1, R8, R11, R18—1,800 ohms
R2, R5, R12, R15—270,000 ohms
R3, R13—220,000 ohms
R4, R14—2,200 ohms
R6, R16—68,000 ohms
R7, R17—470,000 ohms
R9, R19—100,000 ohms
R10, R20—82,000 ohms
R21—3,300 ohms
R22—1,500 ohms
R23, R24—potentiometer, 500 ohms (Ohmite AB type CU5011 or equivalent)
All fixed resistors ½ watt, 10%
C1, C5—electrolytic, 20–20 µf, 25 v, 20 µf, 450 v (author used 20–20/450, 20/25)
C2, C4, C6, C8—0.1 µf, 400 v, paper
C3, C7—.02 µf, 400 v, paper
C9—electrolytic, 20–20–20 µf, 450 v
T1, T3—input transformer, 500-ohm pri to 50,000-ohm sec (UTC A-11)
T2, T4—plate-to-line transformer, 15,000-ohm pri to 500-ohm sec (UTC A-24)
T5—power transformer, 650 vct, 40 ma or higher; 6.3 v, 2 a or higher
TC1, TC2—Centralab C3-300 tone control (includes R-C network and pots). Available from many parts stores and mail-order houses even though not in all catalogs. Network alone, less pots, is PC-190.
V1, V3—12AX7-A
V2—12AU7
V4—6X4
F—fuse, 125 v, 1 a
S—spst toggle switch
Chassis—2 x 13 x 7 inch aluminum



Finished product. Though shown here with oversize rack-mount panel, amplifier could be built into other equipment or housed in cabinet. VU meter and selector are not essential part of circuit.



Under the chassis. Large chassis makes wiring easy.



Rear view shows distinctly professional appearance. All connections except ac power are made to terminal strip.

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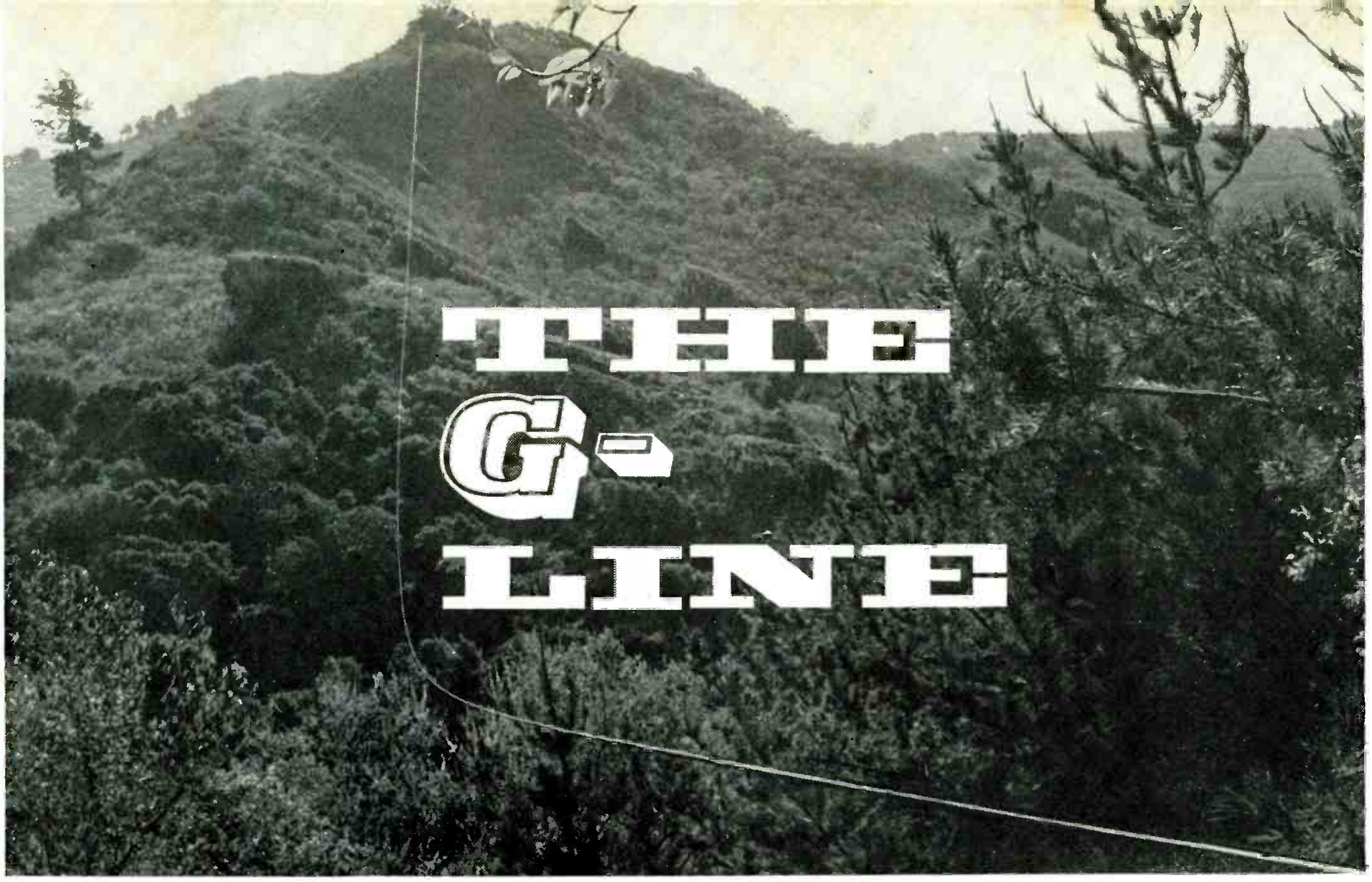

THE G-LINE

. . . Like a glass of water without the glass. This single, unshielded transmission line is nonradiating, and has extremely low loss

By OWEN G. PATRICK

MY WIFE (BLESS HER UN-ELECTRONICS-oriented little heart) had been chipping away for quite some time with "Why can't *we* have all those good TV channels the Cinch Joneses get?"

My explanation that we live in a valley, walled in by mountains, while the Joneses, though a mere 5 miles away, are in the open; that the "good channels" are 100 airline miles from the both of us, but *they* could receive them and *we* could not, cut little or no ice at all.

"Well, you're in electronics, so do something about it" was her understanding reply.

When neighbor Bill added his "Say, why don't you–" to hers, the ground was freshly plowed and ready to seed. Perhaps I could make like a modern-day Merlin and conjure up those "good channels," thus making Number One happy. I must admit that, in addition to the stimulus of the challenge, I too liked Perry Mason.

There were acceptable signals from San Francisco, San Jose, Sacramento and Oakland atop a 600-foot hill known locally as Saddle Mountain. The big problem was how to transport all that flickering drama over some 3,400 feet of rough terrain to our house on the floor of Carmel Valley.

I began to consider common forms of transmission lines, and found that none were right for us. Coaxial lines, even the more recent types developed for community antenna distribution systems have fairly high losses in the upper vhf. These lines are also expensive and require messenger support, which means frequent poles and special equipment.

The relatively high loss of 3,400 feet of this line would also require an antenna-site amplifier, which means duplexing power and rf on the transmission lines. Open wires are not as lossy as coaxial lines, but they too present problems, not the least of which is radiation.

If lines with spacers are used, there will be losses in the dust and moisture bridges formed at each spacer. Open-wire lines (without spacers) were considered–two wires under tension, separated only at the supporting poles–but this type of line will modulate the signal, causing video flutter somewhat like sound bars. This is due to a rapid impedance variation when the lines "sing" in gentle winds. Also, this type of line is subject to bird-perching, which usually results in the conductors being shorted together.

I finally decided to abandon the usual lines and techniques and to investigate waveguides. Not the rectangular or round "plumbing" usually associated with the term, but the external waveguide, a "surface waveguide," as it was termed by George Goubau, who developed it at Fort Monmouth in 1953.

The *G-line*, as it came to be called, is just a single insulated wire. When rf power is properly given to and taken away from this single conductor, it responds with some amazing results. Its loss is very low, approximately 6 db/mile over the vhf TV band. This means the output voltage from a 1-mile line is half that of the input. Unlike coax or open-wire line, its loss does not increase with frequency. It does not radiate. Its impedance is approximately 300 ohms, and it is inexpensive.

G-line is not a panacea for *all* situations. For those of you who live in an area given to long periods of snowfall, read no further, for this and heavy ice loading on the line will increase attenuation severely. Rainfall and fog, however, affect the line very little.

If a situation requires abrupt sharp turns, the line can make it, but the rf cannot, and will spit right off the turns. This doesn't mean you can't make turns with the G-line. It just means that you have to make the turns gently, with a large radius.

The G-line's last shortcoming is that it must be held clear of all objects for a radius of a half wavelength at its lowest operating frequency. This includes buildings, poles, the ground, metals and foliage.

Why — and how — it works

Sommerfeld, in 1899, suggested the possibility of an external waveguide, but attempts to transmit rf energy in this way failed. Then George Goubau, a German-born physicist, discovered that

Since the name G-Line is a trade mark used by Surface Conduction, Inc. for their products which are also protected by patents, we have asked for and received permission to publish this article under this name. The permission was given in view of the fact that it represented a private study proving both the ingenuity of the author and the reality of the G-Line.

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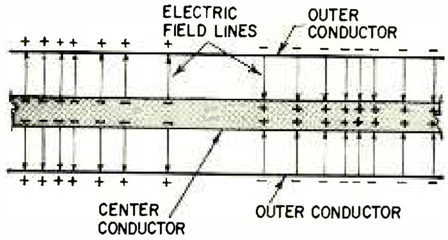


Fig. 1—Pattern of charges and imaginary, symbolic electric field lines describe electrical configuration on ordinary coax cable.

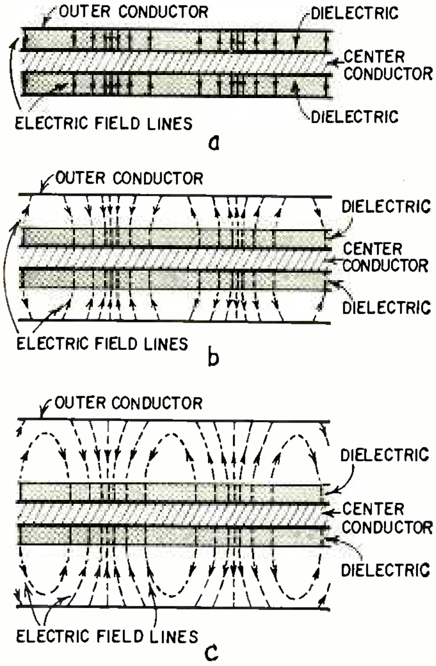


Fig. 2—This is how G-line develops logically from coax. In (a), dielectric is continuous from inner to outer conductor; field lines are straight. In (b), discontinuity appears in dielectric at boundary between plastic and air (their dielectric constants are different) and lines curve. Drawing (c) shows how field lines begin to curve back onto center conductor as outer conductor is moved farther away.

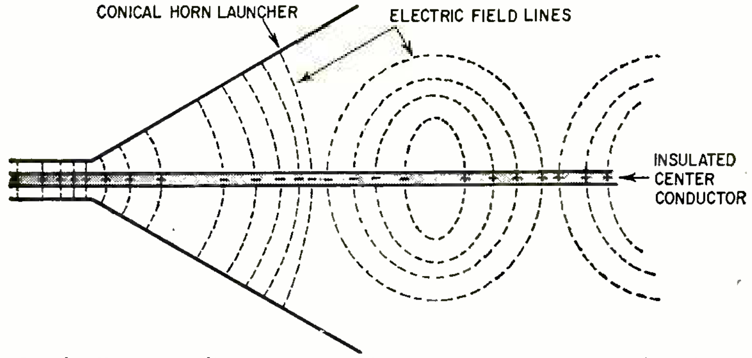


Fig. 3—Gradually expanding outer conductor is means of transforming coax into G-line. One such "launcher" must be at each junction between G-line and coax.

all the line needed to make it propagate was insulation.

Examining the electric field within a longitudinal section of solid-dielectric coax line, you can better understand the role of the insulation Goubau found so necessary. The electric field lines vary in direction and magnitude with the distance along the line. The entire pattern, maintaining relationships shown in Fig. 1, moves away from the source at nearly the speed of light. Notice particularly that the electric lines are shown beginning on charges on the surface of a conductor and extending to charges on the opposite conductor.

All of this is just another way of saying that there is a difference in potential and that electric lines of force are depicted as beginning and terminating on charged bodies. That is, they begin and terminate on charged bodies *if the transmission line is not to radiate.* Herein lies the problem, for what we plan to do is to expand the outer conductor gradually, until it becomes so large that, in effect, it doesn't exist electrically.

Normally this would mean that the electric lines of force beyond this point would have only one body on which to begin or end, and hence could detach themselves from the conductor and join heads to tails, forming closed loops that move away from the wire, taking all the energy with them. That is, if the outer conductor is removed, we expect the inner conductor to become an antenna. This is true if the dielectric before and after expanding the outer conductor is the same (air, as an example). However, our example is a solid-dielectric line, and the secret to the operation of the surface waveguide lies in continuing this solid dielectric after the outer conductor is removed.

Where the outer conductor has an increased diameter, the dielectric is no longer all solid; it is part air and part solid. The speed with which the charges move on the surface of conductors depends, among other things, on the surrounding dielectric. The charges, to which the electric lines are attached, tend to move with a greater velocity on the surface of the outer conductor than on the inner conductor, thus forcing the electric lines to curve (Fig. 2).

If we continue this process, gradually making the outer conductor larger and larger, the electric lines will bend in an arc so that they begin at a charge of one polarity on the inner conductor and end with an opposite charge on the *same* inner conductor (Fig. 3). Thus the electric field becomes imprisoned by one conductor and cannot detach itself, whereupon the expanded outer conductor is unnecessary and can be omitted.

In practice, the enlarged portion of the outer conductor is called a *launcher*. A complete transmission system requires one at each end of the line. The one at the receiving end has been called a *catcher*.

All this seems to suggest that these launchers should be exponentially shaped. Experiments show that this

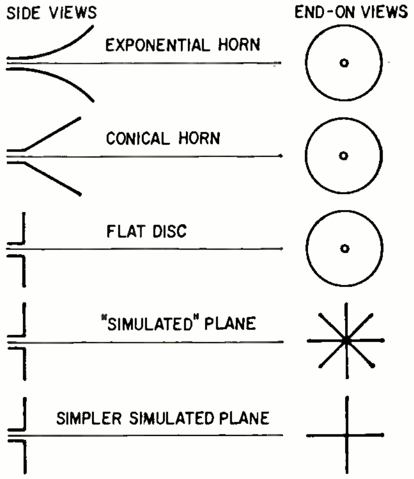
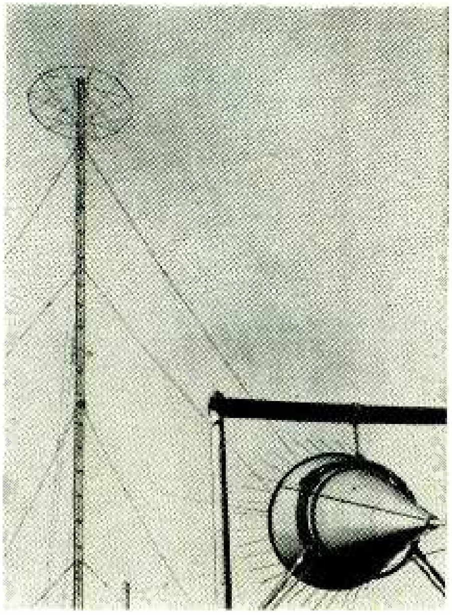


Fig. 4—Exponential or conical horns are near-ideal transformers; actual or simulated disc termination is simpler to make and nearly as effective.

form is not necessarily best, and in any case, not many of us have the wherewithal to construct such a gadget. I decided to corrupt the optimum in favor of a design that was easy to make and



The launcher in the foreground feeds 1,250 watts of vhf power via G-line to a small directional array halfway up the medium-wave tower in the background. This installation is in Munich, Germany.

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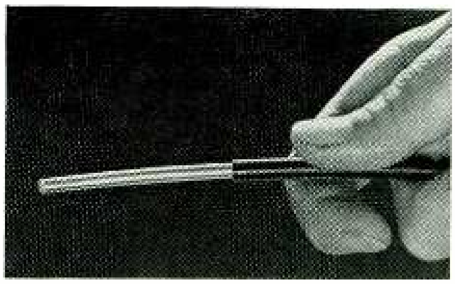

Fig. 5—Author used No. 6 aluminum wire with plastic insulation for G-line.

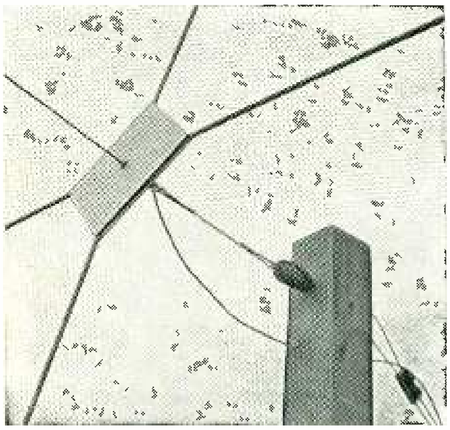

Fig. 6—Front of launcher, looking from G-line side, showing support pole and guying arrangement.

much less expensive. Fig. 4 shows the natural transition from the ideal to the simplified practical. This simplification only adds about 1 db loss overall.

Put one up

The wire I used in our system is No. 6 aluminum with a black commercial-grade polyethylene jacket (Fig. 5). Aluminum was selected because this system consisted of two 1,700-foot spans and here the weight is important. Any plastic-insulated wire will do, such as common No. 14 or No. 12 solid-copper house wire. Rubber-insulated and so-called "weatherproof" wire should not be used; those dielectrics are lossy and absorb power.

Ideally, the line should be constructed from wire with an overall diameter twice that of the conductor itself. However, variation from this formula does not change the performance greatly.

Our launchers were made with four ½-inch x 6-foot aluminum tubes located between and along the diagonals of two 12-inch x .060 inch aluminum squares (Figs. 6, 7). Two small squares of ¼-inch Plexiglass or Lucite with holes in their centers to admit the bared end of the wire form the insulator block. A knockout punch cut relief holes in the centers of the two aluminum plates. The entire sandwich was secured by 1-inch 6-32 machine screws.

The size, height, weight and whether or not "deadmen" will be used at the terminals of the G-line will depend on the particular circumstances. Saddle Mountain's two 1,700-foot catenaries were suspended between 6 x 6-inch x 10-foot posts set in the ground 3 feet and tied back to expandable anchors. These supports were later found to be far more rugged than necessary since this line required only a 200-lb stress.

Be careful not to exceed the maximum load rating of the wire under the strongest winds expected in your area.

The tie between the supports and the line is ¼-inch nylon rope. Since nylon is very slippery and doesn't knot well, it was bound with copper wire. Nylon rope can be kept from unraveling by fusing the ends with a match or cigarette lighter flame.

The bared end of the G-line is passed through the hole in the launcher insulator (Fig. 8). A slotted bolt connector is slipped over the wire at the rear of the launcher and the wire is then formed around a small cable "thimble" and once again passed through the wire connector.

Once the connector is in place, the nylon tether is secured to the thimble and the G-line is ready to raise.

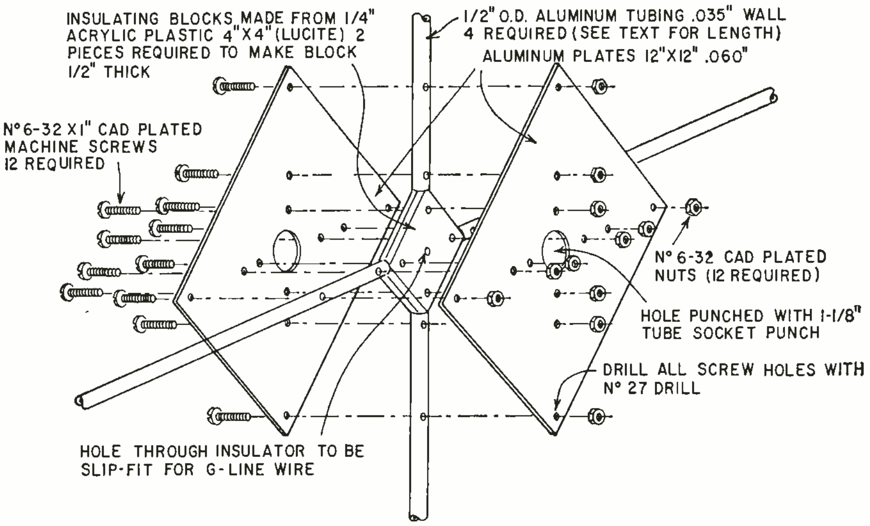

Fig. 7—Exploded view of launcher assembly.

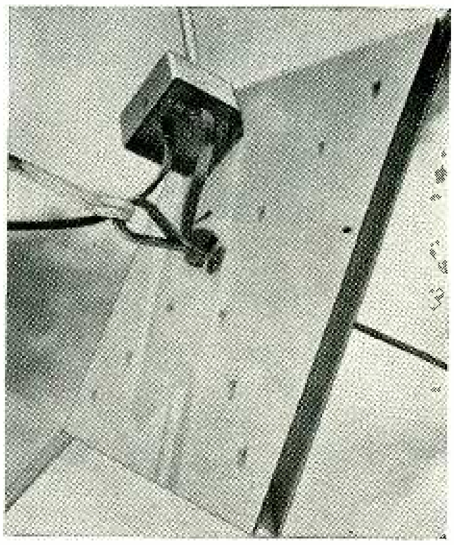

Fig. 8—Rear of launcher shows "eye" bent into aluminum wire, and nylon support rope. Box on back of launcher "sandwich" is transformer to match G-line to 72-ohm coax. Short piece of ribbon lead-in goes from 300-ohm side of transformer to end of G-line.

In our system, 72-ohm coaxial feed lines are used to and from the launchers. Weather-tight transformers such as Jerold's model TO-374 or Taco's Magi-Mix No. 1597 match the G-line's 300-ohm impedance to that of the coaxial line.

Even though transformation to an intermediate impedance of 72 ohms between the G-line and the TV set required a transformer at both ends, it was well worth the small additional cost to be able to run the interconnecting line next to water pipes, on the ground and through walls with complete freedom. With 300-ohm line, a transformer should still be used, even though the impedance of the G-line matches that of the ribbon. A 300-ohm line is balanced, and the G-line is inherently unbalanced.

Our system has been in operation more than 6 years. It has survived winds over 80 mph and has withstood the tests of time and weather with complete success. Its entire cost was less than that of the set we couldn't use without it and everybody's happy. Now don't let a little thing like a mountain range stand between *you* and Perry Mason! END

"Get a load of what I found in your set, Mrs. Broadway — dead about 3 years, I'd say!"

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SIMPLE RF WATTMETER for CB

A load as well as a meter, device reads rms power from dc to about 50 mc

By LYMAN E. GREENLEE

THE SIMPLEST COMBINED DUMMY-LOAD-and-"wattmeter" is still a light bulb. But, by itself, a bulb is not an accurate meter. The best you can do is guess at the transmitter power.

This little instrument combines a small pilot lamp with a pair of solar cells and a microammeter. Fig. 1 shows the schematic. The meter reading depends on only the light output of the bulb, which in turn depends on only the power the bulb gets from the transmitter.

Two selenium self-generating solar cells are connected in parallel and mounted close to the pilot lamp. The rf current lights the bulb, and the dc output from the solar cells goes to microammeter M through the rf choke, bypassed by C to remove any stray rf from the microammeter. Observe polarity when you wire the solar cells.

Mount the assembly in a light-tight case. R is a 1,000-ohm calibrating pot shunting the meter (M), and is adjusted *only* when calibrating the instrument to set the 0–500 microammeter to full scale. After calibration, it may be locked or sealed in position permanently, and will not be disturbed unless recalibration is necessary. A burned-out pilot bulb may be replaced without recalibrating the instrument, if it is of the same make and type as the original.

The pilot light is mounted in a socket which is a push fit inside a rubber grommet. To change bulbs, pull out the socket. A clip holds the coax line and socket in place on the front panel. Wrap bulb and socket with a small piece of plastic tape to make sure the bulb will not work loose. I bent a U-shaped piece of tin-can metal and soldered it to the back of R to act as a reflector and to confine the light from the bulb to the solar cells. The only purpose of the reflector is to increase the reading of the microammeter. If the meter can be made to read full scale without it, leave it off. Mount the solar cells close to the bulb, as shown in the photo.

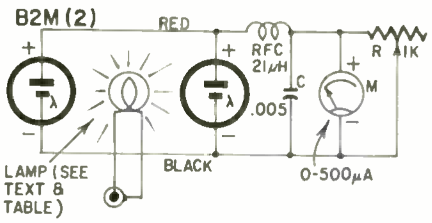
There is some variation in solar cells. Before using them, check each one by connecting it directly to the microammeter. A good cell should give a full-scale reading when held close to a 60-watt light bulb. If it doesn't, the cell is weak and will not work in the wattmeter.

Wiring is simple and not critical, since the leads carry direct current. Mount C and RFC exactly as shown in the photo, with C across the meter.

Calibration

Fig. 2 shows the calibrating circuit. Calibrate the instrument by adjusting the rheostat, taking readings of the ac voltmeter and milliammeter and comparing with the corresponding readings of the microammeter. First, set the rheostat to apply full rated voltage to the bulb. Adjust R so that the microammeter reads full scale. Calculate wattage by multiplying voltage and current. *Example:* If the ac meters read 6 volts and 120 ma, the power is 0.72 watt (6 × 0.12 = 0.72). With a No. 40 bulb, set the microammeter to full scale with 1 or 1.2 watts maximum input to the pilot lamp. With a 46 bulb, the maximum level should not exceed 2 watts. These wattage levels *can* be exceeded by 25% or

The wattmeter. Scale should be calibrated in watts. At top, cable ends in phono plug; adapter, top left, fits screw type coax connector. Other end of coax is soldered directly to lamp socket terminals, visible above clamp at bottom of case.



C—.005 µf ceramic
M—meter, 0–500 µa, full scale
R—pot, 1,000 ohms, wirewound
RFC—21-µh rf choke (Ohmite Z-28 or equivalent)
Selenium cells (2)—International Rectifier Corp. type B2M
Lamp—see text and table
Phono plug
Coax cable (RG-58A/U)
Case—Bakelite, with panel, 6 x 3 x 2 inches. (A metal case such as the Bud CU-2105-A Minibox, 5 x 4 x 3 in., is preferable. It reduces radiated interference when checking transmitter. Connect coax shield to case at lamp socket.)

Fig. 1—Circuit of wattmeter. Meter reading depends on light output of bulb.

SUITABLE PILOT BULBS

Type	Voltage	Current (amps)	Max. Watts at design voltage
40 or 47	6–8	0.15	1.2
46	6–8	0.25	2.0
1447	18	0.15	2.7
1449	14	0.20	2.8
1487	12–16	0.20	3.2
432 or 433	18	0.25	4.5
1458	20	0.25	5.0

These levels can be exceeded by 25% without danger of burnout. Choose a bulb your transmitter will light to average brilliance.

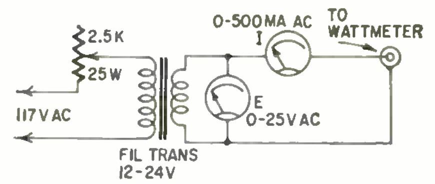
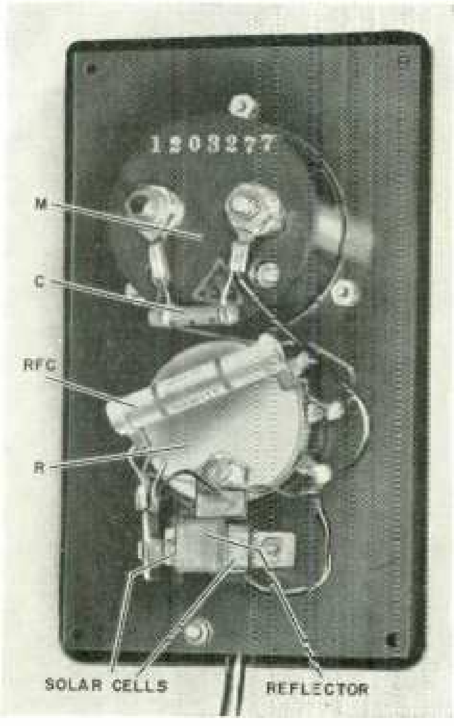


Fig. 2—The calibrating circuit.



Wiring is very simple, and not critical.

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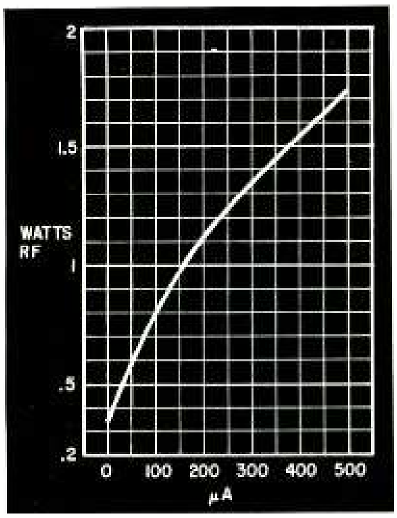


Fig. 3—Calibration curve for No. 46 pilot lamp from 0.5 to 1.75 watts. Your curve will depend on lamp type you use, but should hold for all lamps of same type.

more. But for maximum bulb life, calibrate within manufacturer's rated limits. After determining the full-scale maximum position and adjusting R, continue calibrating by varying the rheostat to reduce the current to the bulb. Plot points on a graph like Fig. 3 for the various microammeter readings. Vary the rheostat to reduce the reading of the microammeter to even values such as 450, 400, 350 µa, etc. For each of these checkpoints, read voltage and current, multiply to get wattage, and transfer this wattage value to the graph. Do not reset R.

The instrument can be used for checking power output or alignment, either with or without modulation. Plug the meter into the antenna jack, turn on the transmitter and take a reading. Don't leave the meter connected to the transmitter for a long time because heat from the lamp may affect the sensitivity of the solar cells. Ventilation inside the closed meter box is not good, so take a reading and disconnect the meter.

By installing a phono plug on the end of the coax line and making up an adapter to an Amphenol connector, the wattmeter will fit virtually all CB transceivers. This adapter can be made up by soldering a Switchcraft 3501-FP phono jack to an Amphenol UG-203/U plug. The end of the Amphenol sleeve must be reamed out until the Switchcraft jack is a press fit into the sleeve. Use a short length of bare wire to connect the center prong of the Amphenol plug.

A transmitter with a maximum output of less than ½ watt will not give a satisfactory reading with a 5-watt pilot bulb such as the type 1458. If it is hard to get a reading, make sure the bulb is not burned out and that the transmitter will actually light a bulb similar to the one in the wattmeter. END

marvelous electronic diaper change indicator

By DAVID W. CRAMP

A REAL HAGGARD-LOOKING GUY WAS waiting for me when I opened the shop one Saturday morning.

"Boy, am I glad to see you," he said. "You're the only TV guy who can help me."

"Well, I'll try," I told him. "What seems to be the difficulty?"

"I hate to change diapers," he said.

"Diapers?" I asked. "You sure you got the right place?"

"Yeah, I got the right place. I heard of you. It's like this. All day long my wife watches the soap operas on TV. She don't move from the set and she has it turned up as loud as it'll go. Even the commercials. Now our new baby is very little and isn't housebroken yet. Every night when I get home my wife is glued to the set and the baby is crying away only you can't hear him on account of the loud TV. I go in to say hello to the baby and find him wet and crying. I feel sorry for him and change his diaper which hasn't been changed since I left for work.

"I tell my wife she should change the baby's diapers when he cries and she says she does every time she hears him cry but she can't hear him on account of the loud TV."

"Why don't you get her to turn the set down?" I asked.

"I suggested that, but we live in a duplex with cardboard walls and she says she has to keep our set turned up or she hears the set next door and that lady is stupid and has lousy programs on all day and my wife can't concentrate on her own programs with all that noise from the next apartment."

"Would your wife change the baby's diapers if she was able to tell when he was wet?" I asked.

"Oh, yes! Deep down she really loves the little fellow and she could duck out and change him during some of the less interesting commercials."

"Well, then," I reassured him, "you can relax. Your troubles are over. I'll be over Monday night and fix you up."

"Oh, thank you, sir!" He practically gurgled as I backed up to keep him from licking my hand in gratitude.

Monday night I went over to his house with a little black box, a dozen new diapers with a two-pronged connector sewed in one corner of each one, and a crystal microphone. We put one of the new diapers on the baby and I hooked up the other stuff and we turned on the TV set and waited. Nothing happened so after we waited 15 minutes I had the guy feed the baby a bottle of warm water. Ten minutes later the set started to howl.

"What's that?" the man asked.

"That tells you that your baby needs changing," I told him."

We checked and sure enough, the diaper was wet.

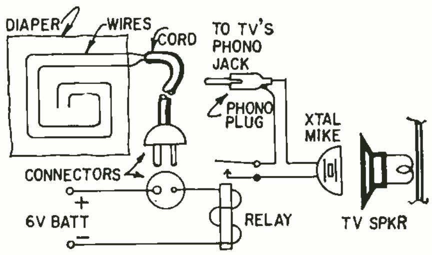
"Now," I said, "you tell your wife every time the set howls she is to go to the baby's room, unplug his diaper from this wire leading from this little black box and that'll stop the howling. Then get her to put one of these diapers on the baby and plug it into the little black box."

"Will it work every time?" he asked.

"Every time," I assured him. "As long as your wife uses these diapers I brought and they're dry when she puts them on the baby."

Well, he begged me to tell him how the indicator worked but I refused, because I wanted to keep it a secret until I could apply for a patent. Now that everything is set I can reveal the secret.

First, I bought a dozen diapers. Then I took some fine wire from the secondary of an old transformer and



soaked off the insulation with acetone. I cut 24 three-foot lengths of this wire and soldered one end of each wire to a separate prong on the male ends of 12 two-pronged connectors. My wife wove the two wires from each connector through a different diaper and sewed the connector to a corner of the diaper. She was very careful not to allow the wires to come closer than ½ inch to each other. I then made up the circuit shown below.

The relay stayed open so long as the diaper remained dry. As soon as the diaper was wet by the baby, the salt in the urine formed an electrolyte, completing the circuit between the wires woven into the diaper. This closed the relay and fed the mike input into the TV set through the phono jack. Since I had taped the mike to the speaker grill, a terrific feedback howl started and kept going until the diaper was unplugged. A new dry diaper kept the circuit open until the next wetting.

Where do you write to find out about getting the Nobel Prize? END

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AUTOMOTIVE ALTERNATORS

HOW TO KEEP THEM WORKING

If you own a car or work on mobile radio gear this article is must reading

By **CHARLES J. SCHAUERS**

ANYONE WHO HAS ENOUGH ELECTRICAL gear in his car to draw a lot of current from his auto battery will find an alternator valuable. Even with the engine idling, the alternator provides several times the current delivered by the ordinary dc generator. This has made it popular with radio amateurs, CB radio operators, police departments, the military and anyone else whose car is packed with current-gobbling air conditioners, spotlights, radios, etc. In many late-model cars, alternators are standard equipment.

An alternator is not complicated. It is easier to work with than an ordinary generator—think of it as a sort of "inside-out" generator. That is, the armature is stationary and the field revolves within it. Its output is three-phase ac which is instantly converted to dc by built-in silicon diode rectifiers.

Instead of a commutator, the alternator uses slip rings. These, their brushes and the bearings are the only parts that wear. Fewer moving parts mean fewer troubles. The small slip-ring brushes used carry only an excitation voltage and last much longer than the load-carrying brushes on generators. The design of the alternator permits current to be taken directly from the stationary armature and insures long operating life for the unit—as much as 3 to 10 times the normal life of a dc generator.

An earlier article by Mr. Schauers, "Installing an Alternator," appeared in the November 1962, issue on page 34.

The new Leece-Neville alternator (now in stock at distributors in every principal city) is the 6000 series rated at 40 amperes. Designed specifically for passenger cars, it replaces the old dc generator.

As simple as any electromechanical device can be, the 6000 is a medium-duty unit that delivers 5 to 10 amperes at curb idle (500 rpm). It consists of a pair of end housings, a ceramic brush holder, a stator, rotor, six tiny rectifiers

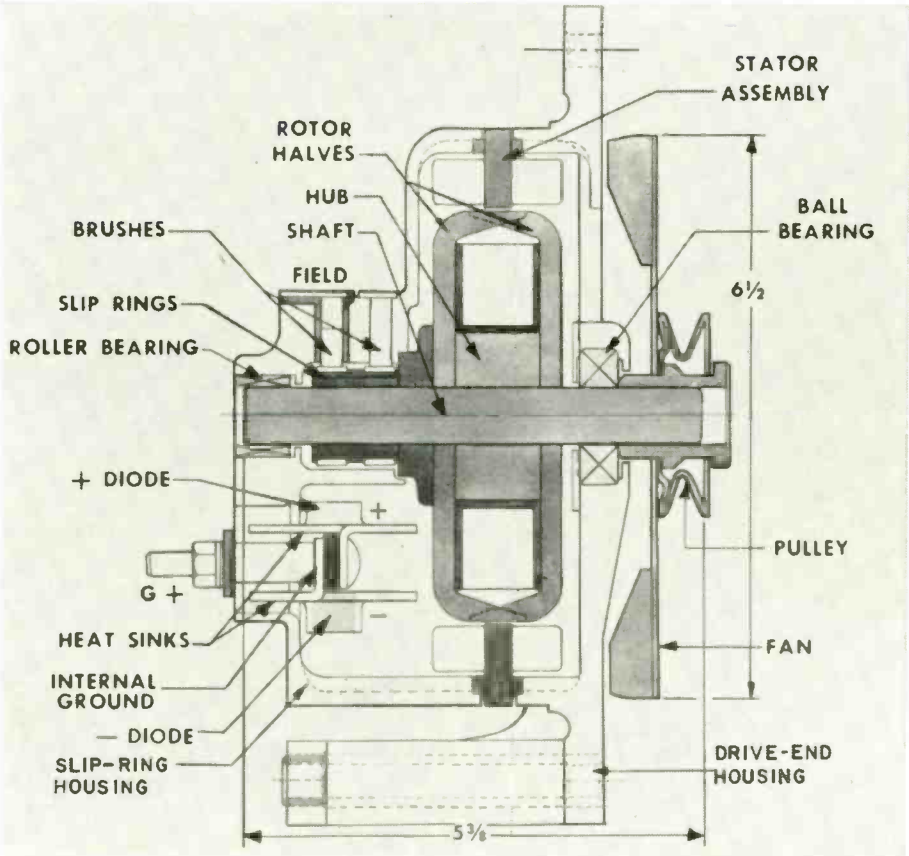

Fig. 1—Cutaway view of alternator with working parts identified.

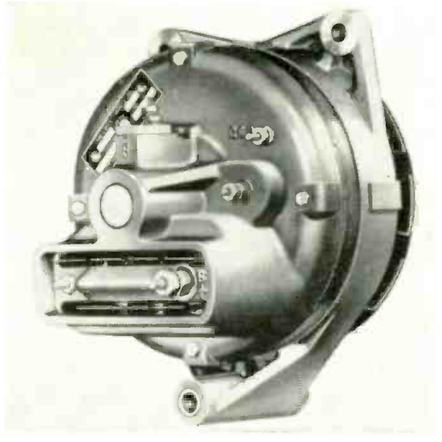

Fig. 2—Rear view of a fully assembled alternator.

held between a pair of heat sinks, a cooling fan and a drive pulley. Four through-bolts, equally spaced around the periphery of the unit, hold the assembly together. Fig. 1 is a cutaway view of the alternator and Fig. 2 shows now it looks from the rear assembled. Fig. 3 shows it mounted in a car.

Construction

The drive-end and slip-ring housings are rugged, lightweight die-cast aluminum. The drive-end housing supports the stator and rotor at one end, and will hold the alternator when mounted on the engine. If desired, the slip-ring end housing, stator and rectifiers may be easily removed for testing. The drive-end housing is mounted on the engine and holds the rotor in position. This speeds service, since the entire alternator assembly does not have to be taken out and replaced.

The slip-ring housing supports the opposite end of the main components, and also contains the ceramic brush holder and silicon rectifiers, which are held in an extended air scoop to enhance cooling. Since the scoop may interfere with installation, the through-bolts can be loosened and the entire slip-ring housing rotated to a different quadrant to eliminate mounting problems.

Two brushes—one insulated and one grounded—provide the electrical connection between the slip rings and the field terminal and ground. The brushes are in a molded ceramic holder that inserts in the slip-ring housing only one way, holding the brushes perpendicularly in line with the rotor shaft to avoid improper installation and possible regulator damage.

The insulated brush contacts the field terminal through the brush spring. The ground brush contacts a ground strap attached to the brush holder. One of the two brush-holder retaining screws goes through the strap and holder into the brush end housing, making a ground connection to the housing.

The powdered bronze-graphite brushes are interchangeable to reduce inventory problems. If field current exceeds 5 amperes, the compression coil type brush springs collapse as a further safety measure.

Voltage output is developed in the stator, which consists of a laminated steel frame and three windings. The enameled copper-wire windings are wound into slots machined in the inner diameter of the frame. The design of the windings makes the stator self-current-regulating so a separate current regulator is not needed.

A lead is connected between the junction of the three stator windings and a terminal on the brush end housing. This neutral terminal provides a convenient method for reaching the connected ends of the windings for testing stator continuity and ground. It also energizes the load relay on 12-volt regulator systems using a charge indicator light.

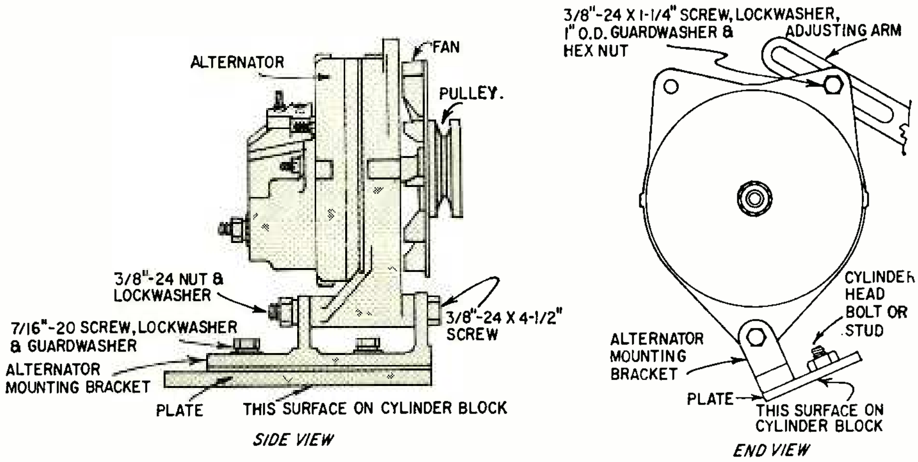

Fig. 3—Two sketches showing how an alternator is mounted in a car.

The rotor is a solid steel shaft with two 6-fingered pole pieces, a field coil and a slip-ring assembly mounted on it. The two pole pieces overlap to encase the field coil, making it in effect, a 12-pole rotor. The current flowing through the field coil provides the stator with the magnetic field needed to produce the required voltage and current.

The slip rings consist of a pair of 7/16-inch-wide brass sleeves supported by a bakelite insulator that separates them from the rotor shaft and each other. The two ends of the rotating field coil are attached to them, so they serve as a connection between the coil and the brushes.

If the field coil, pole pieces or shaft needs replacement, a complete rotor assembly must be installed. The slip-ring assembly can be replaced but the rotor components cannot.

Six silicon diodes are mounted on two metal heat sinks. These diodes convert the ac output of the alternator to usable dc. Three positive diodes on one heat sink connect directly to the alternator output terminal and are insulated from the other housing. The other heat sink, with three negative diodes, connects directly to the alternator housing and ground side of the system. One positive and one negative diode are connected to each of the three stator windings (Fig. 4). A ceramic capacitor is connected between the insulated heat sink and ground, to reduce voltage surges and protect the diodes from damage while the alternator is operating.

In typical negative-ground systems, output from each stator winding leaves the alternator by way of the positive diodes and the output terminal and returns through the negative diodes. In a positive-ground system, the flow is the opposite. The rectifiers permit flow in only one direction, eliminating the need for a circuit breaker or cutout relay.

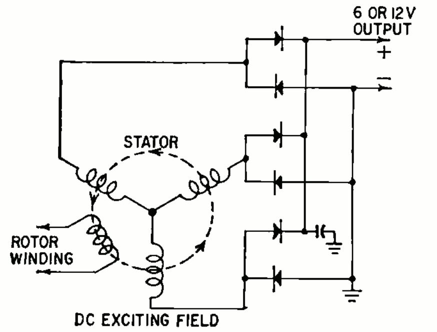

Fig. 4—Electronic circuit of alternator for negative-ground systems.

A cooling fan is mounted on the drive end of the rotor shaft. It draws cooling air over the rectifiers. The rotor shaft is supported on the drive end by a ball bearing, and on the slip-ring end by a roller bearing. Both are prelubricated, and require no regular service.

The regulator

A load relay and a double-contact voltage regulator make up the two parts of the regulator, which is installed in the same location as the original regulator on the car. A series of openings in the regulator's base make the installation easy.

The load relay opens and closes the main charging circuit between the alternator and battery, and also energizes the alternator field coil by connecting the field circuit to the battery. The relay consists of a magnetic switch that is operated by voltage obtained either from the alternator neutral terminal or from the battery. If used on a system with a dash ammeter, the relay is energized when the ignition switch is closed. If used on a system with a charge indicator light, it is energized when the alternator starts to charge. Besides its other functions, the load relay is also a safety device that disconnects the battery from

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the alternator when the system is not operating.

The voltage regulator controls the alternator output by governing the flow of field current, thereby limiting the charging voltage to prevent overcharging the battery and subsequent damage to lights and accessories. The double-contact regulator does this two ways. If current flow is high or alternator speed is relatively low, it operates on its upper contacts to insert resistance into the field circuit and reduce the current flow. If current flow is low or alternator speed is relatively high, it operates on its lower contacts to ground the insulated end of the field and interrupt the current flow.

Maintenance

The maintenance required by the 6000 series alternator is much, much less than for an automotive dc generator. However, any electromechanical device requires maintenance periodically. If maintenance instructions are followed implicitly, an alternator will give excellent service.

If you run into trouble in the charging system, remove the F-lead from the alternator and attach a jumper from terminal F to terminal B. This takes the regulator out of the circuit and allows full-field operation. With the engine idling, the alternator should show a high rate of charge in the full-field condition. If it does not, the battery, system wiring or the regulator should be suspect.

If the alternator does not show a high rate of charge when running full-field, it should be removed from the vehicle immediately.

Disassemble the alternator according to the instructions furnished by the manufacturer. Then check the rotor to see whether it is open or shorted. Do this by measuring the resistance of the coil with an ohmmeter on the slip rings. Resistance should be between 3.8 and 4.2 ohms for the 12-volt and 1.9 to 2.1 ohms for the 6-volt alternator.

If you find the brush springs are collapsed when you remove the brushes, the rotor probably has a shorted coil and the entire rotor should be replaced.

Never measure the rotor coil resistance at the field terminals; it will not be a true reading. This is due to the variability of the slip-ring and brush contact resistance when the alternator is not operating.

Clean the rotor if it checks out OK. Brush it with a good cleaning solvent. Remove the solvent by brushing with kerosene and wiping the rotor dry. Never dip the entire rotor into a cleaning bath.

Inspect the slip-ring assembly. If it is defective, replace it. Do not try to repair it. Next, inspect the slip-ring brushes. If they are burned, broken or cracked, replace them. Replace brushes that are 3/16 inch long or shorter (due to wear).

Disconnect the silicon rectifier section from the stator by unsoldering each diode. The test recommended by Leece-Neville is to hook up a 24-volt battery in series with a 24-volt test lamp. If the test bulb lights when applied to the individual rectifier in one direction (forward), and does not light in the other direction (reverse), the rectifier is OK. If the lamp lights in both directions, the rectifier is shorted. If the lamp does not light in either direction, the rectifier is open. The procedure recommended by the manufacturer for replacing the rectifiers should be followed to a "T."

Before resoldering the rectifiers to the stator, check the stator for grounds. You do this the same way you would check an armature in the old dc generator. A lamp in series with 117 volts and a pair of test leads are used for the check. Touch the test prods to each stator lead and the stator core. If the lamp does not light, everything is OK—there are no grounds.

The same test lamp can be used to check stator winding continuity. Each of the three stator phases is checked separately and should show a closed circuit.

After a complete electrical check and visual examination, clean the stator in the same manner as the rotor.

If the alternator has undergone a complete overhaul, replacing the bearings is a must.

The alternator is reassembled by starting at the end of the disassembly instructions and working back. Then install the alternator in the car and check charging under full-field condition. Recheck the voltages, readjust the fan belt, and when you're sure everything is right, give the customer a wide smile.

Radio noise

A properly operating alternator creates little or no radio interference. Sometimes, however, the regulator may act up and create an annoying clicking noise. This can be eliminated by replacing the regulator or cleaning and readjusting the old one according to service instructions furnished with the unit.

If a new regulator does not make for quiet operation, connect a 10-ohm resistor *in series* with a 0.1-μf capacitor across the regulator voltage terminals. *Never* try a capacitor across *any* regulator terminals without a resistor in series or burned points will result.

Coaxial type capacitors in the regulator supply leads will help reduce conducted noise.

The author acknowledges with much gratitude the assistance and material provided by Leece-Neville Co. and Mr. James E. Stratton to make this article possible. END

Correction

Mr. Geisler noticed that he had supplied the wrong diagrams for Figs. 9 and 10 of the "Transistor Power Amplifier Directory" (October 1963, page 34) at about the same time that errors in these circuits were reported by Capt. W. B. Bernard of Longboat Key, Fla., and Richard J. Wolski of Bytom, Poland. The correct diagrams for Figs. 9 and 10 are shown.

Note that 1.5-volt batteries have been added to both circuits. They must be disconnected when the amplifiers are not being used.

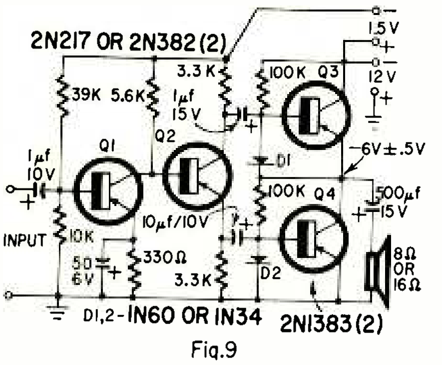

Fig.9

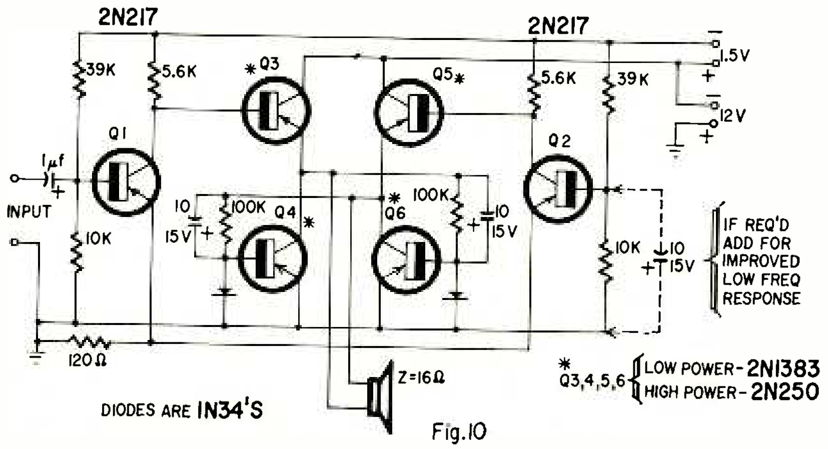

Fig.10

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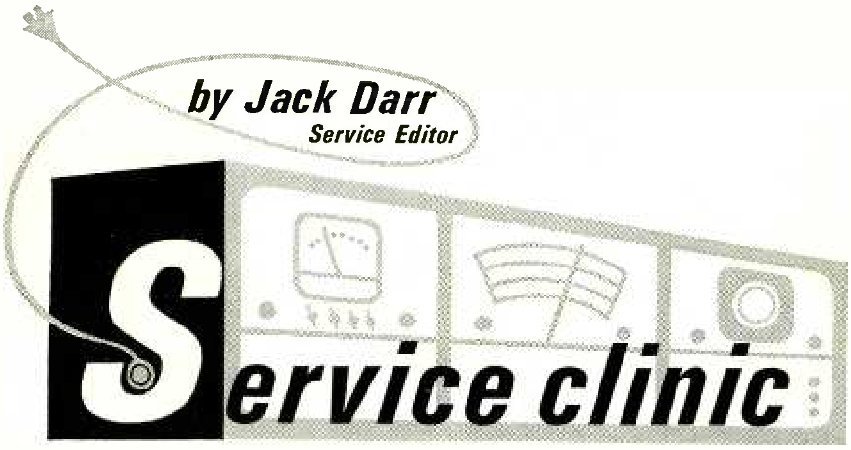

by Jack Darr
Service Editor

Service clinic

This column is for your service problems—TV, radio, audio or general and industrial electronics. We answer all questions individually by mail, free of charge, and the more interesting ones will be printed here.

If you're really stuck, write us. We'll do our best to help you. Don't forget to enclose a stamped, self-addressed envelope. Write: Service Editor, Radio-Electronics, 154 West 14th Street, New York 10011.

SUBJECT THIS MONTH IS OFF-COLOR troubles. No, we're not going to tell dirty jokes! We're talking about off-color response from the color circuits. Since we have two signal paths for the video information, one for the brightness and the other for the color, we can have all kinds of troubles!

Look for what *is* there, and for what *isn't*. In some of the older circuits, the color amplifiers were hooked up so that you lost the color amplified by that particular tube. For example, if the red amplifier went out, no reds. The picture went blue-green. Most later models, because of the dc coupling used in color video circuitry, seem to *increase* the color. If the red amplifier goes out, the red gets brighter. Here's a "f'rinstance". We pulled tubes from an RCA CTC9 chassis to see what would happen, and this is what we found. (See Fig. 1.)

6CG7, green amplifier: picture turned bright green and lost focus.

6CG7, red, blue amplifiers: picture turned bright purple, lost focus.

12AZ7, X and Z demodulators: no effect at all on black and white picture, total loss of color signal on color.

You might repeat this test on the next color set you service; the results will tell you about what's going to happen if a given tube goes out. Of course, these are all twin triodes: if only one half goes out, as is common in some of these tubes, you'll lose only the color associated with the one tube. Most likely, instead of losing the color, you'll lose *control* over it. The screen will show *more* of that color.

If the dead tube has been getting weaker for quite a while, the color-temperature controls may have been adjusted to make up for that. So, when the new tube is installed, you'll have to check the color temperature, at least, and probably readjust it. Always keep the "Kine Gain" (RCA's name) as low as possible, for maximum life on the Big Bottle. Happy hue-hunting!

Hourglasses and onions

This Philco makes an hourglass-shaped pattern on the screen. If I reverse the line plug, the thing changes to an onion shape. When the line plug is pulled out, the raster flashes back to normal for a split second before it goes out. Everybody I ask says they never saw such a thing, but I've got it, and I get slightly violent thinking of it! I need help!—M. S., Wooster, Ohio

Hang on, help's on the way! This pattern (Fig. 2) is obviously due to some kind of a *60-cycle* influence. The basic cause is the horizontal oscillator going into and out of oscillation at a 60-cycle rate. Somewhere, a 60-cycle sine wave is getting into your horizontal oscillator. From the amplitude characteristics, I'd say that it looked as if the *plate supply* was raw ac!

So, up scope and after 'em! Trace the B-plus supply lines to your horizontal oscillator to see where this is getting in. Since this seems to be a *60*-cycle pattern, and your power supply is a voltage doubler (which would show a 120-cycle pattern), I'd say there was some heater–cathode leakage somewhere.

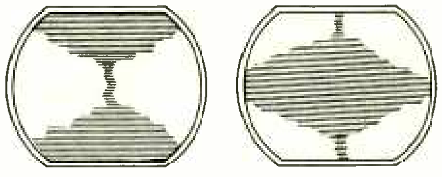

Fig. 2—Hourglass or onion shape. Depends on which way line plug is inserted.

This could be in the oscillator tube, the afc tube or even in the horizontal output tube. I'd substitute every tube that is in any way associated with the horizontal circuits, and even in the sync circuits. Also, I'd bridge filters. If this didn't help, and some of the filters were multiple units, I'd disconnect some and try shunting with individual units. Of course, this needs to be done only if the scope shows the 60-cycle waveform on the B-plus supply lines. After you find the 60-cycle waves, leave the scope hooked at that point, and start shunting capacitors, etc., until you find something that will take them out.

Be sure to replace the 10DE7 vertical output tube and the damper; heater–cathode leakage in either could cause this trouble. Also, stray leakage to chassis from the horizontal oscillator *grid* circuit could be the villain.

Toy-train transformer

I have a toy-train transformer with a dc circuit for powering special gadgets. The train runs OK, but I don't get any dc: none of the gadgets works—no whistle, etc. I've taken the transformer apart, but I can't find the rectifier! Could

(Continued on page 57)

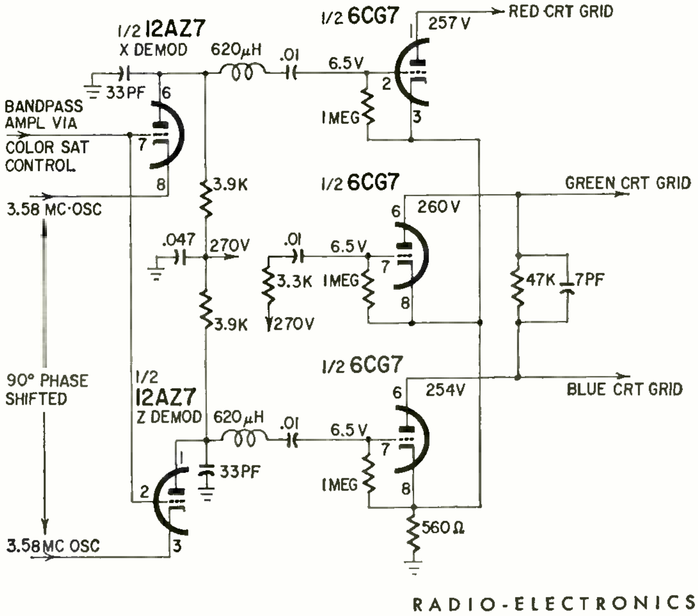

Fig. 1—Color demodulators and amplifiers. If the demodulator tube goes out, all color disappears. Black-and-white not affected. If color amplifier is pulled, corresponding color dominates picture, which also goes out of focus. Handy to keep in mind for diagnosis.

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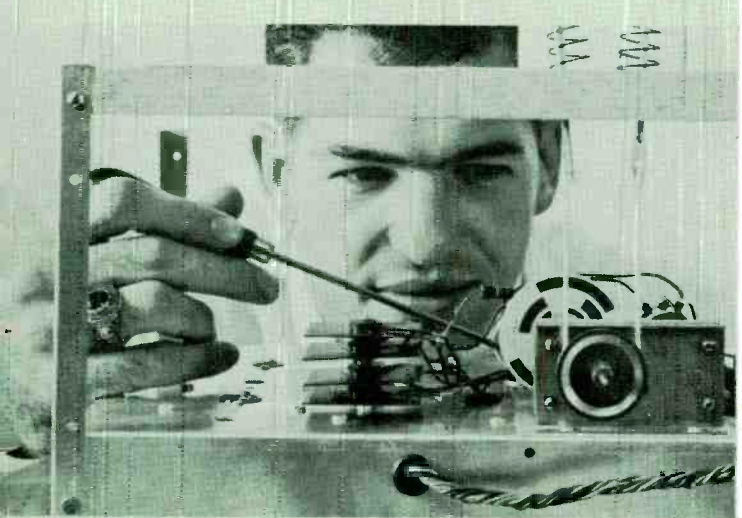

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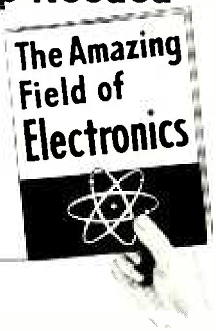

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(Continued from page 54)

I get a surplus transformer and make a new one?—A. F., New York, N.Y.

The first one of these I saw almost drove me nuts! Only two wires went to the track, yet we could blow whistles, throw switches, etc., by pushing buttons on the transformer! After quite a while, another man and I finally took the transformer apart, and found out how it works (Fig. 3)! The dc is "superimposed" on the low-voltage ac which runs

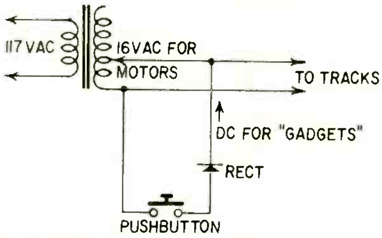

Fig. 3—One method used to actuate accessories in a toy train layout. Rectifier produces mixed dc-and-clipped-ac output when switched in. When rectifier is out of circuit, power is pure ac.

the train motors. We couldn't find a rectifier, either. It is evidently potted inside the transformer somewhere.

Your transformer ought to work as is, if you just add another rectifier to replace the one which is evidently either open or shorted.

Just connect a surplus dry rectifier to the 16-volt ac output of the transformer and wire it through the control pushbutton on top, and it ought to work as well as ever. You can even use small silicon TV replacement rectifiers, since the current drain is pretty small.

Glass replacement for 21MP4

What tube would you recommend to replace the 21MP4 metal kine? I'd like to use an all-glass tube.—A. J. K., Milwaukee, Wis.

The 21YP4 or 21YP4A will replace the 21MP4 metal tube. This is a very common conversion. Most technicians are glad to get a chance to eliminate any metal-cone tube, because of the shock hazard. Be sure to ground the external coating on the new tube.

Horizontal off-frequency

I had quite a few troubles in an old RCA KCS-40. Now I've got them down to one: the horizontal oscillator's off frequency. I've got four pictures on the screen, sidewise. The oscillator is running on the fourth harmonic. I can adjust coils and things and get it down to about two pictures, but no further. Any suggestions?—R. H. N., Great Lakes, Ill.

Let's get one thing straight before we start. *Four complete* pictures on the screen would *not* indicate that the oscillator was running on its fourth harmonic, but on the "1/4th" harmonic: 3937.5 cycles! The fourth harmonic would be 4 times 15,750 cycles, *63,000* cycles! This might sound academic, but it is important. Why? Because the frequency of operation indicates the nature of the defect in such cases.

If the frequency is far *below* normal, too *slow*, it means that one of the frequency-determining parts in the circuit is far too *big!* The coil (for example) is set for far too much inductance, or a too-big capacitor has been installed. Symptom on the screen: four pictures, *not* overlapping but complete.

If the oscillator frequency is too high, one of the parts is *smaller* than it should be. This is a more probable situation. A capacitor has opened up, some turns in a coil are shorted, etc. Symptom: multiple *overlapping* images. You can plainly see that parts of each picture are actually overlaid on the rest.

Funny snow

I've got a funny one on an Emerson 1120D TV; it's got a built-in antenna on the back cover. I replaced a tube in it and it worked. Channels 11 and 13 come in fine, but channel 2 has white flecks all over the screen! When I took the back off to see what was the matter, they disappeared; put the back on again, and there they are. Finally, I disconnected one side of the antenna, and everything works fine! Now, give me an explanation for this, so I'll know what's going on the next time!—R. L. B., Baltimore, Md.

This is "spike" radiation from the horizontal sweep, getting into the built-in antenna, which is very close to the horizontal sweep cage, yoke, etc., on one side of the set. I'd say that you probably disconnected the half of the antenna closest to the sweep.

You got the snow on the low channel, but not on the two high ones. This is natural, as the low channels are much more susceptible to pulse interference than the high ones. You can verify this by checking the difference in auto ignition-noise pickup between low and high channels, on any kind of antenna.

There are several cures for this condition. The most obvious is a bit of shielding on the horizontal sweep system. Try wrapping the yoke leads in metal foil, grounding this with a wrapping of bare wire at each end. Rabbit-ears on top of the cabinet, or one of those "under-the-rug" antennas would also cure the trouble, in this one set, which seems to be a mild case.

In severe cases of this trouble, clean up all the flyback shielding. Once in a while you'll find a set where some genius has left the flyback shield off entirely! Make a new one out of copper screen or any suitable metallic material, and wrap the yoke leads. In a few cases, a severe corona discharge from the bell of the picture tube, the high-voltage rectifier socket, and so on, causes trouble.

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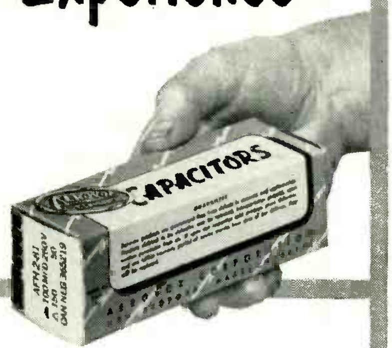

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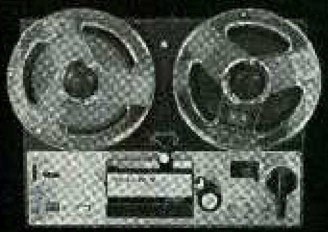

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CRT diagnosis

Can you tell whether a CRT is bad by observing the video information at its input? This assumes that sweep and high-voltage circuits are working properly. —J. V. C., Houston, Tex.

Yes and no! If your scope showed a signal of about 50 volts p–p at the input of the CRT (Fig. 4) and, *at the same time,* you had other symptoms – dim raster, loss of focus, smearing and haziness and very low contrast—I would say this would help. However, in a matter involving CRT replacement, with the attendant expense, be sure to use *all* the clues available before you make up your mind.

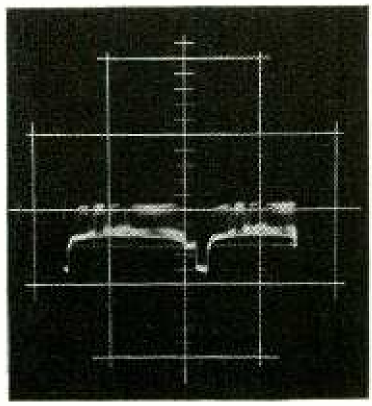

Fig. 4—The amplitude of this signal is about 50 volts peak to peak.

Capehart CX-33 conversion

I have a Capehart CX-33, which uses a 170-AR picture tube; this tube is shorted. Can I replace this tube with a 21ZP4B? I'm going to mount it on the wall. Will the present horizontal output transformer work with the new tube, and what additional drive and high voltage will I need to scan the new tube?— F. K., Newark, N. J.

This should be a practical conversion. Your original 170-AR picture tube has a deflection angle of 70°, and so does the 21ZP4B. The rated high voltage for this chassis is 11 kv, which should be sufficient to operate the larger tube. You might get slightly better results with the type 21EP4, which also has a 70° deflection angle.

Your major problem will probably be width. This should be fairly easy however, if you overhaul the horizontal output stage carefully, and put it into first-class condition. If it is insufficient, try adding a small capacitor across the damper tube, about a 200 pf, with a voltage rating of at least 5 kv, and adjusting width and horizontal linearity coils. Check the plate current of the 6BG6 output tube after all adjustments have been completed. It should not be over 100 ma. Check the screen resistor, and adjust the screen voltage to not over 350. (You might get a little more width, if the screen voltage is *less* than 350 at present, by raising it to that figure. Not over it, though!)

Sheraton flyback replacement

I can't find any information on a Model T-5410 Sheraton TV. Needs a new flyback. Can you tell me who made this set, and where I can get the flyback? —W. L. W., Jackson, Tenn.

This set, I'm fairly sure, was originally made by Video Products Corp., and you'll find the service data for it in Sams *Photofacts 218,* Folder 10, under Chassis 250XL.

The flyback can be replaced by a Triad D-43 or Merit HVO-25, if the original part number was ET-119.

Stewart-Warner: bigger CRT

Can I convert a Stewart-Warner 9104A TV set from a 12LP4 to a 16LP4, or to a 17ATP4? Would I have to use a new flyback and vertical output transformer?—J. W., Columbus, Ohio.

If you use the 16LP4 on the Stewart-Warner you won't have to make very many changes in the chassis. Stewart-Warner, along about that period, was noted for conservative design. In other words, you ought to have plenty of reserve to drive the larger tube with the original parts, assuming they are all in good shape.

The 12LP4 and the 16LP4 both have the same basing and deflection angle; the only difference lies in the the amount of ultor voltage required: 12LP4 specifies 11,000, and the 16LP4, 12,000. However, I have seldom found too much difference in brightness with the high voltage off only 1,000 volts. Besides, I think you can push the old Stewart-Warner up to 12 kv without too much trouble, by increasing the drive, etc. You could even raise the output by such measures as cutting the 6BG6 screen resistor down a little to raise the screen voltage. Watch your cathode current, though; don't let it get above 105 ma, or you'll shorten the tube life.

Conversion to the 17ATP4 would be quite a lot more difficult, and I would not recommend it for the added ¾ inch or so of screen width. This is a 90° tube and you definitely would have to change the yoke, flyback and vertical output transformer, and probably the horizontal and vertical output tubes, too. In addition, the horizontal drive would have to be increased by something like 40%, and you might find yourself rebuilding the horizontal oscillator stage, too! Therefore, the 16LP4 would be a much more practical conversion. END

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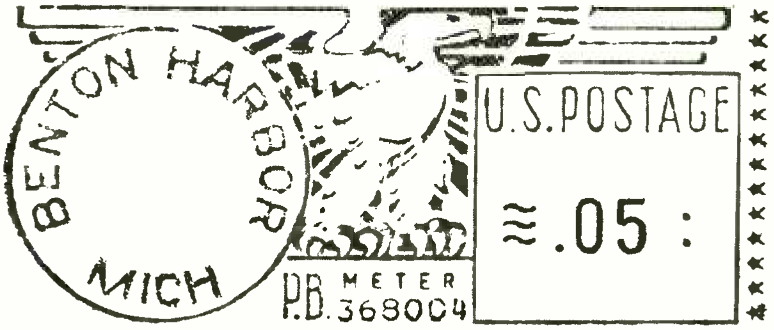

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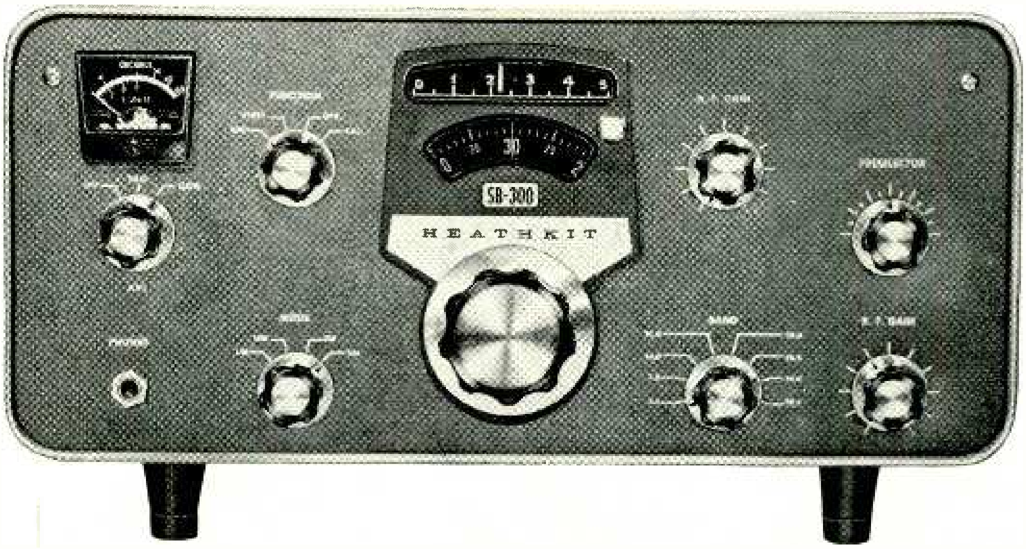

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Check these Specifications!

Frequency range (megacycles): 3.5 to 4.0, 7.0 to 7.5, 14.0 to 14.5, 21.0 to 21.5, 28.0 to 28.5, 28.5 to 29.0, 29.0 to 29.5, 29.5 to 30. **Intermediate frequency:** 3.395 megacycles. **Frequency stability:** 100 cps after warmup. **Visual dial accuracy:** Within 200 cps on all bands. **Electrical dial accuracy:** Within 400 cps on all bands. **Backlash:** No more than 50 cps. **Sensitivity:** Less than 1 microvolt for 15 db signal plus noise-to-noise ratio for SSB operation. **Modes of operation:** Switch selected: LSB, USB, CW, AM. **Selectivity: SSB:** 2.1 kc at 6 db down, 5.0 kc at 60 db down (crystal filter supplied). **AM:** 3.75 kc at 6 db down, 10 kc at 60 db down (crystal filter available as accessory). **CW:** 400 cps at 6 db down, 2.5 kc at 60 db down (crystal filter available as accessory). **Spurious response:** Image and IF rejection better than 50 db. Internal spurious signals below equivalent antenna input of 1 microvolt. **Audio response: SSB:** 350 to 2450 cps nominal at 6 db. **AM:** 200 to 3500 cps nominal at 6 db. **CW:** 800 to 1200 cps nominal at 6 db. **Antenna input impedance:** 50 ohms nominal. **Muting:** Open external ground at Mute socket. **Crystal calibrator:** 100 kc crystal, ±.005%. **Front panel controls:** Main tuning dial; function switch; mode switch; AGC switch; band switch; AF gain control; RF gain control; pre-selector; phone jack. **Rear apron connections:** Accessory power plug; HF antenna; VHF #1 antenna; VHF #2 antenna; mute; spare; anti-trip; 500 ohm; 8 ohm speaker; line cord socket; heterodyne oscillator output; LMO output; BFO output; VHF converter switch. **Tube complement:** (1) 6BZ6 RF amplifier; (1) 6AU6 Heterodyne mixer; (1) 6AB4 Heterodyne oscillator; (1) 6AU6 LM osc.; (1) 6AU6 LMO mixer; (2) 6BA6 IF amplifier; (1) 6AU6 Crystal calibrator; (1) 6HF8 1st audio, audio output; (1) 6AS11 Product detector, BFO BFO amplifier. **Power supply:** Transformer operated with silicon diode rectifiers. **Power requirements:** 120 volts AC, 50/60 cps, 50 watts. **Dimensions:** 14⅞" W x 6⅝" H x 13⅜" D.

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Scott 310E and Electro-Voice EV Two

THE SCOTT 310E IS THE MOST SENSITIVE, versatile, complex and high-priced tuner in the renowned Scott line with the single exception of the 4310 Broadcast Monitor, virtually the same except for VU meters and some facilities useful chiefly in broadcast service. It is quite possibly the most elaborate and flexible tuner on the market for handling stereo multiplex reception and its aberrations.

The 310 contains the same rf and i.f. section as several other tuners in the line. An extremely well designed cascode rf stage and mixer, three wide-band i.f. amplifiers, two limiters and a wide-band ratio detector yield an IHF sensitivity in the region of 2 μv and a practical high-fidelity sensitivity at least as good as that of any other tuner on the market. To minimize cross-modulation and overload distortion, agc is applied to the rf and one i.f. stage. Where maximum sensitivity is needed, a switch reduces the agc to a minimum.

The capture ratio is among the best and the selectivity good enough to make adjacent-channel reception possible. This portion of the tuner has had several years of use in previous Scott tuners and has earned them a reputation among the top two or three on the market.

No matter how sensitive the tuner, multiplex stereo reception presents problems. The 310E is notable for the quite elaborate measures it takes to deal with them. The multiplex is a rather complex version of the switching type circuit, employing a 6U8, two 12AU7s and eight diodes, and delivers as good stereo as I have heard.

Three additional double triodes and five diodes, plus two relays, are used in an automatic switching and muting system. There are switched high-frequency rolloff filters for both the main and sub-channel. This system provides automatic interchannel noise suppression and automatic switching of mode of operation, plus adjustments to make marginal signals tolerable, offering a so-far unprecedented flexibility and convenience of operation.

To begin with, there is an interchannel muting or "squelch" circuit with a threshold control on the panel. This can be adjusted to receive the weakest signal capable of giving any semblance of high-fidelity, or to work on extremely strong stations only. In any event, it will provide interstation noise muting in fringe as well as primary areas. It can also be adjusted to mute the receiver if a signal fades below any chosen threshold level. Normally it would be adjusted to mute the receiver when any signal falls below a level that yields high-fidelity quality. A relay does the actual switching, without any objectionable transients. A small pilot light indicates when the squelch is operating.

A switch provides a choice of three modes of operation. In the first position, the 310E is strictly a monophonic receiver. All programs, mono or stereo, are played back monophonically. In the second position the tuner switches automatically for mono or stereo programs. If a station changes from mono to stereo, or vice versa, the tuner automatically accommodates itself to the changes. In the third position it becomes a stereo-only receiver, responding only to stations broadcasting stereo and passing over any monophonic programs.

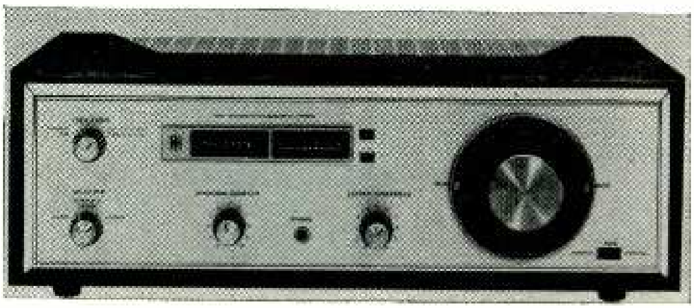
One big problem with stereo reception, especially in the fringe areas, is that signal levels are often too low for good stereo reception, or may fade below the good-signal threshold from time to time. It is often possible to receive the same program satisfactorily in the mono mode. Hence most tuners provide a switch so the tuner can be switched to mono under such circumstances.

The 310E has a uniquely satisfactory answer to this problem. There is a Stereo Threshold circuit with a control on the front panel. This can be adjusted so that when a stereo signal falls below any desired level, the tuner automatically switches to mono. If the signal again rises to a satisfactory level, the tuner switches back to stereo automatically. Thus the program is heard with the least amount of noise and without interruption. The shift from stereo to mono is far less noticeable than a sharp increase in noise and distortion would be. This control circuit also works through a relay which is free of transients. (There is occasionally an increase in distortion for a short time just before the control trips.)

The 310E provides means for dealing with marginal stereo reception if you insist on listening to it. Sensitivity can be increased by throwing the agc switch to the PARTIAL position. The subchannel is the most likely to be marred by noise; to offer relief from this the function switch has a position that switches a high-frequency rolloff filter into the sub-channel audio. There is a sacrifice in stereo separation. For even noisier situations, you can switch a filter into the main channel to attenuate the high-frequency noise, multiple-path distortion, etc., without affecting channel separation.

It takes some time to learn how to operate all this wealth of control circuitry to best advantage. Once it is mastered, it certainly does offer just about every imaginable way of dealing with either stereo or mono reception problems, and makes reception just about as noise-free as possible. These advantages are accompanied by a surprising lack of "bad features." I found it possible to set the two relays chattering by some combination settings of both the SQUELCH and STEREO THRESHOLD, but apparently this is not likely to happen in actual use. The relays make an audible click as they go in and out but it would not normally be heard over program material.

As in all Scott tuners, the tuning is very smooth and—with the tuning meter



H. H. Scott's 310E FM stereo tuner.

SPECIFICATIONS
(All specifications are the manufacturer's)

Usable sensitivity (IHF): 1.9 μv
Cross-modulation rejection: 85 db
Signal-to-noise ratio: 65 db
Harmonic distortion: 0.5%
Drift: .02%
Frequency response: 30 to 15,000 cycles, ± 1 db (IHF measurements made only from 30 to 15,000 cycles. Tuners actually have wider frequency range.)
Capture ratio: 2.2 db
Selectivity: 50 db
Stereo separation: 35 db or higher [Mfr does not give frequency—*Editor*]
Audio hum: 66 db below 1 volt audio output
AM suppression: 60 db
Detector bandwidth: 2 mc
Dimensions (with optional cabinet): 15½ x 5¼ x 13¼ inches

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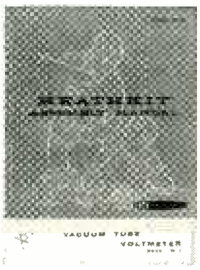
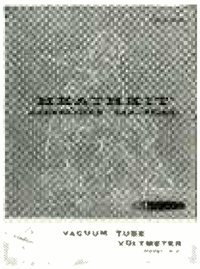
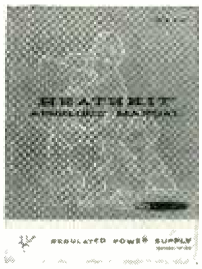
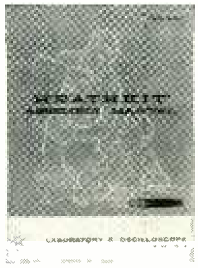

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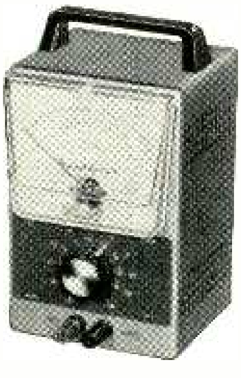

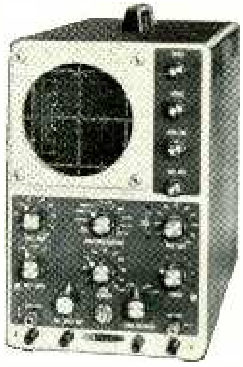

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SPECIFICATIONS—Meter scales: DC & AC (RMS): 0-1.5, 5, 15, 50, 150, 1500 volts full scale. **AC peak-to-peak:** 0.4, 14, 40, 140, 400, 1400, 4000. **Resistance:** 10 ohm center scale x1, x10, x100, x1000, x10K, x100K, x1 meg. Measures .1 ohm to 1000 megohms with internal battery. **Meter:** 4½" 200 ua movement. **Multipliers:** 1% precision type. **Input resistance DC:** 11 megohms (1 megohm in probe) on all ranges. **Circuit:** Balanced bridge (push-pull) using twin triode. **Accuracy:** DC ±3%, AC ±5% of full scale. **Frequency response:** ±1 db, 25 cps to 1 mc (600 ohm source). **Tubes:** 12AU7, 6AL5. **Battery requirement:** 1.5 volt, size "C" flashlight cell. **Power requirements:** 105-125 volt 50/60 cycle AC 10 watts. **Dimensions:** 7⅜"H x 4-11/16"W x 4⅛"D.

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SPECIFICATIONS—Frequency response: ±1 db 10 cps to 500 kc, ±2 db 10 cps to 1 mc, all ranges. **Ranges:** VOLTS-Ten ranges from 0.01 to 300 volts RMS full scale. **Decibels:** Total-range —52 to +52 db, meter scale —12 to +2 db (0 db=1 mw in 600 ohms), ten switch selected ranges from —40 db to +50 db in 10 db steps. **Input impedance:** 10 megohms shunted by 12 uuf on ranges 10 to 300 volts, 10 megohms shunted by 22 uuf on ranges .01 to 3 volts. **Tube complement:** (1) 6AW8, (1) 6EJ7/EF-184. **Accuracy:** Within 5% of full scale. **Power requirements:** 105-125 volts AC, 50-60 cycles, 10 watts. **Dimensions:** 7⅜"H x 4-11/16"W x 4⅛"D.

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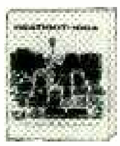
SPECIFICATIONS—Output: 0-400 volts regulated DC at 0-100 ma cont., 125 ma intermittent, 0 to —100 volts DC at 1 ma variable bias voltage, 6.3 volts AC at 4 amps, filament voltage. **Regulation:** Output variation less than 1% from no load to full load; Output variation less than ±0.5 volt for a ±10 v. change at 117 v. AC input. **Ripple:** less than 10 millivolts RMS, ripple, jitter and noise. **Output impedance:** less than 10 ohms, DC to 1 mc. **Meters:** Voltmeter 0-400 V or 0-150 V.; Milliammeter 0-150 ma. **Dimensions:** 13"W x 8½"H x 7"D.

Heathkit "Extra-Duty" Lab 5" Oscilloscope • Professional styling & features at low cost • Full 5 MC bandwidth—ideal for Color TV servicing • Heath patented sweep circuit—10 CPS to 500 KC • Push-pull vertical & horizontal output amplifiers • Finest oscilloscope value in the industry!
Kit IO-12...24 lbs.................$76.95
Assembled IOW-12...24 lbs......$126.95

SPECIFICATIONS—(Vertical) Sensitivity: 0.025 volts RMS per inch at 1 kc. **Frequency response (referred to 1 kc level):** ±1 db 8 cps to 2.5 mc; +1.5 to —5 db, 3 cps to 5 mc; response at 3.58 mc, —2.2 db. **Rise time:** 0.08 microseconds or less. **Input impedance:** (at 1 KC) 2.7 megohms at X1; 3.3 megohms at X10 and X100. **(Horizontal Channel) Sensitivity:** 0.3 volts RMS per inch at 1 kc. **Frequency response:** ±1 db 1 cps to 200 kc; ±3 db 1 cps to 400 kc. **Input impedance:** 4.9 megohms at 1 kc. **Sweep generator:** Range—10 cps to 500 kc in five steps, variable, plus any 2 switch-selected preset sweep frequencies in this range. **Synchronizing:** automatic lock-in circuit using self-limiting synchronizing cathode follower. **Power requirements:** 105-125 volts 50/60 cycles AC at 80 watts; fused. **Dimensions:** 14⅛"H x 8⅝"W x 16"D.



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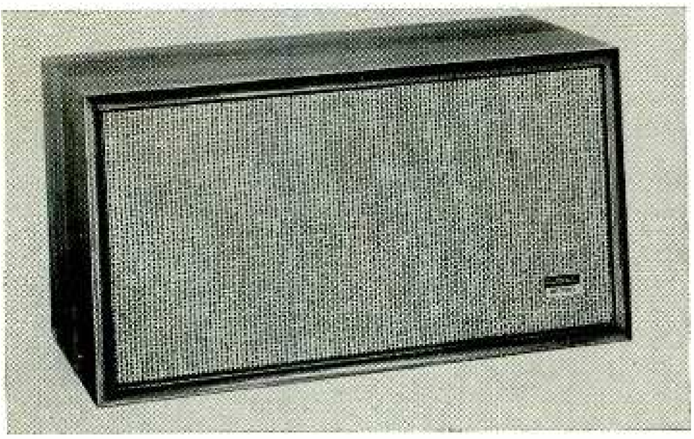

The Electro-Voice EV Two speaker system.

—easy to resonate for minimum distortion. There is no afc, but the tuner is inherently stable and wide enough in bandwidth to stay on tune for days at a time. Individual level controls for each channel permit loudness of radio reception to be adjusted to equal that of other program sources. There are two sets of output jacks, one for preamp and another for tape recorder, line or what-not. Furthermore, the tape recorder can be plugged into a jack on the panel.

In short, the 310E is sensitive enough to provide stereo reception anywhere it is possible at all, and with its automatic circuitry makes it possible to hear the program without interruptions or noise and with a minimum of attention by the user. Those to whom the price of $280 is not a deterrent will find it a highly satisfactory and satisfying piece of equipment.

The E-V Two

THE ELECTRO-VOICE TV TWO'S ARE NOT small as bookshelf speakers come today, and not light. But they supply precisely what is missing in a few of the smaller speakers—the awesomeness and presence which a good fundamental, low-distortion bottom-end response yields.

The EV Two is the middle-priced member of a new line of three acoustic-suspension systems. The EV One is a thin-line system with a 10-inch woofer. The EV Two and Four share the same 12-inch woofer and the same cabinet. The Four has a mid-range speaker as well as a compression horn-loaded tweeter; the Two has the woofer and tweeter only. The Four is priced at $134, the Two at $106; and both are available in kit form for $94 and $80, respectively. The low- and high-end response are virtually identical; the difference is largely in the mid-range.

The response of the Two's we tested is smooth and virtually free of distortion at moderate levels down to about 40 cycles. They go considerably lower, though doubling distortion is noticeable below 40 cycles (on sine waves but not on music). The middle and high end seem more assertive than in the AR's

SPECIFICATIONS
(All specifications are the manufacturer's)

Type of system:	2-way, shelf-size, acoustic suspension
Speakers:	12-inch cone woofer; ring-diaphragm compression-loaded horn tweeter
Frequency response:	30 to 15,000 cycles
Crossover:	800 cycles
Rated impedance:	8 ohms
Power capacity:	30 watts
Size:	14 x 25 x 13½ inches
Finish:	Choice of wood veneers, finished 4 sides

Available in kit form, prefinished 4 sides.

and KLH's. This, and a more alive, less tautly damped bottom, are the features which most immediately distinguish this new line from the older acoustic suspension systems. The transient response is good though the sound is not as "dry" as in the AR's. This I suppose is in keeping with what is almost a traditional Electro-Voice emphasis on vibrancy and liveness of tone, and offers an overall sound quality intermediate between that of the older acoustic-suspension systems and that of typical bass-reflex or ducted-port types. It should appeal to many.

Instead of a continuously variable pad for controlling the balance between woofer and tweeter, these speakers have a slide switch that provides three high-end curves. Middle position is flat, and the other two offer a boost or drop from 2,000 to 5 db at 20,000 cycles. This seems to me a sensible simplification. Actually this is about as close as most people ever come to balance and assures a more uniform response from the pair than usually achieved with continuous controls. It offers much less opportunity for misadjustment.

The Two's are not small. They are slightly larger than AR-3's — 14 x 25 x 13½ inches. They weigh about 40 pounds apiece. Their design is simple and tasteful, and they can be used either vertically or horizontally. The name plate can be rotated accordingly.

In brief, the EV Two's produce a quite spectacular sound, with a big low-down bass, sharp and rather assertive high end and an overall tone quality that is the best, to my ears, that Electro-Voice has yet produced.—*Joseph Marshall*

The answers to

WHAT'S YOUR

Neon-bulb circuit

The purpose of the voltmeter is to start the four neon lamps on a voltage lower than the combined firing voltage of four lamps. For several microseconds after the vtvm is connected across terminals A and B, the IR drop across both the ballast resistor and the voltmeter is low, and as a result, most of the supply voltage is applied to three lamps. This voltage level is above the combined firing voltage of three lamps and the lamps fire.

When the three unbridged lamps are lit, the rise in current produces an IR drop that exceeds 74 volts across the 10-megohm voltmeter resistance. This causes the bridged lamp to fire. After four lamps have fired, the maintaining voltage across each lamp is 59, and the IR drop across the ballast resistor is 30 volts. For practical purposes, the voltmeter reading is 59 volts. When the voltmeter is disconnected, the lamps will continue to glow and the total current will decrease by approximately 6 microamperes.

The Innocent Black Box

The black box contains a flashlight bulb. An ohmmeter allows a high circuit current of 50 to 80 ma (normally) for reading low ohms in the R × 1 range. This heats the lamp filament and the meter reads hot resistance. But in the R × 10 range, current is very low and meter reads almost cold resistance.

No-signal stinker

Only one possibility here. (Note that there is *no voltage drop* across those big plate resistors!) Grid voltage is zero, cathode voltage zero, so the tube isn't blocked. *The tube heater is not burning!* Since the tube is good, this is probably a socket trouble. This is a metal tube, so you wouldn't see it at first; you'd have to wait for it to get warm. Check: measure heater voltage on the ends of the base pins, not on the socket terminals.

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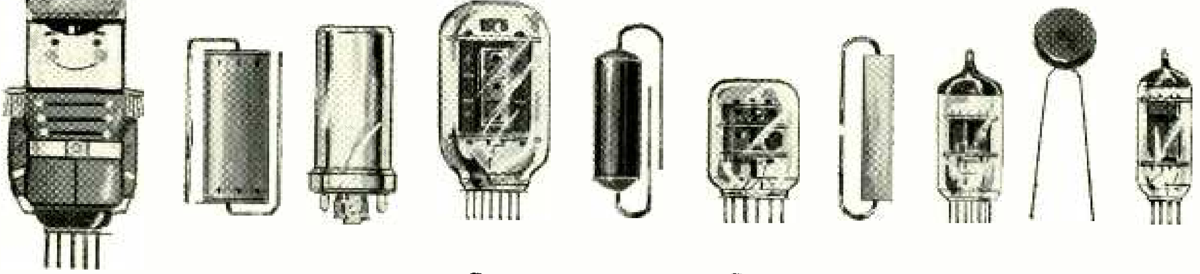
Ready for final inspection-



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SPECIFICATIONS—Test circuit: AC bridge, powered through special bridge transformer by an internal 60 cycle supply or by an external audio generator with 10 volts output. Upper frequency limit: 10 kc. **Capacitance, 4 ranges:** 10 uuf to .005 ufd; .001 ufd to .5 ufd; .1 ufd to 50 ufd; 20 ufd to 1000 ufd. **Capacitor leakage:** DC test voltages from 3 to 600 volts in 16 steps. **Resistance, 3 ranges:** 5 ohms to 5000 ohms; 500 ohms to 500 K ohms; 50 K ohms to 50 megohms. **Comparator circuit:** External standard R, L or C; Max. Ratio 25-1. **Power supply:** Transformer-operated, half-wave rectifier. **Power requirements:** 105-125 volts AC, 50/60 cycles, 30 watts. **Dimensions:** 9½" high x 6½" wide x 5" deep.

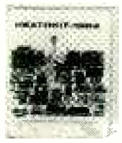
Kit IT-11 . . . 7 lbs. $29.95

Heathkit Mutual Conductance Tube Tester

• Finest tube tester value in the industry! • Provides complete and thorough tests of all tube types • Indicates Gm to 24,000 micromhos • Ultra-sensitive grid current test • Direct reading ohmmeter leakage test • Built-in switch-operated calibration circuit • Constant current heater supplies • Life test • Built-in adapter for compactron, nuvistor, novar & 10-pin miniature tube types • Tube data subscription service available.

SPECIFICATIONS—Power requirements—Voltage: 105-125, 60 cycle AC. **Watts:** 10-60 (dependent upon tube under test). **Plate supply:** (SILICON RECTIFIERS). **DC volts:** 26, 90, 135, 225 + variable 80 to 200 (Separate DC supply for space charge grids). **AC volts:** 20, 45, 177. **Bias supply:** (SILICON RECTIFIER). **Low range:** 0 to negative 5 volts DC. **High range:** 0 to negative 20 volts DC. **Signal voltages:** 2, 1, .5, .25 volts AC 5000 cycles. **Filament supply voltage:** .65, 1.1, 1.5, 2, 2.5, 3.3, 5, 6.3, 7.5, 10, 13, 20, 27.7, 35, 47, 70 and 115. Currents: 300, 450, 600 ma. (Note: Filament voltage is reduced 10% during life test). **Testing circuits Gm:** (Mutual conductance-amplifiers) 0-24,000 micromhos. **Emission:** Rectifiers and diodes. **Leakage:** Direct reading ohmmeter. **Grid current:** ¼ microampere sensitivity. **Voltage regulators:** Firing voltage and regulation tolerance. **Low power thyratrons:** Grid characteristics, conduction capabilities. **Eye tubes:** Control grid characteristics. **Meter AC:** 1000 ohms/volt (1 volt full scale). **DC:** 89 ma full scale. **Scales:** Gm: 0-3000 micromhos. VR test volts: 0-200 volts. Leakage: 0-10 megohms. Diodes O.K. Rectifiers O.K. Line check arrow at midscale. **Tube complement:** (1) 3A4 oscillator, (1) 12AV6 meter control. **Calibration circuit:** Built-in switch operated. **Socket accommodations:** 4-pin, 5-pin, 6-pin, 7-pin combination and pilot light, 5 & 7-pin nuvistor, 7-pin miniature, 7-pin sub-miniature, 8-pin sub-miniature, octal, loctal, 9-pin miniature, 9-pin, Novar, ten-pin miniature, 12-pin Compactron. **Line voltage adjustment:** Continuously variable. **Roll chart mechanism:** Constant tension, free rolling, thumbwheel operated, illuminated. **Dimensions:** Cabinet (outside): 17¾" W x 13½" H x 8½" D. **Panel and chassis:** 17" W x 12¾" H x 5½" D.

Kit TT-1A . . . 34 lbs. $149.95



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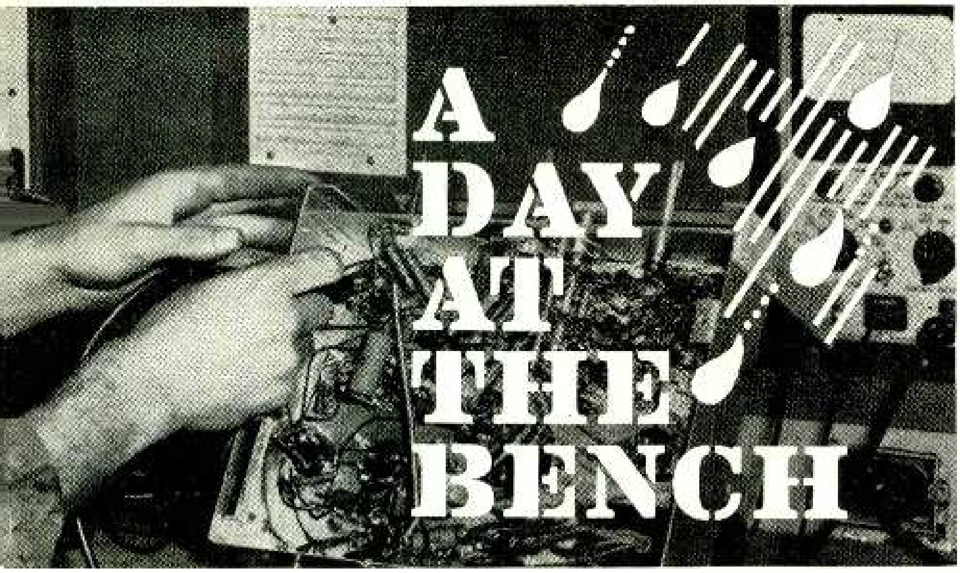

A DAY AT THE BENCH

Meanwhile, back at the shop...the rainy-day blues

By WARREN ROY

IT WAS A GOOD DAY FOR ANTENNA WORK—raining cats and dogs. But, fortunately, not a single antenna call was on the books. My partner Luke was making house calls—his week for them—and I was at the bench trying to put a dent in the conglomeration sitting there. My only real problem was to decide which set to hit first—the G-E whose vertical hold had drifted away, the RCA with horizontal pulling, the Crosley with a partially negative picture or the tape recorder with a frying noise.

Eeny, meeny, miney, mo, it was the Crosley, a model J-21TKMF. The job ticket showed that I had made the house call. Trouble was, all strong local stations produced a picture that was slightly or partially negative. Substituting tubes did no good, so the set was brought to the shop.

Plugged in, turned on and antenna hooked up, it showed the same symptoms as during the house call. Contrast and fine tuning had no effect on the negative. Yet, if I turned the agc control from side to side, I could eliminate the trouble on the affected channels, but then there would be no picture at all on the weaker stations. Obviously, the trouble was somewhere in the agc system.

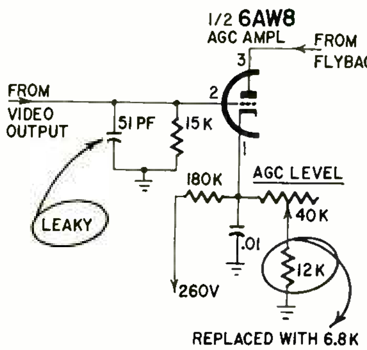

Fig. 1—"The fault had to be somewhere between the video amplifier plate and the agc amplifier grid."

A check with the scope at the agc amplifier grid showed that not enough video was getting through, yet the video amplifier was delivering. The fault had to be somewhere between the video amplifier plate and the agc amplifier grid. It was, after a half hour of lifting capacitors, a leaky 51-pf ceramic (Fig. 1). I replaced it and discovered a new problem. I couldn't get anything but snowy pictures on all channels. No matter how the AGC LEVEL control was adjusted, still snow.

A careful check showed no other fault in the circuit but, if a bias box was connected to the agc line, a normal picture would appear. At this point, I got the notion that perhaps the AGC LEVEL control wasn't giving me enough range. To check this, I temporarily jumped the 12,000-ohm resistor in series with the control. Now I could set the control for a good picture on all channels. For safety's sake, I replaced the 12,000-ohm unit with a 6,800-ohm resistor. Now a normal picture could be tuned in on any channel.

Well, now that this one was out of the way it was time to check the horizontal pulling in the RCA. In the meantime, I left the Crosley running, just to make sure nothing else went wrong. Then just before shutting down a bit later, I'd touch up the linearity and height, check the focus and wipe off the kine faceplate.

RCA 700 series color set

So it's down the bench to the next one . . . This too looked like agc trouble: horizontal pulling here and there, noticeable enough to disturb any normal viewer. The bias box came out again for a quick check. Disable the agc, hook in the box. No change. So it really is horizontal pulling, after all.

Over came the scope. And there was the clue: hash at the horizontal oscillator grid. Tracing back down the line, it was coming through from the sync output, but how? The only thing along the line is an 82-pf ceramic, C611 (Fig. 2). It being on a printed-circuit board, it was easier to lift out the whole capacitor than just one end. The capacitor tester said the C611 was good, but since I already had it out, I replaced it with a new one anyway. Good thing I did, too. Once the new cap was in place, the horizontal pulling was gone. It took a bit of careful checking to find out why—slight leakage in the old capacitor that the checker didn't reveal—but at least I knew that, when that set went back, it wouldn't give the same trouble again.

Lunch time. But before I broke, I went back to the Crosley, noted it was still going strong, tuned it up, turned it off and moved it over to the outgoing shelf. Luke would return it tomorrow.

Tape recorder fun

After lunch it looked like a chance for a little entertainment. I'd get to listen to a jazz tape or two while testing that RCA 7-TRC tape recorder. Customer brought this one. It's supposed to be portable, but weighs about 60 pounds (tons?). The trouble was a kind of frying noise when playing prerecorded tapes. After playing one of Duke Ellington's latest, I was sure it was in the machine and not on the tape. Off for the scope again, in what turned out to be a vain attempt to track down the hash.

It was everywhere in the playback circuit and nothing would reveal the source. Finally, I hooked up a little audio amplifier we keep around the shop and connected a length of shielded cable, with a loop of hookup wire at one end, to the amplifier. Moving the loop around near the recorder revealed the same hash coming through my amplifier. A little searching around showed the noise was loudest when the pickup coil was close to the NORMAL level indicator lamp in the recorder. A new lamp stopped the frying. What the old lamp was doing to cause this noise I'll never know, but it was doing a real good job. I played the other side of Duke Ellington and decided it sounded much better without the frying. Called the recorder

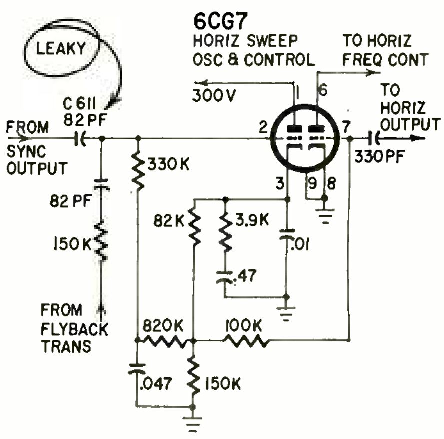

Fig. 2—"The only thing along the line is an 82-pf ceramic . . ."

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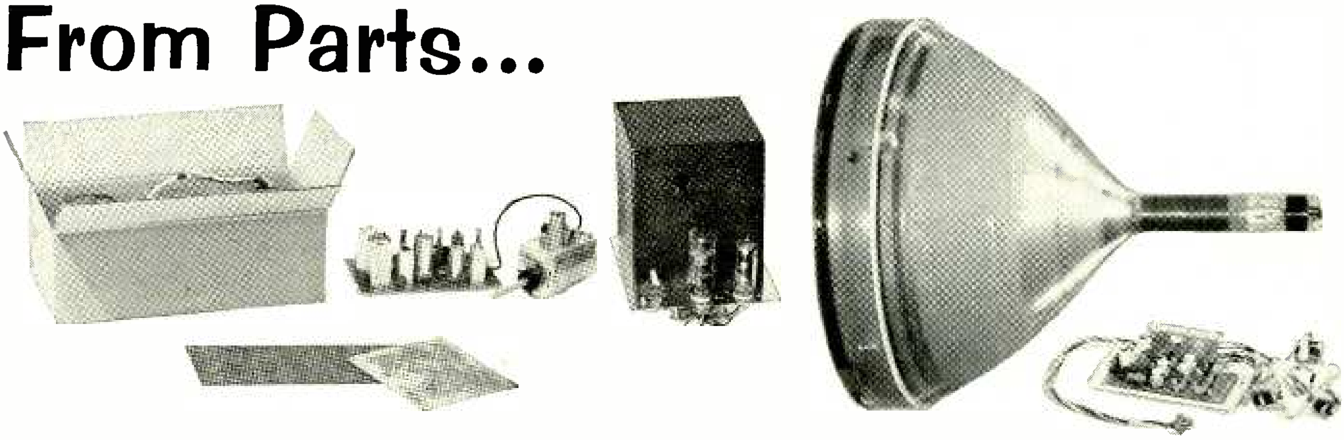
From Parts...



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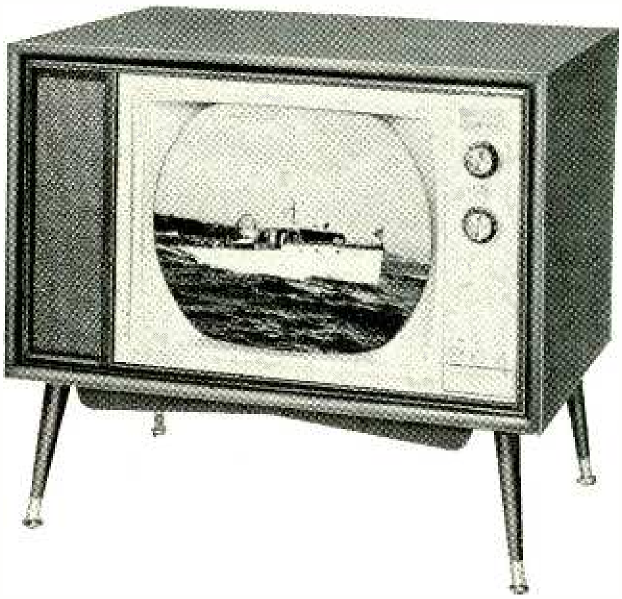

Heathkit High Fidelity Color TV For As Low As $349

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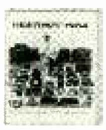
Compare these Heathkit features with others: • 27 tube, 8 diode circuit with optional UHF • High definition RCA 70° 21" color tube with anti-glare, bonded-face safety glass Automatic Color Control • Gated Automatic Gain Control for peak performance • 24,000 volt regulated picture power • Hi-Fi sound with outputs for speaker and hi-fi amplifier • Deluxe Nuvistor tuner with "push-to-tune" fine tuning for individual channels • 3-stage high gain video I. F. • Line thermistor for longer tube life and thermal circuit breaker for component protection • Degaussing coil and built-in dot generator for perfect picture adjustments • • All critical circuits factory-built and tested • Can be custom mounted or installed in handsome walnut cabinet • One year warranty on picture tube, 90 days on parts.

Save On Maintenance Costs! In addition to the initial savings you realize by building this set yourself, you'll save on expensive repair bills too. The simple-to-follow Heathkit instruction manual contains circuit diagrams and a "Servicing Hints" section so you can easily make adjustments and replacements should it ever become necessary.

Versatile Installation! The chassis, tubes, and front panel of the Heathkit Color TV can be mounted in the handsome GRA-53-1 walnut-finished hardboard cabinet. Or if you prefer, it can be mounted in a wall or custom cabinet, and the sound signals fed to an external amplifier unit. Required custom mounting space dimensions: 24-3/4"D x 22-1/4"H x 28"W. In this case the GRA-53-3 Custom Mounting Kit should be ordered to provide physical support between the chassis and front panel.

Optional UHF! An optional UHF tuner is available for coverage of channels 14 to 82.

Kit GR-53, chassis and tubes, 118 lbs. $349.00
GRA-53-1, walnut cabinet, 70 lbs. . . $49.00
GRA-53-2, opt. UHF tuner, 3 lbs. . . . $20.00
GRA-53-3, custom mounting kit, 10 lbs. $4.00



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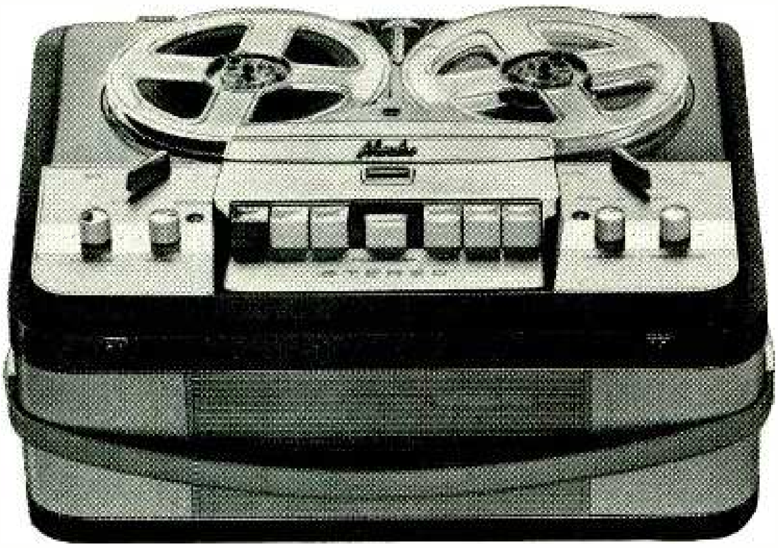
all signal no noise



The most noise-free recordings you have ever heard are to be made on the new all-transistorized Norelco Continental '401' Stereo Tape Recorder, the only recorder using the newly developed AC 107 transistors in its two preamplifiers. The only transistor specifically designed for magnetic tape head preamplifiers, the AC 107 utilizes specially purified germanium to achieve the extraordinary low noise figure of 3 db, measured over the entire audio band (rather than the usual single frequency). This noise figure remains stable over large collector-emitter voltage swings and despite large variations in source resistance.

Hear the new transistorized Norelco Continental '401' • 4-track stereo/mono record and playback • 4 speeds: 7½, 3¾, 1⅞ and the new 4th speed of 15/16 ips which provides 32 hours of recording on a single 7" reel • fully self-contained with dynamic stereo microphone, two speakers (one in the removable cover for stereo separation), dual preamps and dual recording and playback amplifiers • self-contained PA system • mixing facilities • can also play through external hi-fi system • multiplay facilities.

SPECIFICATIONS: Frequency response: 60-16,000 cps at 7½ ips. Head gap: 0.00012". Signal-to-noise ratio: better than −48 db. Wow and flutter: less than 0.14% at 7½ ips. Recording level indicator: one-meter type. Program indicator: built-in, 4-digit adjustable. Inputs: for stereo microphone (1 two-channel); for phono, radio or tuner (2). Foot pedal facilities (1). Outputs: for external speakers (2), for external amplifiers (1 two-channel); headphone (1). Recording standby. Transistor complement: AC 107 (4), OC 75 (6), OC 74 (2), OC 44 (2), 2N1314 (2), OC 79 (1). Line voltage: 117 volts AC at 60 cycles. Power consumption: 65 watts. Dimensions: 18½"x 15"x 10". Weight: 38 lbs. Accessories: Monitoring headset and dual microphone adapter.

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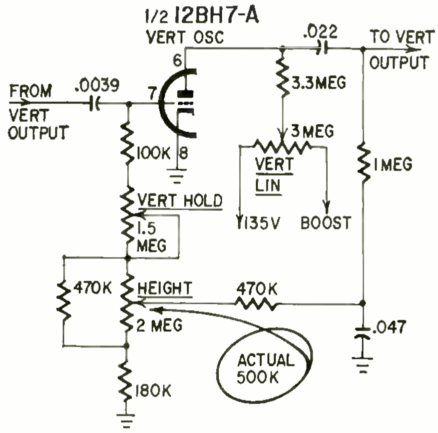

Fig. 3—"Sure enough, it was no longer 2 megohms like it was supposed to be..."

owner, telling him he could come and pick up the machine any convenient time.

Vertical hold next

With pleasure out of the way (for today, anyway) it was time to get to the G-E 14T007 portable with the bad vertical hold. The customer's report showed that it started to go bad some two months back, but he could correct it with the vertical hold control. But now, nothing would help. Adjusting vertical hold would slow down the rolling but wouldn't stop it.

With the set running, the roll was obvious, but I noted as each picture went by it seemed a bit stretched toward the top. As I adjusted the height control, the rolling stopped, but the picture was badly distorted.

The drifting-off report from the customer convinced me that something in the vertical circuit had changed in value so instead of reaching for the scope I went to the ohmmeter. Fifteen minutes of resistance checks didn't turn up a thing, until I remembered that height control. Sure enough, when the variable resistor was removed (Fig. 3), it was not the 2 megohms it was supposed to be, but about 500,000 ohms. In series with the vertical hold control, it altered the vertical frequency enough to throw vertical sync so far off that the hold control couldn't keep the picture still.

A new control from the parts shelf, and the set was working like a dream.

Now I had everything back under control, so I thought I'd sit back a while and wait for Luke to return with the day's new batch of shop work. So I sat back and tuned in a soap opera. Right then the picture disappeared behind a curtain of snow. Checked the antenna and tuner, nothing wrong. Glanced over at another set on the bench and discovered it too showed a snow storm.

"I guess you just can't escape it," I muttered to myself. "It's a day for antenna work after all—on my own!" END

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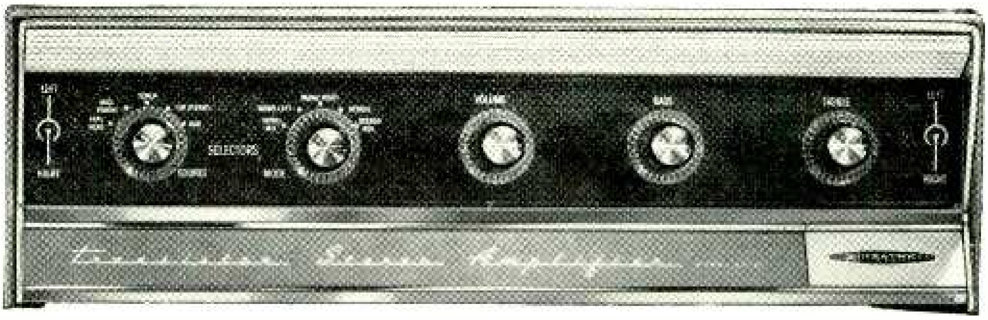
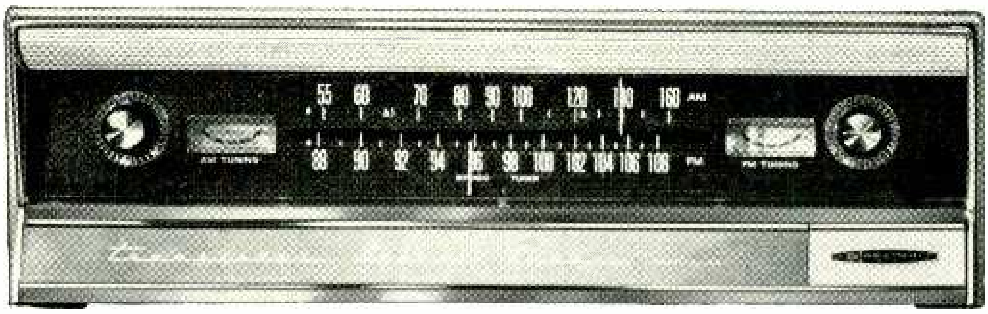
TAKE Heathkit's Deluxe Transistor Stereo Amplifier



ADD the Deluxe Transistor AM-FM Stereo Tuner



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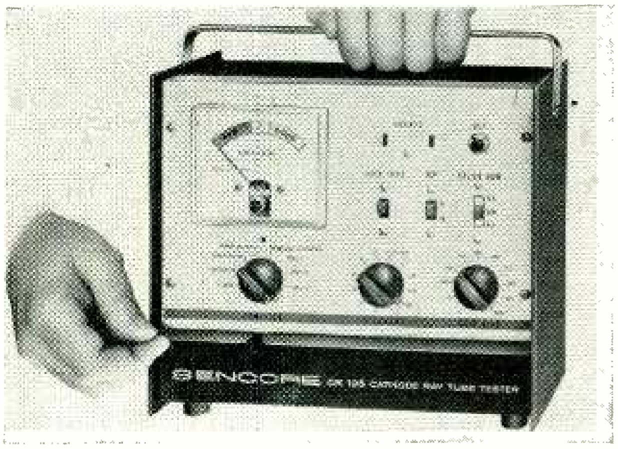


◀ **Sencore CR-125**

International Crystal C-12B ▶

Flexible Pix-Tube Tester
and
CB Frequency Meter

THE "POPULATION EXPLOSION" IN PICture-tube types has demanded greater flexibility in picture-tube testers. Instead of the fixed voltages of the first CRT testers, the modern instrument must have as many variables as a standard tube tester. The Sencore CR-125 is a good example.

Heater voltages are variable from 1 to 12 in 1-volt steps, with a COLOR setting at 6.3 volts. G2 voltage can be set at 50 volts for the "low-G2" tubes, or 350 for the others. This is a necessity, since too much voltage on this element can damage a good tube! Variable grid bias checks the cutoff point on a tube and also checks open control grids. Shorts tests are made with the usual neon lamps. The three guns of a color tube may be tested separately.

The "rejuvenation" circuit, the technician's best frend in public relations, has some novel features. A three-step switch selects either normal, slightly higher or still higher heater voltage: for instance, 6.3, 7.5 and 9.0. The "rejuvenation" voltage is applied by the discharge of a large capacitor; pushing the REJ button discharges this capacitor through the tube elements in the usual way. However, the button must be released to recharge the capacitor. This eliminates one possiblity of "overrejuvenation" or blowing out previously welded elements.

The voltage applied is regulated by the condition of the tube (its current drain, etc.).

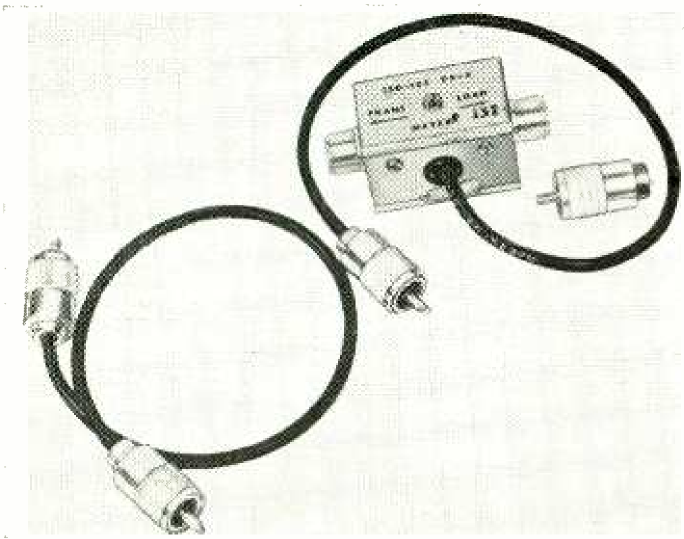
Six CRT sockets are provided, on a three-foot cable: one for all standard CRT bases, plus one for each "special" base connection. The large base for color tubes is there, and a socket for the proposed new color tube, a smaller one. The special bases are labeled and are a different color.

A setup chart gives all data on heater voltage, bias and G2 setting, plus the need for the special sockets. As new tubes are issued, new setup charts will be sent to all registered owners of the CR-125.

The socket cables and line cord stow handily in a snap-lid compartment in the case. A well written instruction book gives a lot of information, plus a parts list and schematic. Much information we like to know is included: the meter, for instance, is scaled in the usual "BAD–?–GOOD," but the book gives the actual beam current corresponding to each sector: 0–200 μa, BAD; 200–300 μa, ?; and above 300 μa, GOOD. The high end of the meter scale is deliberately suppressed to take care of the occasional tube that will read high. A 0–500-μa meter movement is used.

I tried this instrument on several tubes, including an ancient 21AXP22 color tube, and got very good results. Properly used, the CR-125 can be a valuable addition to your instrumentation, make a lot of friends and save a lot of time.

—Jack Darr



This pickoff box used on the C-12B is a vital component. Cable at left joins box to CB transmitter, connector at right contains dummy load. Cable fixed to box goes to C-12B.

International Crystal C-12B

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The C-12B is a portable frequency standard for servicing transmitters, trans-

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ceivers and receivers in the 27-mc Citizens band. It uses 23 crystals—one for each CB channel—as frequency standards with a frequency stability of .0025% from 32° to 125°F and .0015% from 50° to 100°F.

Transmitter frequencies are measured by beating them against the standard crystal for the channel being checked. A direct-reading counter (audio-frequency meter) shows the frequency difference in cycles and whether the transmitter's frequency is within tolerance.

Transmitter power output up to 5 watts can be measured with ±0.25-watt accuracy. An auxiliary circuit measures modulation percentage. A dummy load, an inductive type power takeoff attenuator box and connecting cables are supplied.

Operation

The C-12B is a relatively simple instrument and is easy to use. Here, a small amount of the transmitter's output signal is tapped off the PK (pickoff) box and fed into the frequency meter. In setting up, the first step is to test the self-contained batteries with the built-in voltmeter. The next step is to measure the transmitter's power output. (At least 1 watt output is needed for accurate modulation - percentage measurements and at least ½ watt is needed for accurate frequency measurements.) The C-12B becomes an rf voltmeter that measures the voltage across the dummy load when the RF LEVEL control is fully clockwise and the selector switch is at RF. Readings of 20, 40, 60 and 80 indicate power outputs of approximately 1, 2, 3 and 4 watts, respectively.

The signals from the transmitter and the 1L4 crystal oscillator are heterodyned in a crystal mixer. A low-pass filter removes the input and sum frequencies. The difference frequency is amplified and converted to a square-wave voltage that is rectified to produce a meter reading directly proportional to frequency. A reading of 1,300 cycles or less (the green area of the meter scale) indicates that the transmitter is within the required .005% tolerance.

A higher reading shows that the transmitter's crystal is beyond tolerance or that the oscillator must be retuned. To see if the transmitter's frequency is high or low, just press the HI–LOW switch. This shunts a capacitor across the standard crystal to shift its frequency a few hundred cycles. If the meter reading—and the beat note heard in the phones—rises, the transmitter frequency is high. The note and meter reading fall if it is low.

Checking modulation

Before checking modulation percentage, establish a carrier reference by adjusting the RF LEVEL control so the meter reads 20. Then, with the FUNCTION selector set at MOD, speak into the mike and read modulation percentage directly from the meter. The modulation meter circuit is the conventional AM type that compares the peaks of the detected audio envelope with the preset carrier level.

Aligning receivers

When aligning the receiver's rf circuits, just advance the RF LEVEL control, turn on the C-12B and adjust the receiver's tuned circuits for maximum avc voltage.

The C-12B can be used to calibrate the shop's signal generator so it can be used as a source of modulated precision signals on the CB channels. Simply disconnect the dummy load and connect the generator's output terminals to the LOAD end of the PK box. (This connects the generator directly to the receiver's antenna terminals.)

After setting the C-12B and transceiver to the same channel, we depress the tester's power switch and tune the signal generator for zero beat in the set's speaker. The signal generator is now precisely tuned to the desired channel. We now release the tester's power switch and proceed to use the signal generator for receiver alignment.—*Robert F. Scott*

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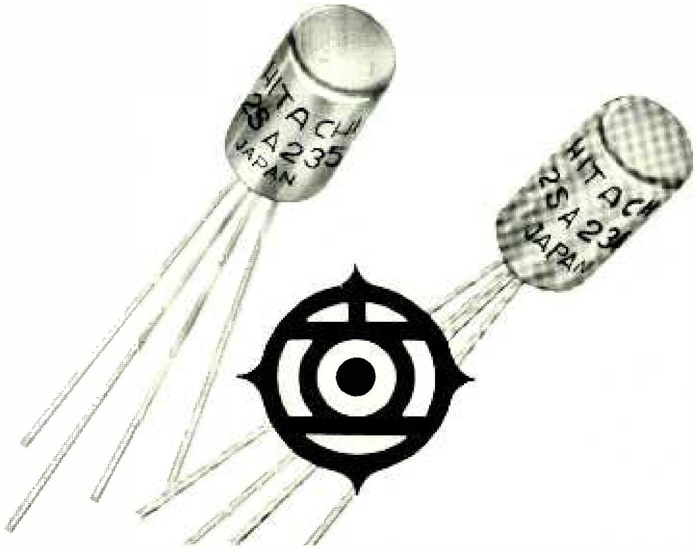

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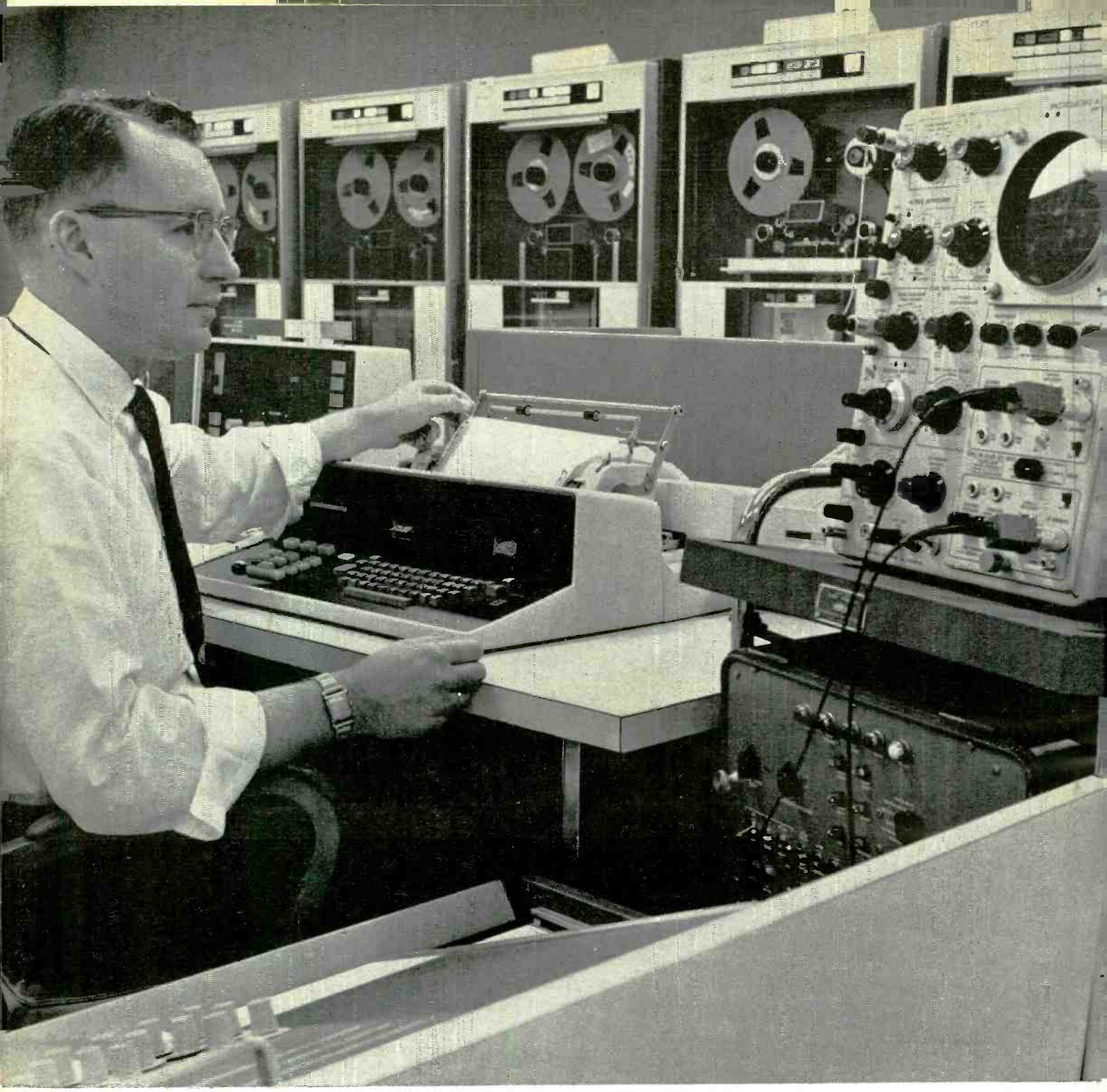

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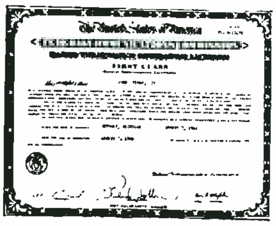

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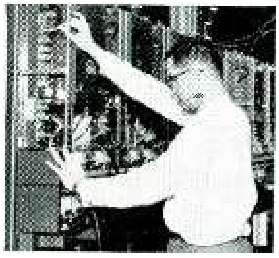

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NEW approach to transistor circuit design

By IRVING M. GOTTLIEB

A new and refreshing insight into transistor operation that simplifies circuit design and may well revolutionize transistor data charts

AFTER WE HAVE MORE OR LESS SUCCESSfully bridged the gap between basic tube and transistor operational theory from a practical point of view, we find that most technical literature, instead of being helpful, unnecessarily *widens* this gap. We are often reminded of the *similarities* between tubes and transistors as amplifying devices. Yet the literature formulates the relationships between transistor parameters with respect to the grounded-base (also called "common-base") circuit. This configuration is equivalent to a grounded-grid tube, though the most common transistor circuit—the grounded emitter—is the equivalent of the ordinary grounded-cathode tube amplifier. In both tube and transistor amplifiers, we are vitally interested in the voltage gain, yet we are told to deal with the transistor as a *current* amplifier. If we are still not convinced, we collide head-on with a monstrosity such as:

$$\text{Voltage gain} = \frac{-\alpha r_c R_L}{r_c[r_b + r_e(1 - \alpha)] + R_L(r_b + r_e)}$$

where

- α = short-circuit current multiplication factor for common-base circuit
- r_b = base resistance
- r_c = collector resistance
- r_e = emitter resistance
- R_L = load resistance.

(The minus sign indicates polarity reversal.)

Sadly enough, this is still an *approximation*, even if we could lay hold of the various elusive quantities contained in the equation. The temptation is overwhelming to ask, "Is this necessary?" Why not use g_m and $g_m \times R_L$ instead, as with vacuum tubes? Indeed, *why not?*

First, let us try to find out how we got into the present state of affairs. The first transistors were point-contact devices, and functioned most stably and predictably in the grounded-base circuit. Thus the grounded- (common-) base configuration was considered the "natural" one. The input diode, unlike a tube in class-A operation, *consumed current*. Accordingly, the transistor was thought of as "current-actuated." This notion was reinforced by the fact that the injected charge carriers constitute current flow.

Then, when the junction transistor made the common-emitter circuit popular, the *current*-transference property was retained as the figure of merit of transistor action. An effort was made to reconcile tube and transistor design with the "duality" theory. In this concept, which depends on currents in transistors being equated to voltages across tubes, a parallel network for tubes, for example, would be dealt with in terms of an equivalent series circuit for transistors. Inductors for the one would become capacitors for the other, and so on. This approach does have mathematical validity. For most *practical* transistor applications, it becomes a complex patchwork, which attempts unsuccessfully to smooth the effects of a wrong turn made in the past.

A new trend of thought

We'll take a short pause while you object to our endeavor to treat the transistor like a tube. An oft-heard axiom is that in the transistor, the input current wave, rather than the input voltage wave, must represent the signal information. That is, to obtain an amplified voltage sine wave across the output load resistance, we must apply a *current* sine wave to the input circuit.

Let us imagine the transistor is *new* to us, and that we follow our intuition and think in terms of *voltage* gain. First, the circuit designer must part company with the physicist, in connection with the "current" approach. Rather than think of *injecting a current into* the base–emitter diode, let us consider that we *impress a voltage across* the base-emitter diode.

This is sound reasoning, for the transit of the charge carriers (current flow) in a forward-biased p-n diode is *caused* by an electric field. The current flowing through the base–emitter diode is due to, and governed by, the *voltage*

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impressed across the terminals of this diode.

In *practical* junction transistors connected in the grounded- (common-) emitter circuit, there is considerable departure from the assumed linear-output (or load-voltage) vs input-current curve. Even if this ideal relationship were exhibited by practical transistors, it would still be a permissible approximation to deal with input voltage. This is because the input-current vs input-voltage curve *is substantially straight for values above the onset of conduction* (Fig. 1).

The transistor is reminiscent of a tube operating in the positive control-grid region. Let's retain the same approach we would use with such a tube: *A signal voltage is impressed at the input. What is the value of the amplified signal voltage developed across the load resistance?*

Generally, the approach advocated in this article yields very satisfactory results. The more rigorous design approach (current input) is often frustrated by complex variables difficult to cope with, or nonprecise data. For example, such transistor parameters as r_e, r_b, alpha (and therefore beta) vary with operating point and temperature. Manufacturer's tolerances are generally quite sloppy, as compared with tube specifications, so circuit design by the classical formulas frequently requires a pretty healthy admixture of cut-and-try. I find that the transconductance method is most often quicker and better.

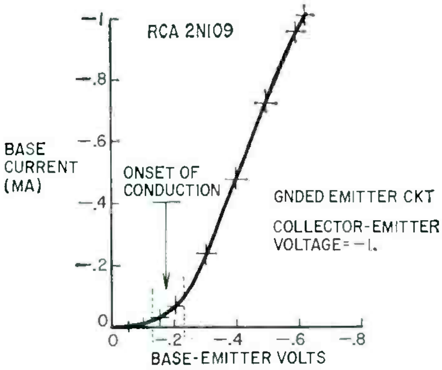

Fig. 1—Base current versus base-emitter voltage for a 2N109. Note near linearity of curve above onset of conduction.

Why not use g_m?

The concept of transconductance is as applicable to the transistor as to the tube. Transconductance is a transfer function which defines the ratio of a change in output current to a small change in input voltage, while the voltage on the output electrode is maintained constant during the measurement. Thus we see that the higher the transconductance of an amplifying device, the greater the control of output

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current exerted by the grid, base or other control element.

It is a simple matter to insert a load resistance in the output circuit of an amplifier so that the current variations appear as voltage variations of greater amplitude than those applied to the input circuit. All this, of course, is "old hat," but it is important to recognize the universality of the transconductance parameter. Transconductance is readily derived from a simple procedure.

Let us connect a transistor as in Fig. 2. Although a p-n-p type is shown, the basic ideas apply to n-p-n transistors when you reverse the polarity of the bias supplies. The objective is to obtain data relating output current, I_c, to input voltage, E_{be} (or V_{be}). We then plot a curve as in Fig. 3. This is analogous to a curve relating plate current to grid voltage in a tube. As with a tube, the slope of this output vs input voltage curve indicates the value of transconductance (figure of merit). Generally, such curves are not absolutely straight, so the measurement of slope requires judgment, and must inevitably be an average or approximate value.

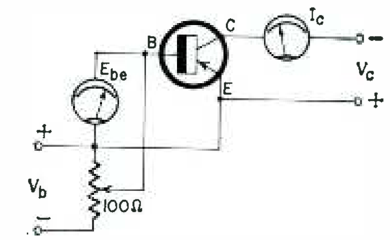

Fig. 2—Simple circuit for obtaining data for transconductance graph. For small transistors, V_b and V_c may be 1.5 and 4.5 volts, respectively.

We know that for reasonably distortionless class-A operation, the choice of operating point, output load resistance and maximum input-signal amplitude must be such that only the fairly linear portion of the transconductance curve is involved. This presents no great problem. For most germanium transistors, these curves rapidly approach a straight line once the base-emitter diode is biased in excess of one-tenth to several tenths of a volt. (In silicon transistors, the onset of conduction occurs at a slightly higher value.)

As with tubes, transconductance is now derived from the ratio of a change in output current to the small change in input voltage responsible for it. If these quantities are graphically scaled off in amps and volts, the ratio is dimensionally in *mhos*. If one or the other quantity is plotted in terms of *milli* or micro units, we must affix the appropriate multiplying factor before our transcon-

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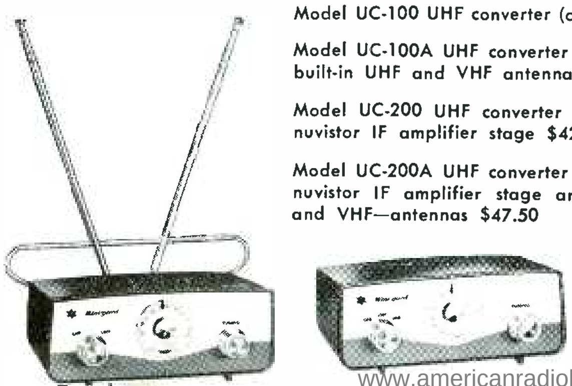

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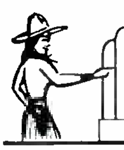

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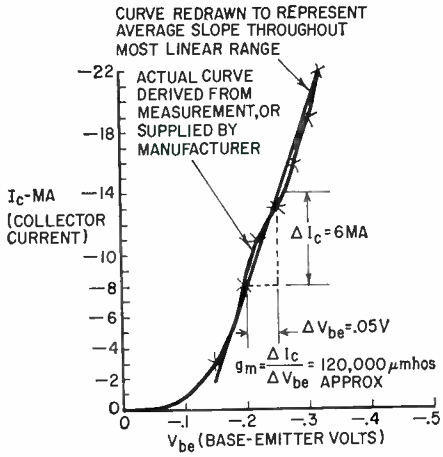

Fig. 3—Transconductance curve for a 2N109.

ductance value.

For example, if we find we are dividing a change of 10 ma by a change of 1/10 volt, our ratio is 100 millimhos, or 1/10 mho. As it is our prime objective to *emulate tube-design techniques,* we note that this ratio is also equivalent to 100,000 micromohos. (Incidentally, this is representative of typical cheap transistors, not "hot" units. High-power transistors have transconductance values on the order of several million micromhos.)

It is natural to wonder whether any correlation or mathematical relationship exists between the grounded-emitter current gain factor, beta, and transconductance. The answer is no; beta in itself *does not* inform us whether the transconductance is high or low. However, the quantity beta/input resistance is dimensionally a *conductance,* and correlates fairly well with transconductance derived from the graphical procedure previously outlined.

The input resistance here is the average over the excursion of the input-signal voltage wave. This relationship does not lend itself quite as well to practical designs, but does provide additional insight into the nature of transistor amplification. For example, knowing that this ratio correlates closely to the actual transconductance would lead us to postulate that power transistors (those with collector currents in the range of a number of amperes) could have higher values of transconductance than small-signal types. This, indeed, tends to be the case.

From theory to practice

From a practical standpoint, the use of transconductance in general, and the relationship voltage gain $= g_m \times R_L$ in particular, greatly facilitates comparison of *predicted* with *actual* performance. This is because instruments in common use for measuring signal levels indicate *voltage,* not current. Thus, the operation of an experimental or bread-

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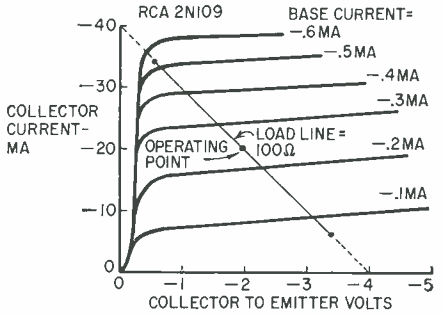

Fig. 4—Conventional method of showing transistor characteristics in common-emitter circuit. Unlike vacuum-tube practice, the family of "anode" (collector) curves is plotted against different input (base) currents.

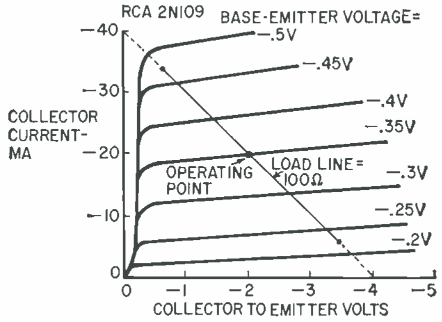

Fig. 5—Suggested method of showing transistor characteristics in common-emitter circuit. The collector curves are plotted against base-emitter voltages *instead of currents as in Fig. 4.*

board amplifier is quickly evaluated by connecting oscilloscopes or vtvm's to the input and output circuits. The accuracy of this method improves as load resistance R_L is made smaller. For a majority of small-signal applications R_L values up to several thousand ohms permit good results to be obtained.

To extend this approach further, we would like to see transistor manufacturers supply collector family curves with respect to input *voltage* rather than with respect to input current as is prevailing practice. In Figs. 4 and 5, we see the collector characteristics of an RCA 2N109 transistor displayed with input current and with input voltage as a variable parameter. Surprisingly, the load line in the latter instance traverses incremental collector curves which are quite evenly spaced. This indicates low distortion in class-A operation, provided we do not drive the transistor too close to zero collector current.

The author would be very grateful for comments and criticism pertaining to this admittedly "off-beat" analysis of transistor operation. In the meantime, give it a try and see if you don't agree that it deprives the transistor of a good deal of elusiveness! END

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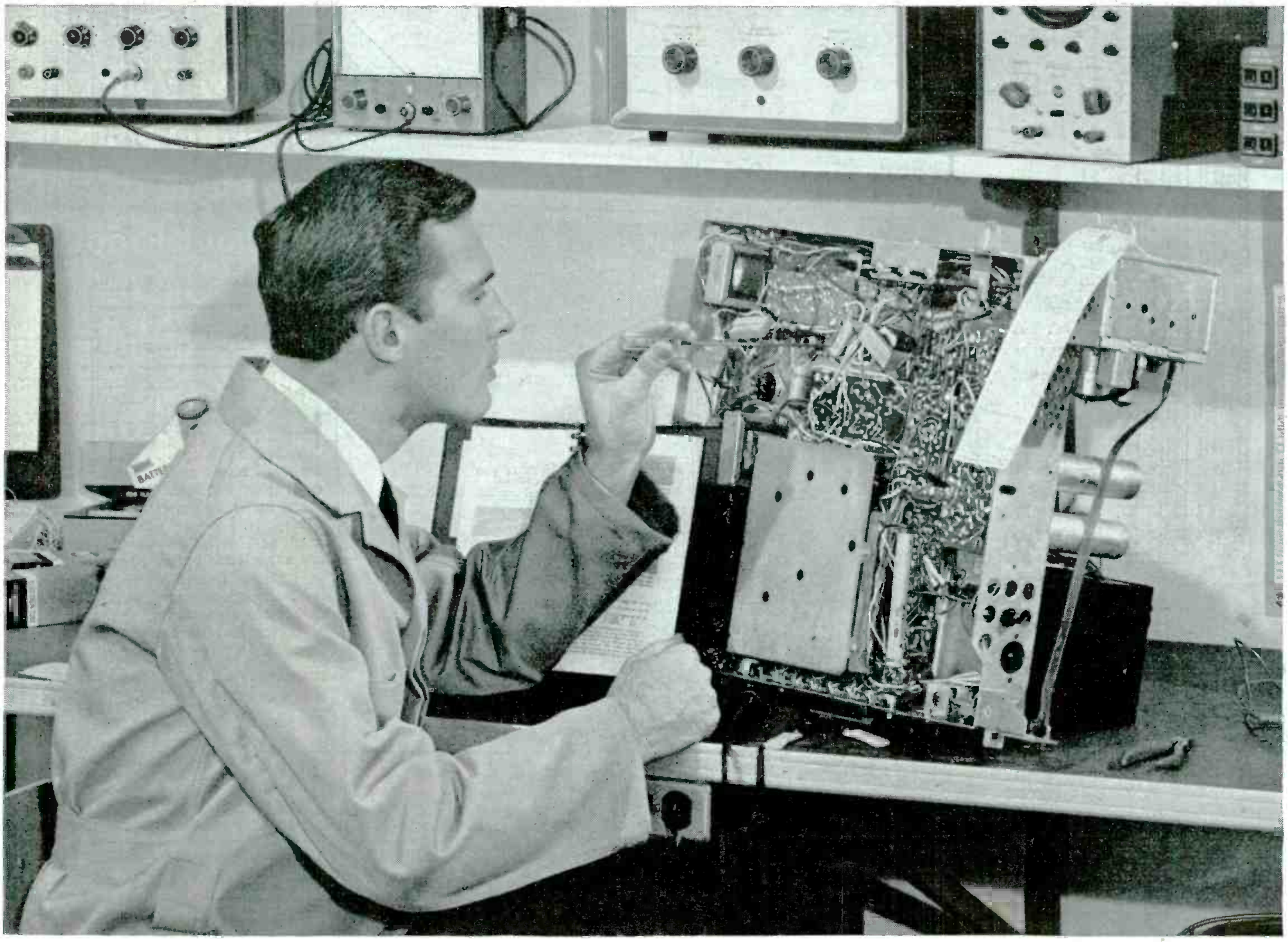

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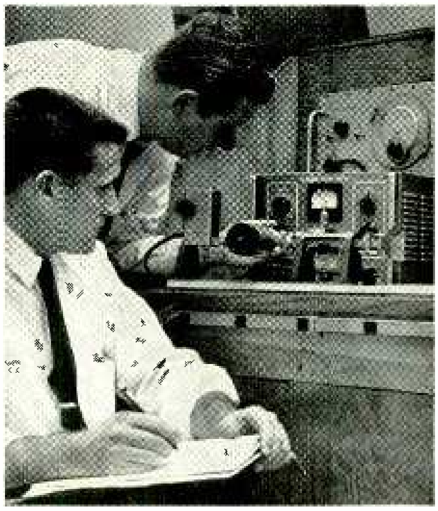

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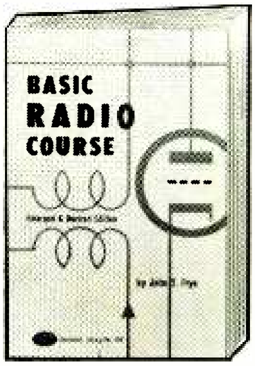

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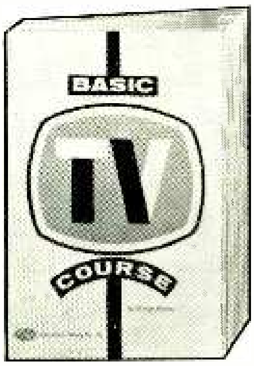

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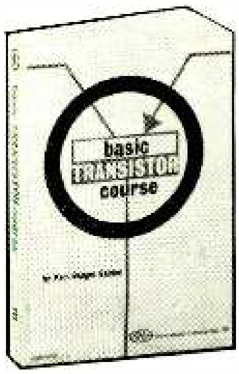

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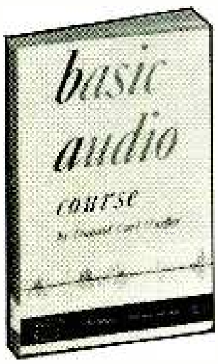

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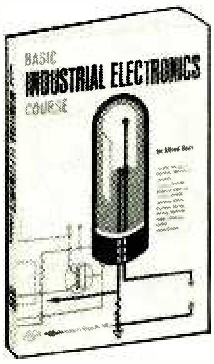

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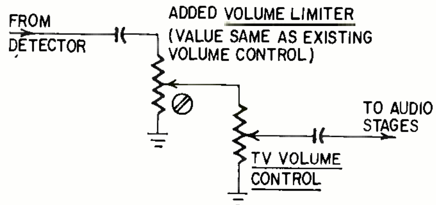
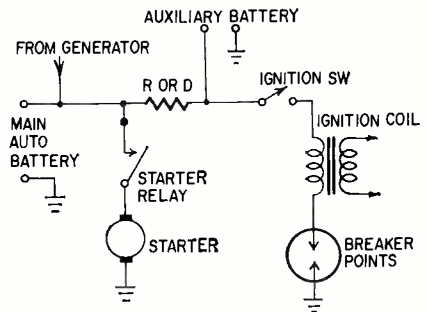


ume limiter. Once installed, turn set volume all the way up and adjust the volume limiter control, located where the kids can't get at it, to set the volume to the maximum level that will not disturb you. Now the volume cannot be turned up too far. For the volume limiter, use a pot with the same value as the existing volume control. Circuits of this type are commonly used in hotel and motel versions of standard TV.—*Warren Roy*

Re: Quick-Start Circuit

I enjoyed reading "Start Your Car Fast" (December 1962) and the related correspondence and ideas discussed in the February, April and August 1963



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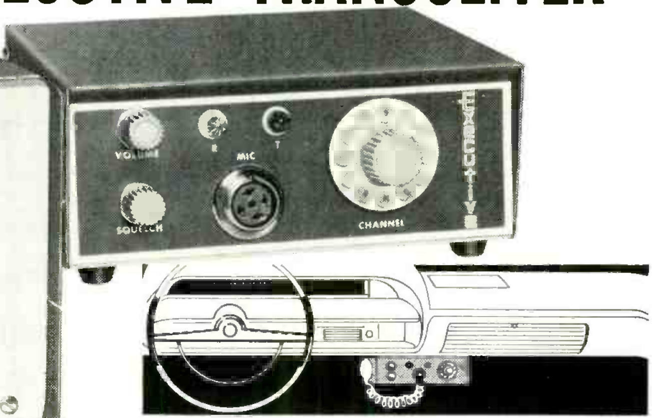

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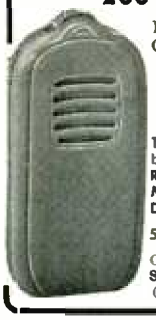

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so its terminal voltage is virtually unaffected. The auxiliary battery charges through the resistor.

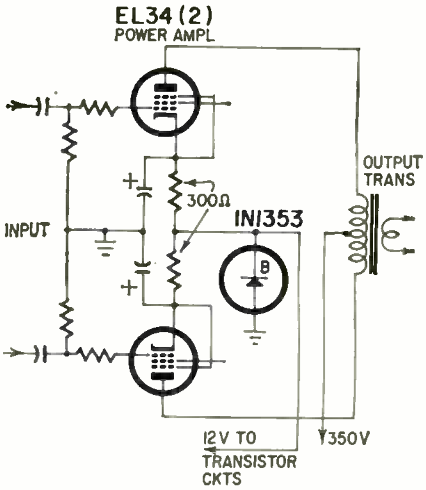
R can be replaced by a rectifier polarized so the auxiliary battery is kept charged and cannot discharge into the starter or the main battery.—*Robert C. Lovick*

Freeloading Transistor Power

Using something that would otherwise be wasted is the same as getting something for nothing. The diagram shows how the Spectran model 100 Spectrum Analyzer uses power ordinarily dissipated in the cathode resistor of the output amplifier to supply the transistorized portions of the analyzer.

The cathode resistor of a power amplifier is usually returned to ground. Here the return is made through a Zener diode. The diode voltage is less than the bias. The operating point of the output stage is maintained by using smaller cathode resistors.

Incorporate this idea in an audio

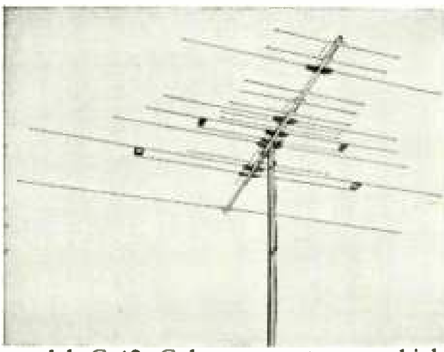


amplifier and you'll have a convenient source of operating voltage for a transistorized preamplifier. Use decoupling to prevent feedback.—*Karl E. Springer*

Correction

The photo of the tower-mounted TV antenna at the top of page 44 of the December issue was incorrectly credited to Winegard.

Here is a photo of the Winegard



model C-42 Colortron antenna which should have run in that position.

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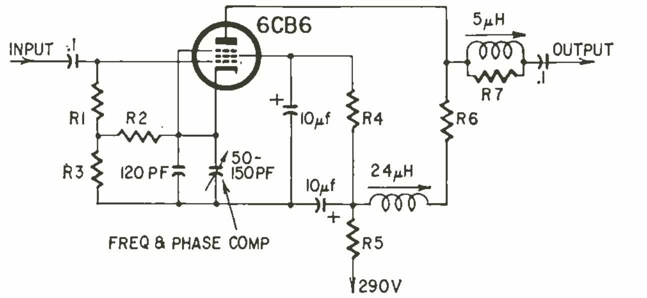
TECHNOTES

Improving Noisy CCTV Amplifiers

After several years of continuous service, even the best closed-circuit TV amplifier systems deteriorate. That's the time to see if you can improve on the original performance, not just restore it.

In many of the systems I've run across, I replaced a 6CB6 with an E180F (Mullard or equivalent). This special-purpose tube has a gold-plated grid and base pins, and a



transconductance of 16,000 μmhos with very low noise. The diagram shows a typical circuit.

To get best results, change several resistor values as shown in the table below. Even if the original tube isn't a 6CB6, or if the values in your circuits are different, the chart will be a guide.

	6CB6	E180F
R1	510,000 ohms	220,000 ohms
R2	150 ohms	150 ohms
R3	7,500 ohms	3,300 ohms
R4	3,000 ohms	2,200 ohms
R5	3,000 ohms	1,800 ohms
R6	1,500 ohms	750 ohms
R7	6,800 ohms	4,700 ohms

The same change makes a noticeable improvement in ordinary TV sets.—*B. C. Terrell*

[The E180F is available from Allied and other electronics supply houses.—*Editor*]

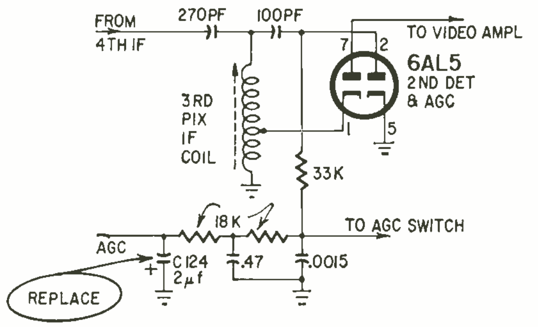
Zenith 19R20, etc.: Cogwheel

A severe cogwheel effect in the picture on one of these chassis at high or normal brightness, that disappears at low brightness settings, is caused by core saturation in the horizontal output transformer.

Replace the transformer to cure this.—*Jim Wilhelm*

RCA KCS45-49 Hint

Replacing the 2-μf agc filter capacitor (C124) has corrected many tricky and borderline conditions in these chassis.



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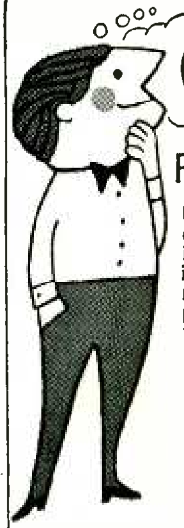

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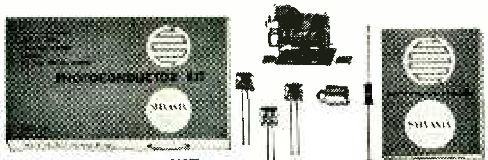

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In most sets, an S-shape weave in the picture has been corrected by changing that capacitor. So too has soft, unstable vertical hold. A dark, overloaded picture can be caused by a shorted C124. When open, it can be responsible for certain kinds of horizontal tearing.

I have recently made it standard operating practice to replace this capacitor in any set that still has the original.—*Charles B. Randall*

Wilcox-Gay Recordio R-804

Owners of this recorder may find a sudden loss of audio, heralded by smoke and the smell of a burning transformer. The fault is in the tiny F-4 silicon rectifier, which shorts out as a result of power-line surges. The little rectifier was probably used to save space, but isn't suitable for this job—the voltage is too high.

The remedy is to put a fuse in the ac line and replace the F-4 with a miniature 75-ma selenium rectifier. Because of space limitations, you will have to mount the new rectifier directly on the five-lug terminal strip.—*Robert E. Forschner*

Longer Battery Life for EICO 555/565 Vom's

If you use the resistance ranges on these meters frequently, the four penlight cells (size AA) will wear out in about a month. I replaced mine with a Mallory TR-146 mercury battery in series with a 100,000-ohm pot. The mercury battery has a much longer life than the zinc-carbon cells,

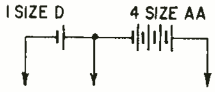


Fig. 1

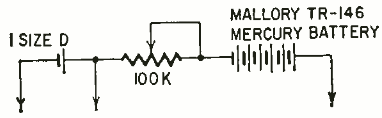


Fig. 2

and once its voltage does start to drop, the pot's resistance can be reduced to compensate.

You can find space inside the case for the battery and the pot. Fig. 1 shows the original circuit, and Fig. 2 the modification.—*Allan Glaser*

Philco Chassis TV-440

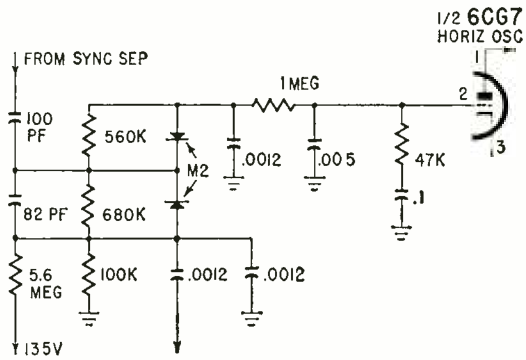
Complaint: Horizontal weave.

Solution: Pins 3, 6 and 7 of the afc tube (a 6AL5) are tied together on the printed-circuit board, and the foil conductor is grounded to the chassis through a metal screw. This screw tends to loosen slightly, giving a ground path of greater than zero ohms resistance. The 6AL5 heater supply then gets into the horizontal circuit.

Tighten the screw to prevent recurrence, or, better yet, solder a jumper to the chassis.—*Charles Andrews*

Hotpoint 14S202

Complaint: Plays a few minutes, then the raster leaves abruptly. Stability also affected by fine-tuning.



Cause: Dual selenium diode M2 (see diagram) becomes unbalanced. Change it, and be sure to use heat sink when soldering.—*William Porter* END

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___3S4	.75	___6CG8	.80	___8EB8	.94	___12SK7GT	.95
___3V4	.63	___6CL8	.79	___8FQ7	.56	___12SL7	.80
___4BQ7	1.01	___6CM7	.69	___9CL8	.79	___12SN7	.67
___4CS6	.61	___6CN7	.70	___11CY7	.75	___12SQ7GT	.91
___4DT6	.55	___6CQ8	.92	___12A4	.60	___12U7	.62
___4GM6	.60	___6CR6	.60	___12AB5	.60	___12V6	.63
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___5BK7	.86	___6CY5	.70	___12AF3	.73	___18FW6	.49
___5BQ7	1.01	___6CY7	.71	___12AF6	.67	___18FX6	.53
___5BR8	.83	___6DA4	.68	___12AJ6	.62	___18FY6	.50
___5CG8	.81	___6DE6	.61	___12AL5	.47	___19AU4	.87
___5CL8	.76	___6DG6	.62	___12AL8	.95	___19BG6	1.39
___5CQ8	.84	___6DJ8	1.21	___12AQ5	.60	___19EA8	.79
___5EA8	.80	___6DK6	.59	___12AT6	.50	___19T8	.85
___5EU8	.80	___6DN6	1.55	___12AT7	.76	___21EX6	1.49
___5J6	.72	___6DQ6	1.10	___12AU6	.51	___25AX4	.70
___5T8	.86	___6DT5	.81	___12AU7	.61	___25C5	.53
___5U4	.60	___6DT6	.53	___12AV6	.41	___25CA5	.59
___5U8	.84	___6DT8	.94	___12AV7	.82	___25CD6	1.52
___5V6	.56	___6EA8	.79	___12AX4	.67	___25CU6	1.11
___5X8	.82	___6EB5	.73	___12AX7	.63	___25DN6	1.42
___5Y3	.46	___6EB8	.94	___12AY7	1.44	___25EH5	.55
___6AB4	.46	___6EM5	.77	___12AZ7	.86	___25L6	.57
___6AC7	.96	___6EM7	.82	___12B4	.68	___25W4	.68
___6AF4	1.01	___6EU8	.79	___12BD6	.50	___32ET5	.55
___6AG5	.70	___6EV5	.75	___12BE6	.53	___35C5	.51
___6AH4	.81	___6EW6	.57	___12BF6	.60	___35L6	.60
___6AH6	1.10	___6EY6	.75	___12BH7	.77	___35W4	.42
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___6AM8	.78	___6GH8	.80	___12BQ6	1.16	___50B5	.69
___6AQ5	.53	___6GK5	.61	___12BR7	.74	___50C5	.53
___6AS5	.60	___6GK6	.79	___12BV7	.76	___50EH5	.55
___6AT6	.49	___6GN8	.94	___12BY7	.77	___50L6	.61
___6AT8	.86	___6H6	.58	___12BZ7	.86	___70L7	.97
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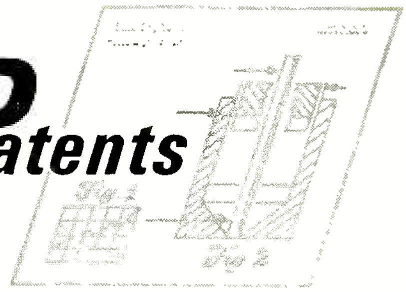
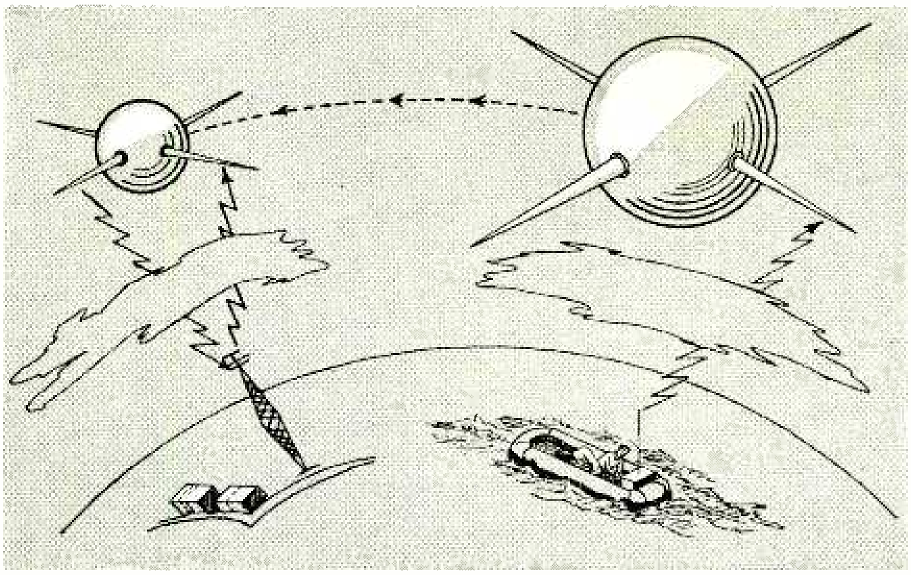


new Patents

Radiolocation by Satellite

PATENT No. 3,063,048

Frank W. Lehan, Glendale, and Glenn L. Brown, Los Angeles, Calif. (Assigned to Space-General Corp., Glendale, Calif.)



Shipwrecked survivors or lost nose cones can be quickly located with the aid of orbiting satellites. A constant-frequency signal, transmitted from a drifting lifeboat or other source, is recorded together with time markers generated in the satellite. Due to Doppler effect, the frequency undergoes maximum rate of change at the instant the satellite and the source are closest.

Later, the satellite passes over a receiving station and the signal is played back. The time markers show the exact instant when the frequency underwent its maximum rate of change. Calculation will disclose where the satellite was at that instant. This idea is in many ways simpler than earlier ones.

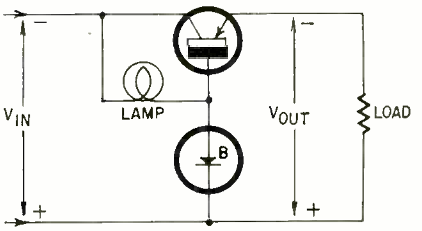
Improved Regulator

PATENT No. 3,099,790

Thomas G. Marshall, Jr., Franklin Park, N. J. (Assigned to RCA)

One common type of regulator uses a Zener diode in series with the base of a transistor (see diagram). Since the load voltage remains nearly equal to the diode voltage, the output is held constant. The transistor permits a larger current to be controlled than the Zener itself can handle.

Zener voltage, however, changes somewhat with diode current. This affects regulation. This invention utilizes a pilot lamp to maintain a steady current through the diode. Since the filament resistance rises with its temperature, the current tends to remain constant even when the input is varied over a small range.



The combination of lamp and diode improves the regulation.

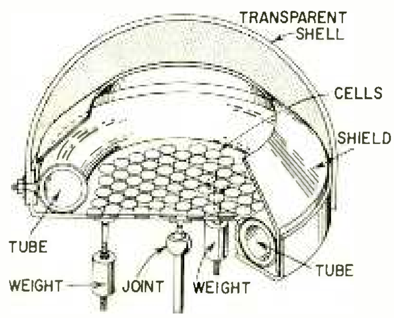
Self-Orienting Sun Battery

PATENT No. 2,993,125

Charles W. Geer and William W. Jacquish, Los Angeles, Calif. (Assigned to Hoffman Electronics Corp.)

The output of a solar cell is maximum when it faces the sun directly. This panel of cells is arranged to track the sun automatically. It is mounted on a joint which permits tilting in any direction. Weights can be raised or lowered to adjust the center of gravity of the device.

A transparent tube with an absorbent layer is filled with ether. A reflecting shield is placed above the tube. If the sun's rays arrive obliquely, only the far end of the tube is heated. The ether vaporizes, then condenses on the cooler side. This weights the panel to tilt toward the sun. The absorbent prevents the liquid from running to the low side. END



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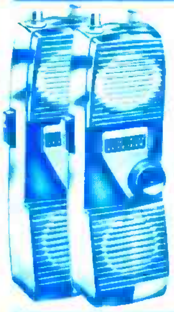

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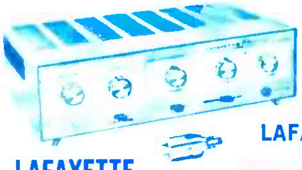

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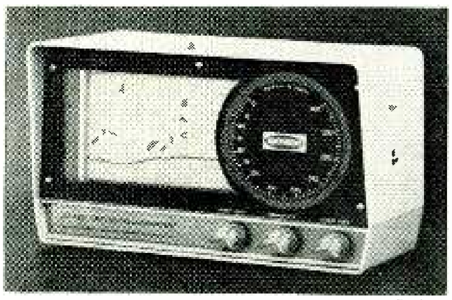
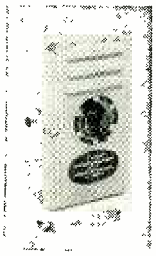


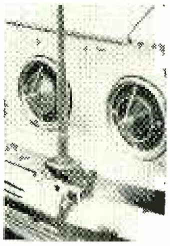
use same transducer used in *DE-122, DE-705A, DE-716* and *DE-718A*.—**Raytheon Co.**, Lexington 73, Mass.

BURGLAR ALARM FOR APARTMENT DWELLERS installs on inside of apartment door. No external wiring, no drilling through door, no exterior lock or key. 2 separate time-delay components permit occupants to leave or re-enter



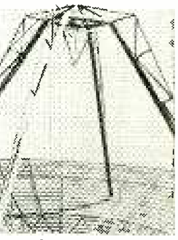
without sounding alarm. Time delay of 12–15 seconds after door opens cancelled by inserting proper key and turning to off. Alarm may then be reset to "Alert."—**Dadco,** PO Box 112, Hillside Manor Br., New Hyde Park, N. Y.

HEAVY-DUTY BUMPER MOUNT accepts all standard butt antennas with 3/8-24 threads. Bronze die-cast base with heavy chrome plating.



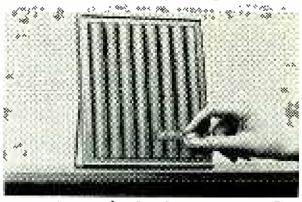
Stainless steel bracket adjusts to vertical position regardless of placement on bumper.—**Webster Mfg.**, 317 Roebling Road, S. San Francisco, Calif.

LOG PERIODIC UNIDIRECTIONAL ARRAYS. Trapezoidal, nonplanar feeds used with



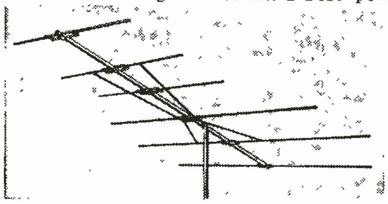
antenna or by themselves. Beamwidths changeable. *Model ALP-100:* frequency range 100 mc to 2,000 mc; gain 6 db; vswr less than 3:1. 3-db and 10-db beamwidths 70° and 125° respectively. Average power 100 watts. *Model BLP-100:* same as *ALP-100,* but covers frequency range from 1–7 kmc.—**Antenna Systems Inc.,** Grenier Field, Manchester, N. H.

INDOOR TV ANTENNA for color and black-and-white TV. Vhf, uhf and FM. Two separate antennas; electrically lengthened or short-



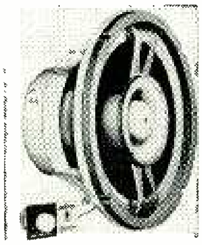
ened to match station's frequency.—**Gallo Electronics Corp.,** 12 Potter Ave., New Rochelle, N. Y.

ALL-CHANNEL YAGI TV ANTENNAS, *models DG600, DG620, DG700.* Separate Yagi sections for low and high vhf bands. *DG620* peaked



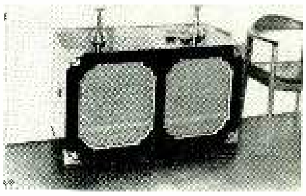
for extra gain on low band. *DG700* additional director.—**Clear Beam Antenna Corp.,** PO Box 471, Canoga Park, Calif.

UNITARY HI-FI SPEAKERS, *Sigma* series. 7 new 8- and 12-inch models: *SG-80,* dual 8-in. cone; *SG-84,* 2-way 8-in. coaxial; *SG-210,* 3-element



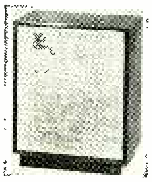
12-in. coaxial; *SG-88,* 8-in. coaxial with through-bore, horn-loaded compression tweeter; *SG-20,* 3-element 12-in. coaxial; *SG-222,* multi-cell 12-in. horn coaxial; *SG-223* (illus.), reflex horn coaxial.—**Jensen Mfg. Co.,** 6601 S. Laramie, Chicago.

MULTIPLE SPEAKER SYSTEM. 18-inch woofer with bass response to 16 cycles. Hartley 200MS, 10-inch unit, handles middle and high fre-



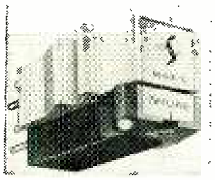
quencies. Crossover 400 cycles.—**Hartley Products Co.,** 519 E. 162 St., Bronx, N. Y.

CONSOLE SPEAKER SYSTEM uses pair of electrostatic radiators for treble; heavyweight



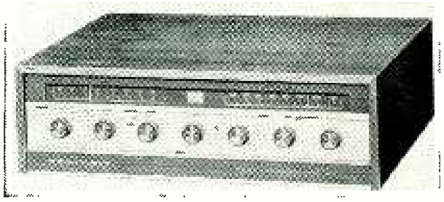
woofer with high-compliance cone. Response 30 to beyond 30,000 cycles per second.—**Neshaminy Electronic Corp.,** Furlong, Pa.

HI-FI CARTRIDGE, *model M44.* No-scratch, retractile stylus tracks at 15° vertical angle, proposed as RIAA standard and used by major record companies to cut records. Reduces IM and harmonic distortion 75 to 90% compared to earlier versions. Frequency response flat 20–20,000 cycles;



channel separation more than 25 db at 1,000 cycles.—**Shure Brothers Inc.,** 222 Hartrey Ave., Evanston, Ill.

ALL-TRANSISTOR, ALL-MODE STEREO RECEIVER, *model AR-13.* Solid-state circuitry, two 20-watt power ampliers, 2 separate preamplifiers, wide-band AM, FM and FM stereo tuner. Automatic switching to stereo plus stereo indicator light; 2 filtered tape recorder outputs, high-gain rf stage and high-Q rod antenna. Amplifier specs: power output per channel: 20 watts/8-ohm load, 13.5 watts/16-ohm load, 9 watts/4-ohm load. IHF



music power output: 33 watts/8-ohm load. Power response: ±1 db from 15 cycles to 30 kc rated output; ±3 db from 10 cycles to 60 kc rated output. Harmonic distortion below 1%. Channel separation: 40 db at 20 kc, 60 db at 1 kc.—**Heath Co.,** Benton Harbor, Mich.

STERECORDER, *Sony model 600,* 4-track stereo and mono recorder. Vertical or horizontal operation, mike and line mixing, source and tape monitoring. 2 VU meters, sound-with-sound, sound-

on-sound, separate monitor level controls. hysteresis-synchronous drive motor. 7½ and 3¾ ips. Frequency response 30–18,000 at 7½ ips; signal-to-noise 50 db; flutter and wow 0.17% or better at 7½ ips; bias frequency 100 kc; inputs: 2 high-level line, 2 mike or magnetic phono. Outputs: 2 600-ohm 8-db lines, 600-ohm binaural earphone monitor.—**Superscope Inc.,** Audio Electronics Div., 8150 Vineland Ave., Sun Valley, Calif.

TAPE RECORDER, *Retro-matic 220,* 2-speed quarter-track stereo recorder with 2-directional playback. Capstan between 2 playback heads so tape pulled over head in forward or reverse playback. Automatic reverse playback controlled by timed silence-sensing device to detect end of program. Amplifier 6 watts per channel, 20–25,000

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*They have been on demonstration as a system for several years at the AR Music Rooms, on the west balcony of Grand Central Terminal in New York City, and at 52 Brattle St., Cambridge, Mass. No sales are made there; you may ask questions if you like, but most people just come and listen.

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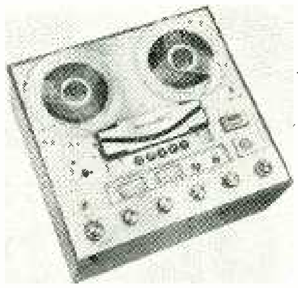
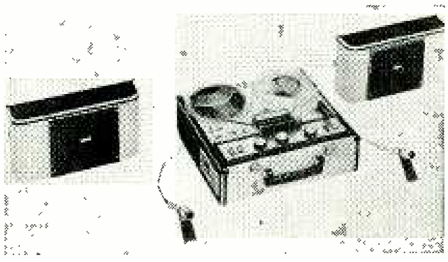


cycles response for record/playback at 7½ ips.—**Viking of Minneapolis, Inc.,** 9600 Aldrich Ave. So., Minneapolis, Minn. 55420.

4-TRACK STERECORDER, *model 200.* 2 mounted speakers in lid of carrying case for speaker separation up to 15 feet. 2 VU meters, separate record buttons, 4-track mono or sound-

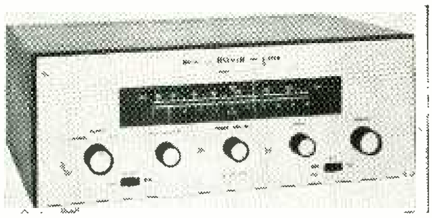


on-sound recordings, 2 speeds, digital tape counter. Power requirements: 70 watts, 110–117 volts ac, 60 cycles. Frequency response: 50–14,000 cycles at 7½ ips. Signal-to-noise ratio: 45 db. Inputs: 2 mike and 2 high level. 29 lb.—**Superscope Inc.,** 8150 Vineland Ave., Sun Valley, Calif.

ALL-BAND NUVISTOR PREAMP, 6 through 160 meters. Noise figures 1.5 to 3.4 db depending upon band. Gain exceeds 20 db. Panel contains

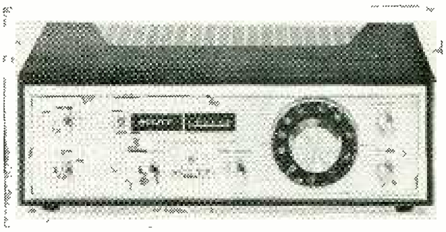
bandswitch, tuning capacitor and 3-position switch. Power requirements: 120 volts at 7 ma and 6.3 volts at 0.27 amp.—**Ameco Equipment Corp.,** 178 Herricks Rd., Mineola, N. Y.

FM TUNER-AMPLIFIER, *model 3102* for professional offices, markets, schools, office buildings and other places for background music from FM programs or phonograph records. Use any number of paging microphones. Remote switching



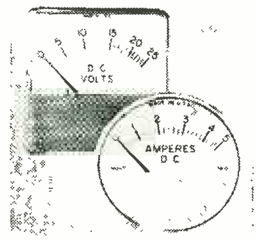
mutes music when mikes used. Amplifier output 15 watts at less than 2% distortion. Response flat 50–20,000 cycles. Output 4, 8, 16 ohms; 25- and 70-volt lines. Separate tuner, mike volume controls.—**Truetone Electronics Inc.,** 14660 Raymer St., Van Nuys, Calif.

TRANSISTOR AUTOMATIC FM MULTIPLEX TUNER, *model 4312.* Silver-plated, nuvistorized front end. Wide-band i.f. and detector stages. Usable sensitivity 1.9 μv (IHF); signal-to-noise ratio 65 db; harmonic distortion 0.5%, drift .0.2%; frequency response 20–20,000 cycles ±1 db. Capture ratio 2.0, selectivity over 35 db, spurious response rejection 85 db, audio hum (db below 1 volt) 66; AM suppression 60 db; separa-



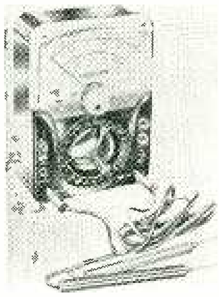
tion over 30 db.—**H. H. Scott Inc.,** Dept. P, 111 Powdermill Rd., Maynard, Mass.

PANEL METERS. *No. 740* (round) and *793M* (square). Anti-static-treated distortion-free



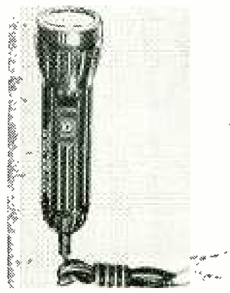
fronts. Milliameter, ammeter or voltmeter ranges.—**Hoyt Electrical Instrument Works Inc.,** 42 Carleton St., Cambridge 42, Mass.

30,000-OHMS-PER-VOLT MULTITESTER, *model TE-60.* 33-μa 4-in. meter with 2-color calibrations. Sensitivity 30,000 ohms per volts dc and 15,000 ohms per volt ac. 1% precision resistors



used for all multipliers. Full-scale ranges: dc volts: 0–0.25, 1, 2.5, 10, 25, 100, 250, 500, 1,000; ac volts: 0–2.5, 10, 25, 100, 250, 500, 1000; direct current: 0–.05, 5, 50, 500 ma, 0–12 amps; resistance: 60,000 ohms; 6 and 60 megohms; decibels: −20 to +56. 2 lbs.—**Lafayette Radio Electronics Corp.,** 111 Jericho Turnpike, Syosset, N. Y.

FLASHLIGHT WITH CONTINUITY TESTER, *No. 308CT.* Plug, clips and insulated leads for checking wiring, circuits, fuses, grounds, shorts,



opens, controls, switches and relays for appliances, radio, TV, tubes, lamps and bulbs.—**Union Carbide Corp.,** 270 Park Ave., New York, N. Y.

CATHODE REJUVENATION TESTER, *model 445.* Tests and rejuvenates all picture tubes

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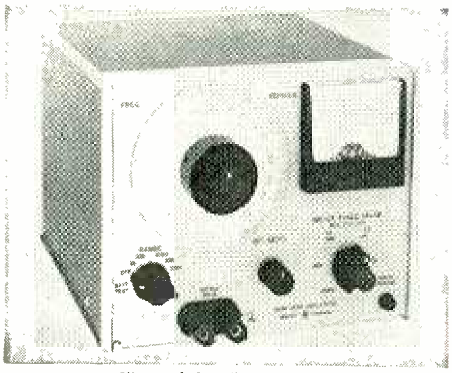
at correct filament voltage from 1 to 12, all Hi G-2 and Lo G-2 picture tubes, including tubes that require 30 volts, 110° tubes and 19- and 23-in. tubes, also color.—**B&K Manufacturing Co.,** 1801 W. Belle Plaine Ave., Chicago, Ill.

TEST OSCILLATORS. Metered outputs calibrated in either volts or dbm. *Model 208A:* monitor meter and output attenuator; 5-μv to 2.5-volt signals into 600 ohms. *Model 208A-DB:* meter and



attenuator calibrated in dbm, attenuator variable from 0 to 10 db in 1-db steps. Both oscillators' frequency range 5 cycles to 560 kc; frequency stability usually better than 5 parts in 10⁴; hum and noise less than .05% at maximum output; distortion less than 1%.—**Hewlett-Packard Co.,** 1501 Page Mill Rd., Palo Alto, Calif.

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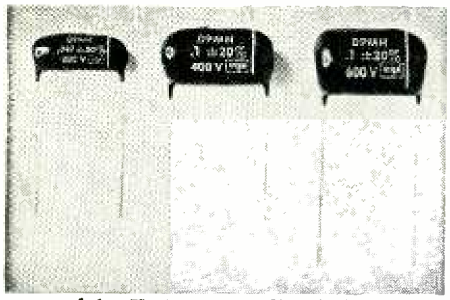
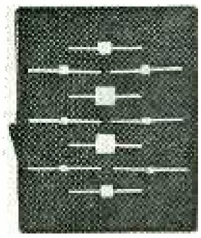


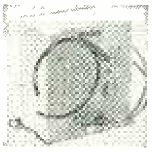
separated by Kraft-polyester-film dual dielectric. Sizes from 0.340 x 0.690 to 0.900 x 1.56 in. Capacitance range .001 to 0.47 μf at 200 to 600 wvdc. Radial leads for printed boards and point-to-point wiring.—**Cornell-Dubilier Electronics Div.,** 50 Paris St., Newark 1, N. J.

ULTRAMINIATURE CAPACITORS. Sample kit *USK-63:* four UY02's, two UY03's, two UY04's and two UY05's, with capacitance ranges between



5 and 2,000 pf. Glass encapsulated, ceramic-fixed. —**JFD Electronics Corp.,** 15 Ave. at 62 St., Brooklyn 19, N. Y.

FLYBACKS. Exact replacements for recent Westinghouse TV's. *Part No. HO-368,* exact replacement for 21 chassis and 90 models; *Part No.*



HO-369, 14 chassis and 73 models; *Part No. HO-370,* for 4 chassis and 28 models.—**Stancor Electronics Inc.,** 3501 Addison St., Chicago, Ill.

UNIVERSAL 2-WATT WIREWOUND CONTROL. *Model U39* shaftless potentiometer with contact arm grounded to housing. Fiber adapter plate furnished with each control. Resistance values from 5 to 5,000 ohms. Use as potentiometer or

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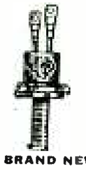

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200	1.95	2.75	3.45
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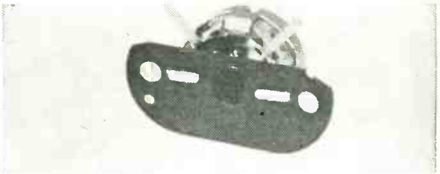

rheostat above-chassis or for printed-circuit mounting.—**Clarostat Mfg. Co. Inc.**, Dover, N. H.

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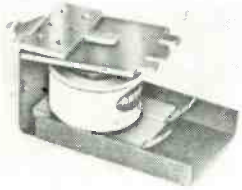

continuously at 10% above or 15% below rated voltage. Standard units for 10 and 15 amp.—**Artisan Electronics Corp.**, 171 Ridgedale Ave., Morristown, N. J.

CHARGE-RETAINING BATTERIES. Low standing loss. Linear, relatively flat voltage on discharge. Voltage practically linear between 2.12

and 1.95. Retains electrical characteristics during repetitive cycles.—**Electric Storage Battery Co.**, Wisco Div., 1222 18 St., Racine, Wis.

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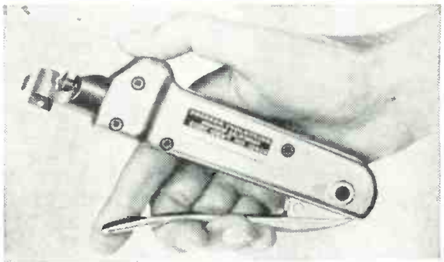

contacts. 2 heads for wire sizes 16 through 26. Ratchet mechanism will not release connector until crimp cycle complete.—**Prosser Industries Inc.**, 900 E. Ball Rd., Anaheim, Calif.

All specifications from manufacturers data.

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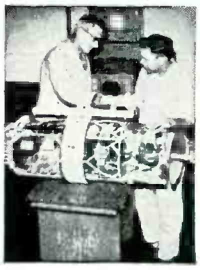

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Silicon Rectifier Standards

Late in 1963, the National Electrical Manufacturers Association (NEMA) published the first comprehensive standards for silicon rectifier diodes and stacks.

The standards are intended to clear up confusion in manufacturing and specifying diodes because of wide variations in testing and rating methods. The 65-page standards book (known officially as *NEMA–EIA Standards for Silicon Rectifier Diodes and Stacks*) sells for $5 a copy from NEMA, 155 E. 44 St., New York 10017.

The book contains standardized definitions, terminology, symbology, rating methods, physical configurations, as well as extensive supplementary material on military specifications.

technicians' News

Five Named to Calif. Radio-TV Repair Agency

Sacramento, Calif.—California Gov. Edmund Brown has named five members to serve 4-year terms on a new board aimed at curbing abuses in TV and radio repair.

The men are Keith V. Anderson, president of Handy Andy TV & Appliances; Earl C. Loughboro, Ventura; Mrs. Ruben E. Jimenez, Manhattan Beach; Miles J. Rubin, Los Angeles, and Thomas Schneider, Berkeley.

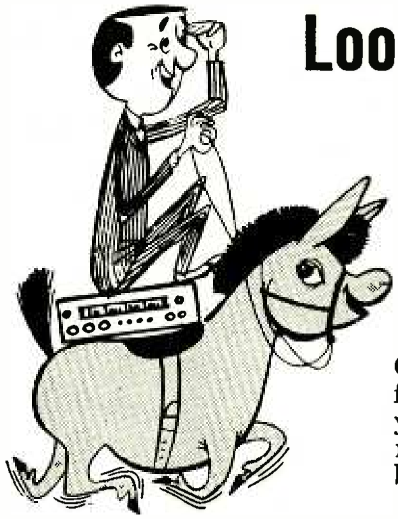
The new bureau was created in connection with the state licensing law, which requires registration of all persons engaged in electronic repair, and prohibits fraudulent repair and advertising practices.

Small-Business Subcommittee Hears TV Technicians' Story

Service technicians, reported Frank Moch, executive director of the National Alliance of Television & Electronic Service Associations (NATESA), follow a traditional formula in charging for services rendered. Approximately 60% of the total bill for a house call is for labor, 40% for service. Speaking before the distribution subcommittee of the House Select Committee on Small Business (Rep. James Roosevelt, chairman), Moch declared that there is a "gross fallacy" in this formula, and pointed out that legitimate markups on parts used, as is normal practice in other service trades, are "absolutely essential to survival of the servicer."

Moch quoted the Government's own statistic that TV–radio service people average less than $90 for a week that often runs as much as 86 hours.

The cause of this "continuing strangling of the very essential radio–TV service industry," Moch said, is rooted in the practice of certain wholesalers of selling at wholesale prices to the general public, thus putting themselves in competition with retail dealers and servicers. He quoted from two letters he received from the Federal Trade Commission and the Justice Department in answer to queries made "so we might know where we stand." The FTC cited two cases in



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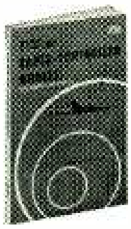
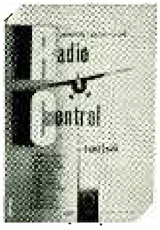


Fun with Radio-Controlled Models, by Edward L. Safford, Jr.
Simple projects for the beginner. Covers steering, motor and engine control, relays, escapements, installation.
No. 106 $3.20



Radio-Control Handbook (revised edition), by H. G. McEntee.
The standard handbook in this field – now with new info on servos, actuators, receivers, transmitters for remote control.
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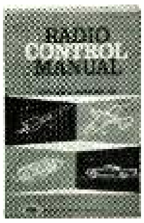

Radio-Control Manual, by E. L. Safford, Jr.
Step-by-step guide to the ultimate in R/C systems. How to start with basic system, advance to multi-channel system by adding components.
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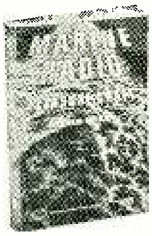

Marine Radio for Pleasure Craft, by Harold McKay.
Covers theory, operation, maintenance of marine radio–plus info on radar, depth, direction finders. Station list; FCC regulations.
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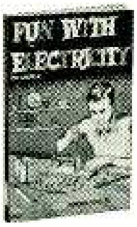

Fun with Electricity, by Thomas Kennedy, Jr.
From a spool-and-magnet motor to more complex voltmeters. Great way to start a youngster–or beginner of any age!
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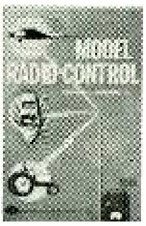

Model Radio-Control, by E. L. Safford, Jr.
Completely new and enlarged book explains theory and gives construction details for plane, auto, boat, remote controls.
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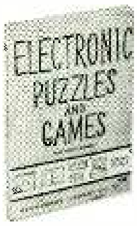

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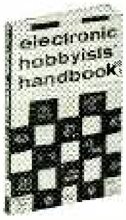

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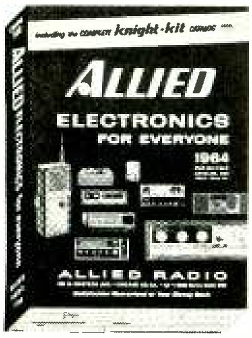

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which a wholesaler was defined as "one who sells to the trade for resale." Yet in a later communication, Moch pointed out, the FTC claimed that a wholesaler, selling direct to consumers at prices that his dealers cannot meet, "is simply making use of his lawful competitive advantage."

The result of such deals, Moch declared, is to make the servicer look like "a real crook when he asks for suggested list prices."

In closing, Moch said, "the proven successful system of specialization which made of this nation a merchandising marvel, cannot be sold down the river to the advantage of a few people with the buying power of many small businessmen."

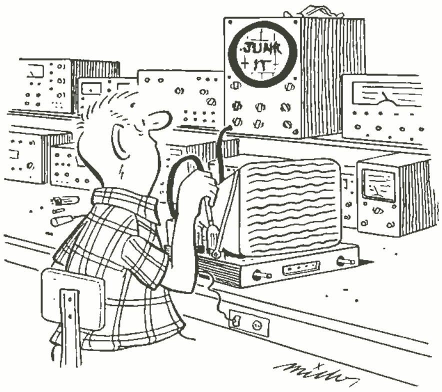
Manufacturers Move To Curb CATV

The *Hoosier Test Probe,* organ of the Indiana Electronic Service Association, reports a vigorous "common effort against the uncontrolled growth of community antenna systems throughout the country" being made by 12 leading antenna and accessories manufacturers. The organization formed for the purpose is called TAME: Television Accessory Manufacturers Institute. (The *E* is there apparently just to make a word out of the abbreviation.)

TAME is alarmed by the "great number [of cable TV systems] which are emerging in areas where good TV reception has been attainable for years with a properly designed TV antenna installation."

Conceived by Morton Leslie of JFD, George Gemberling of Alliance, Sam Schlussel of Channel Master, L. H. Finneburgh of the Finney Co. and Robert Fleming of Winegard, TAME will be a permanent organization with representation in Washington.

The group will try to air its side of the argument over cable systems versus private antennas. It intends to conduct public relations and educational campaigns "in all areas where cable systems are proposed and in operation." END



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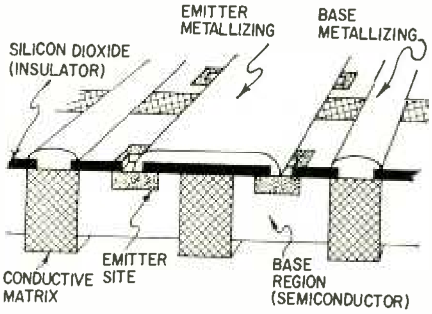
New Semiconductors and Tubes

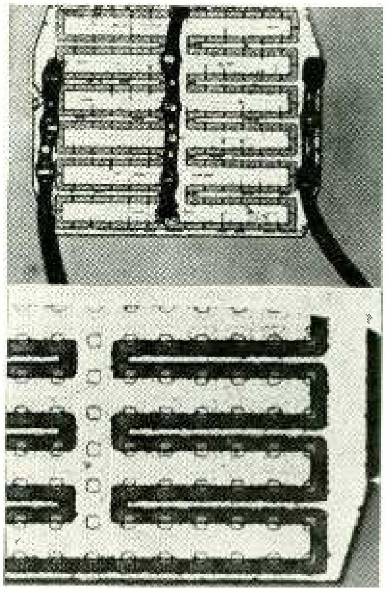
New hi-frequency power transistor

A new "overlay" transistor for uhf space communications is producing as much as 5 watts of rf at 500 mc, according to RCA, maker of the new device.

The heart of this transistor is a tiny checkerboard structure, far smaller than the head of a pin. It consists of a mosaic made up of 156 individual high-frequency transistors, microscopic in size. These units are integrated by a new overlay structure and applied on a silicon wafer by a photo-etch process.

The device, branded TA-2307, is





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hermetically sealed in a ceramic-metal case. All leads are isolated from the package.

The upper photo shows the complete structure with leads bonded on. The lower closeup shows clearly the individual emitter elements, each 0.5 mil square.

Miniature rectifier assemblies

This series of encapsulated power rectifiers includes full-wave bridge, voltage-doubler and full-wave center-tap configurations. The size of the tiny plastic-case units is indicated in the photo.

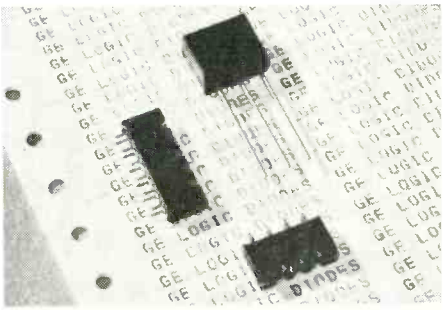
These point up what seems to be a trend in "B-plus" rectification for electronic equipment, from tubes to seleniums to individual silicons to "prepack-

aged" rectifier circuits such as these (See "Silicon bridge rectifiers," "New Semiconductors and Tubes," November 1963, page 98).

The full-wave bridge and full-wave center-tap units are available with piv's of 25 to 1,000 volts and 1-amp output current rating. The doublers have the same voltage ratings with a maximum current of 0.5 amp.

Selenium logic diodes

But . . . selenium is not yet dead. General Electric has just announced two



low-cost selenium logic diode types for computer applications. They are to be priced as low as 5 cents apiece in quantity orders.

The diodes are produced in two-, four- and six-cell packages, designed flexibly so that the units can be used common-cathode, common-anode or individually.

Where's the rub? Simply that these diodes are not nearly as fast as the more elegant and expensive germanium or silicon types. Reverse recovery time is 1.75 μsec; forward turn-on time, 1.5

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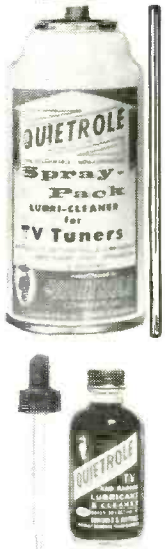

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4 oz. bottle	LIST 2.54
4 oz. bottle (brush-n-cap)	LIST 2.64
8 oz. bottle	LIST 5.07
6 oz. spray can — with extender	LIST 2.79
3 oz. spray can — with extender	LIST 1.79

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μsec. Their capacitance is high and their working temperature range limited—from 30 to 85°C.

The two types are similar except that one will carry up to 20 ma maximum and has a capacitance of 100 to 225 pf, while the other can carry only 10 ma maximum but has 15 to 40 pf capacitance.

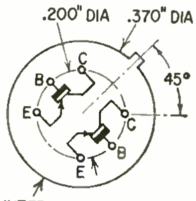
Applications include digital circuitry at 50 kc or less, voltage stabilizing circuits, diode capacitor memory for low-word-capacity register type storage, and solid-state relays.

Dual transistors

Just as dual (and eventually triple) tubes made the scene in the early 1930's, so now dual transistors are becoming more familiar.

Hughes Semiconductors has announced two dual p-n-p silicon alloy transistors, the 2N2871 and the 2N2872. They have two completely independent devices in one TO-5 package with six leads.

The transistors are designed for chopper service, dc-to-ac conversion, or



2N2871, 2N2872

any other low-level saturation switching. Nothing appears to have been sacrificed by bringing two units into one case. Maximum collector current per unit at 25°C ambient is 100 ma, and total power dissipation is 400 mw. The collector junction temperature can rise as high as 165°C.

Breakdown voltages between all three elements of each unit are 60 for the 2N2871 and 110 for the 2N2872. Typical switching speed is 1 mc. END

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Wireless Association of America	1908
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Television	1927
Radio-Craft	1929
Short-Wave Craft	1930
Television News	1931

Some larger libraries still have copies of Modern Electrics and the Electrical Experimenter on file for interested readers.

In February, 1914, Electrical Experimenter

The Radioson Detector, by H. Gernsback.
Currents of Ultra-High Frequency, by H. W. Secor.
An Efficient Transmitting Loose Coupler.
An Extra Large Amateur Aerial.
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Radio-Electronics HIGH FIDELITY–TAPE RECORDER ISSUE

The March issue of Radio-Electronics will feature TAPE RECORDERS and HIGH FIDELITY. This exciting issue will contain a complete editorial section on tape recorders and high fidelity units and components, including a directory of accessories for the audiophile.

Here are just some of the features which will be in the issue:

Humless preamp you can build Four transistors solve the problem of preamplification and treble and bass compensation without introducing any signal from the supply lines.

Choosing the right tape What are the differences between tapes? Do particular machines do better with one type than with another that has equally good specs? What about "white box" tapes?

Test Records and Tapes There are a number of these on the market at the moment. How do they differ? What special features are offered? Which tape or record for you?

Vertical Tracking Angle Distortion Is it important in stereo recording? Will the new 15° stylus angle reduce or eliminate it?

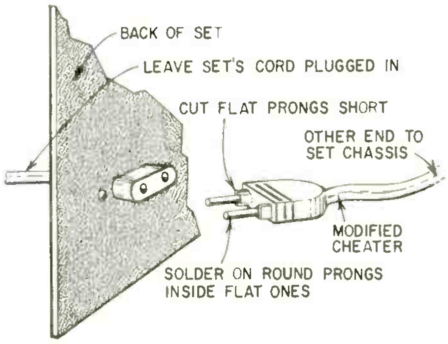
Accessories for the Audiophile A wide range of items, from head demagnetizers to stylus gages, are available to make life easy for the audio enthusiast. Who makes them? Where can they be obtained? And are there any new widgets the audiophile has not heard of yet?

MARCH ISSUE (on sale February 18)

try This one

Cheater Idea

It's not hard to forget a cheater cord in a set. You put the back on, check the set and walk off, leaving the



cheater plugged in. Another frequent misfortune is finding the only available wall outlet behind a chair or a piano. Well, don't move the furniture.

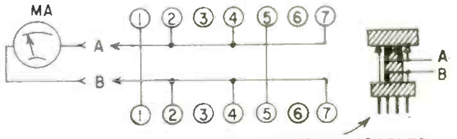
Fix up a cheater cord as shown in the drawing. Partly cut off the flat prongs of the plug, and solder round cheater type prongs on the *inner* sides of the original flat ones. Now, instead of fumbling for a wall outlet, plug the modified cheater plug into the female interlock connector on the set's removable back. The female end of the cord goes to the male chassis connector as usual. In effect, you use the back of the set as a temporary extension cord.

And you very likely won't forget to take your modified cheater cord with you when you leave.—*Edmund Daly*

Adapter Measures VR-Tube Current

Because a VR tube is glowing, it does not mean the correct current is flowing in it. A test adapter socket right on top of the chassis makes it possible to check the current.

Use adapter sockets that can be



7-PIN MINIATURE ADAPTER FOR OA2, OB2, OC2, 5651, ETC.

cross-connected in any desired way. Connect as in the diagrams. The cath-

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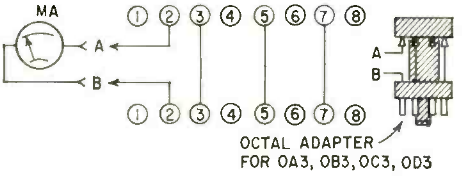
ode lead is broken and a vom, set to read current, is connected from A to B in the schematic. All other connections are straight through from male to female of the adapter. I used a piece of red spaghetti on A to show polarity.

To investigate a VR tube, turn the set off, pull the regulator tube, and put in the proper test adapter with tube on

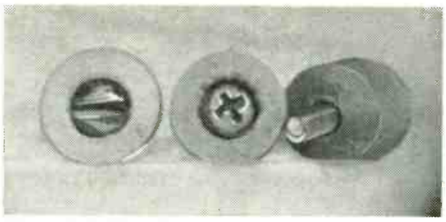


top, connect current meter, turn set on and read milliamperes. A tube manual will give you the maximum and minimum currents.

A word of caution! Don't turn the set on with just the adapter but no gas tube. Some of the components might be damaged by excessive voltage.—*Fred H. Horan*

Feet for Home-made Gear

The little plastic caps you push down on to spray stuff out of aerosol cans make excellent "mar-less" feet for home-built equipment. The holes in them, though they don't go all the way through, are just about right for 4-40 or 4-36 screws, but should be reamed out far enough and deep enough to countersink

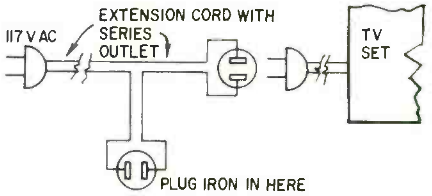


the screw head.

Wood screws can be used, of course, if you want to attach the feet to a wood cabinet.—*James Wallace*

Flatiron Is Short Tester

When you service a TV set that blows the customer's fuses, plug it into

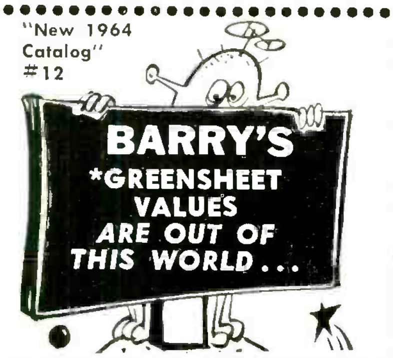


his ac line through an extension cord with a series-wired outlet, and plug his electric iron into that outlet. If there is a short, the iron will heat up to full temperature just as it would if plugged directly into a wall outlet.

If the TV set is OK, the iron will get only barely warm.

This idea may save you a fuse-replacing trip to the basement.—*Charles Andrews*

END



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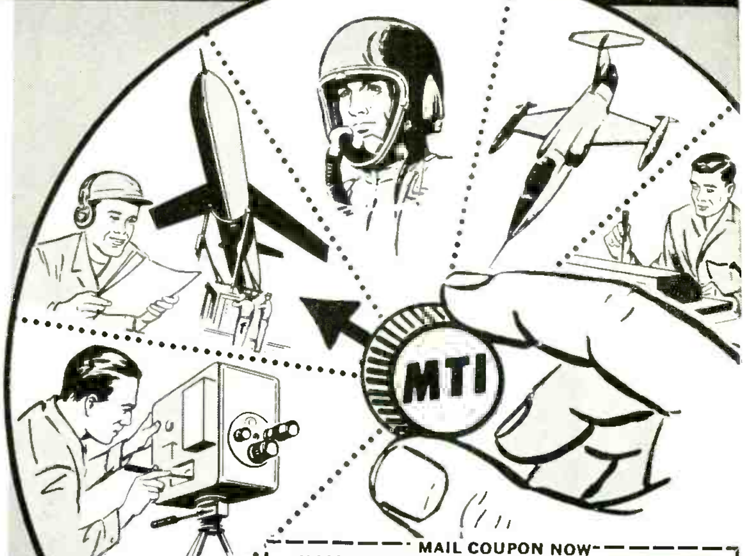

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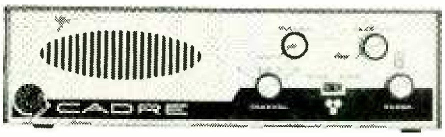

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AVAILABLE ORGAN LITERATURE listed in 16-page booklet. Includes pamphlets, books, magazines and recordings on organs, organists, organ music, history and building.—**Organ Literature Foundation**, Nashua, N. H. 03060.

SUBMINIATURE SQUARE TRIMMING POTENTIOMETERS described in 2-page catalog sheet. Specs for precision and military applications; physical drawings and tolerances; charts for standard resistances, resolution and power ratings.—**Techno-Components Corp.**, 18232 Parthenia St., Northridge, Calif.

POWER AND HAND CRIMPING TOOLS literature gives specs and descriptive photos. Also describes interchangeable heads used on each model.—**Prosser Industries, Inc.**, 900 East Ball Rd., Anaheim, Calif.

TRIMMER AND PRECISION POTENTIOMETERS described in 40-page catalog. Includes quick reference index, illustrations, features, electrical mechanical and environmental specs.—**Dale Electronics, Inc.**, Columbus, Neb.

EMITTER BYPASS (Transfilter) described in *Bulletin 94-20*, 2 pages. Ceramic Transfilter shown in ordinary radio circuit. Circuit diagrams. Set of curves compares selectivity of i.f. stage employing device as emitter bypass vs conventional capacitor bypass.—**Clevite Corp.**, Piezoelectric Div., 232 Forbes Road, Bedford, Ohio.

HIGH-SPEED SWITCHING RELAYS (Micro-Scan), typical circuit applications and specs described in 8-page *Relay Catalog F-5174*. Includes relay definitions, circuit diagrams.—**James Electronics, Inc.**, 4050 N. Rockwell St., Chicago, Ill.

ZENER-DIODE DATA REFERENCE CHART *B-108* lists about 500 types with dissipation ratings from 500 mw to 50 watts and Zener voltages from 6.8 to 200. 8 case styles illustrated. Outline drawings, specs.—**National Transistor,** 500 Broadway, Lawrence, Mass.

LOW-FREQUENCY CRYSTALS described in 6-page brochure. Specs and characteristics. Curves and data on series resistance, frequency vs temperature, average equivalent constants, Q values and holder dimensions vs frequency for JT, XY, NT, HT, 5°X, DT, DD and CT crystal cuts. —**Monitor Products Co., Inc.**, 815 Fremont Ave., So. Pasadena, Calif.

DC TO 30-MC SCOPE described in illustrated brochure. *RD1805A*. For use with plug-in preamplifiers. Technical specs, block diagram.—**Hickok Electrical Co.**, RD Instruments Div., 10514 Dupont Ave., Cleveland 8, Ohio.

MOTOR GENERATOR SETS described in 4 brochures. General line and specialized sets. Discusses models and sizes available, construction features, latest specs.—**Kato Engineering Co.**, 1415 First Ave., Mankato, Minn.

TRANSFORMER CATALOG describes standard, MIL-spec and custom transformers. Complete listings of manufacturer's line of 60- and 400-cycle units. Engineering data on filament, filament/plate and plate transformers, power supply filter reactors, military-standard audio and pulse/toroidal transformers and reactors.—**Ferranti Electic Inc.**, Light Equipment Div., Industrial Park No. 1, Plainview, N. Y.

INDIUM ANTIMONIDE INFRARED DETECTORS. 16-page brochure for users of single-crystal photovoltaic detectors. Explains optimum methods for measuring parameters considered most important when specifying InSb infrared detector characteristics. Also discusses fabrication of detectors.—**Philco Corp.**, Special Products Operations, Lansdale Div., Lansdale, Pa.

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STEREO RADIO-PHONO CONSOLES described in illustrated catalog. Specs, photos, line drawings and explanations of interior features.—**H. H. Scott, Inc.**, Dept. P., 111 Powdermill Rd., Maynard, Mass.

HI-FI SPEAKERS AND KITS covered in 24-page catalog *No. 165-J*. Headphones, private stereo listening, speaker components and system kits. Illustrations, specs.—**Jensen Manufacturing Co.**, 6601 So. Laramie Ave., Chicago, Ill. 60638.

AIRCRAFT BATTERIES described in 4-page brochure. Lists specs, special data about nickel-cadmium batteries, and military and FAA-approved batteries.—**Sonotone Corp.**, Battery Div., Elmsford, N. Y.

POWER TUBES. 36-page booklet *PG-101F* covers vacuum power tubes, vacuum gages, ignitrons, rectifier tubes, thyratrons now available from manufacturer. Full specs, illustrations, graphs.—**RCA Electronic Components & Devices**, Harrison, N. J. 60¢.

1964 ELECTRONICS CATALOG includes industrial electronics, professional and consumer audio, amateur radio, component parts from 187 manufacturers. 400 pp., full specs, illustrations.—**Harvey Radio Co., Inc.**, 104 W. 43 St., New York, N. Y. 10036.

HIGH-FREQUENCY VARIABLE TRANSFORMERS described in 28-page bulletin *P463H*. Ratings and complete technical data for variable transformers which deliver continuously adjustable voltage from 400-, 800- and 1,600 cycle ac power lines.—**Superior Electric Co.**, Dept. P463H, Bristol, Conn.

MIKE, SPEAKER, ACCESSORIES CATALOG. 8 pages, specs, photos. Covers special speakers, drivers, radial projectors, sound columns, paging speakers, mike adapters and fittings, etc. —**Atlas Sound,** 1419-51 39th St., Brooklyn 18, N.Y.

INCANDESCENT PILOT LAMPS described in spec sheet. Also data about manufacturer's line of extended-service pilot lights. Explains reliability, endurance, contains charts showing effect of voltage variation on lamp life, light output and lamp current; results of vibration tests.—**Sylvania Electric Products Inc.**, 60 Boston St., Salem, Mass.

STANDARDS AND COMPONENTS, 8-page bulletin, describes manufacturer's line of standard resistors, inductors and capacitors. Covers fixed-value components, decade boxes, attenuators, voltage dividers and variable inductors. More than 150 standards.—**General Radio Co.,** West Concord, Mass.

TRANSISTORIZED POWER CONVERTER described in spec sheet. Converts engine current of boat to house current. Illustrations.—**Stanley S. Wyman**, Route 2, Box 156, Zephyrhills, Fla.

GUIDE TO STEREO HIGH FIDELITY. 1964 164-page catalog of hi-fi components and accessories, including PA, amateur radio and CB products. Indexed by product and manufacturer. Photos, specs.—**Airex Radio Corp.**, 85 Cortlandt St., New York, N. Y. 10007.

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.

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new Books

SILICON CONTROLLED RECTIFIER HOBBY MANUAL, edited by T. O. Reich. *General Electric, Rectifier Components Dept., W. Genessee St., Auburn, N. Y. 5½ x 8½ in., 70 pp. Paper, $1.00.*

Contains some 15 short articles describing construction of devices using a silicon controlled rectifier as well as introductory material on the device and some information on replacing rectifier tubes with (ordinary) silicon rectifiers. END

MARINE ELECTRONICS HANDBOOK (2nd Edition), by Leo G. Sands. *Howard W. Sams & Co., Inc., 4300 W. 62 St., Indianapolis 6, Ind. 5½ x 8½ in., 288 pp. Paper, $4.95.*

Technical information, Government regulations and marine station listings. Tells how to select radio and safety equipment; covers installation, operation and maintenance.

BASIC ELECTRICITY, prepared by Bureau of Naval Personnel. *Dover Publications, Inc., 180 Varick St., New York 14, N.Y. 6¼ x 9¼ in., 447 pp. Paper, $2.65.*

Covers the subject thoroughly in conventional manner from electrical concepts to alternating current instruments, magnetic amplifiers, and servomechanisms.

AUTO RADIO SERVICING MADE EASY, by Wayne Lemons. *Howard W. Sams & Co., Inc., 4300 W. 62 St., Indianapolis 6, Ind. 5½ x 8½ in., 128 pp. Paper, $2.95.*

Practical information on repair, adjustment and installation with emphasis on transistor circuits. Includes signal-seeking tuners.

PULSE FUNDAMENTALS, by John M. Doyle. *Prentice-Hall, Inc., Englewood Cliffs, N.J. 6 x 9 in., 499 pp. Cloth, $16.00.*

Multivibrators, wave shaping and switching are among the topics covered in this comprehensive text for technicians and students. It includes many practical examples of circuit design.

INTERMODULATION AND HARMONIC DISTORTION, by Howard M. Tremaine. *Howard W. Sams & Co., Inc., 4300 W. 62 St., Indianapolis 6, Ind. 5½ x 8½ in., 176 pp. Paper, $3.95.*

An authoritative handbook on audio distortion and its measurement. Describes several commercial instruments; details construction of a lab-type IM analyzer.

INTRODUCTION TO ELECTROMAGNETIC FIELDS AND WAVES, by Charles A. Holt. *John Wiley &*

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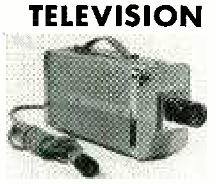

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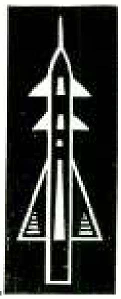

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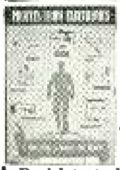

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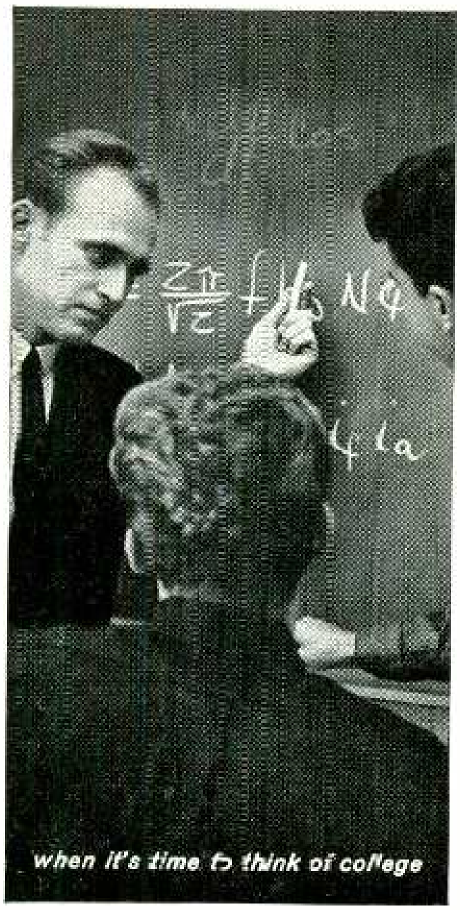

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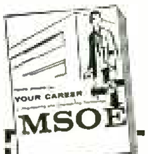

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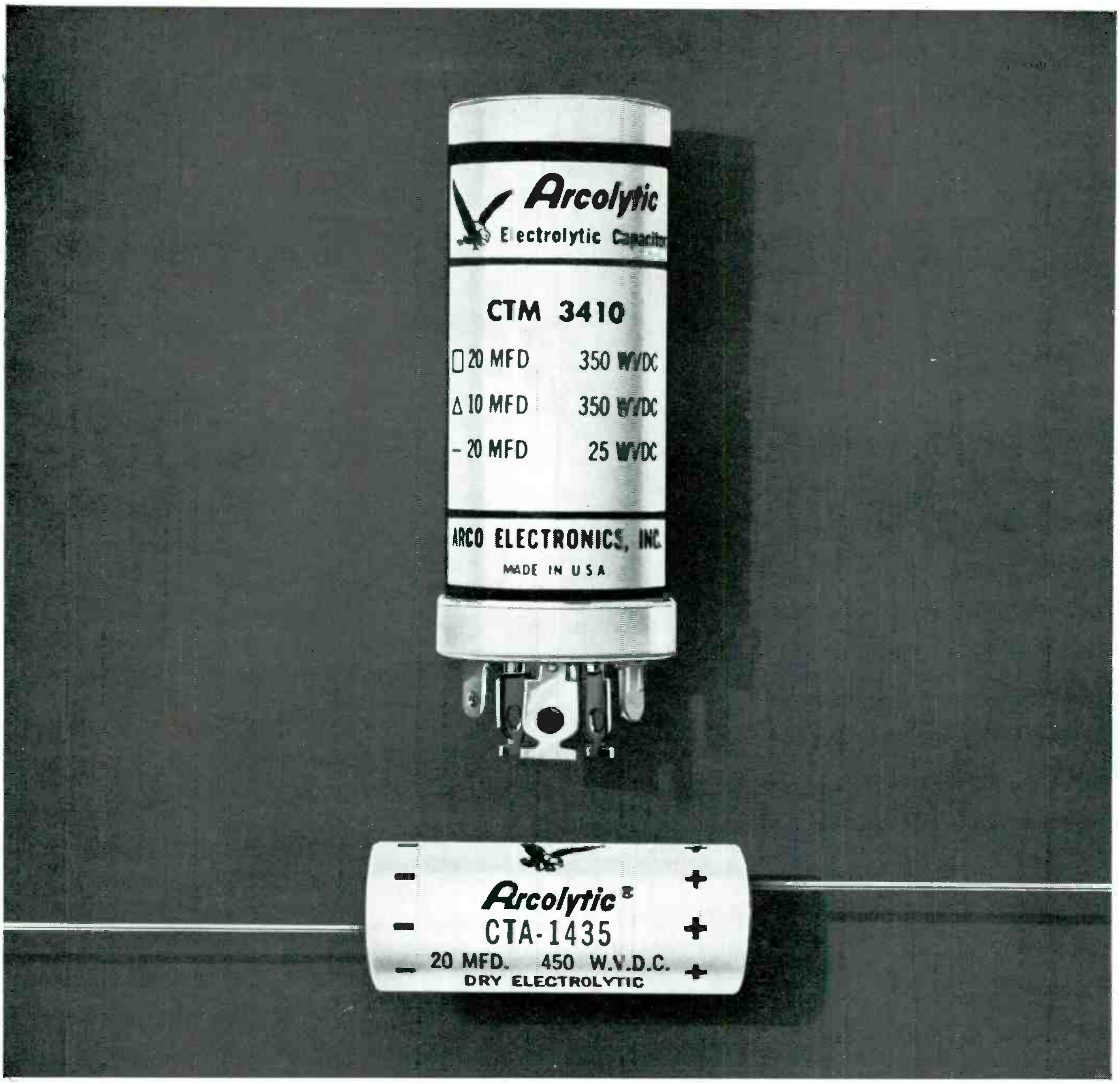

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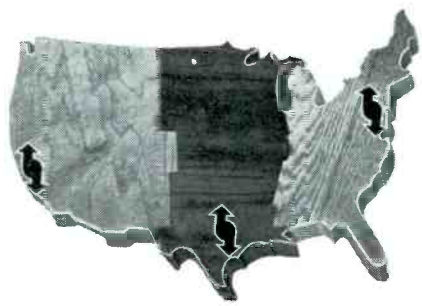

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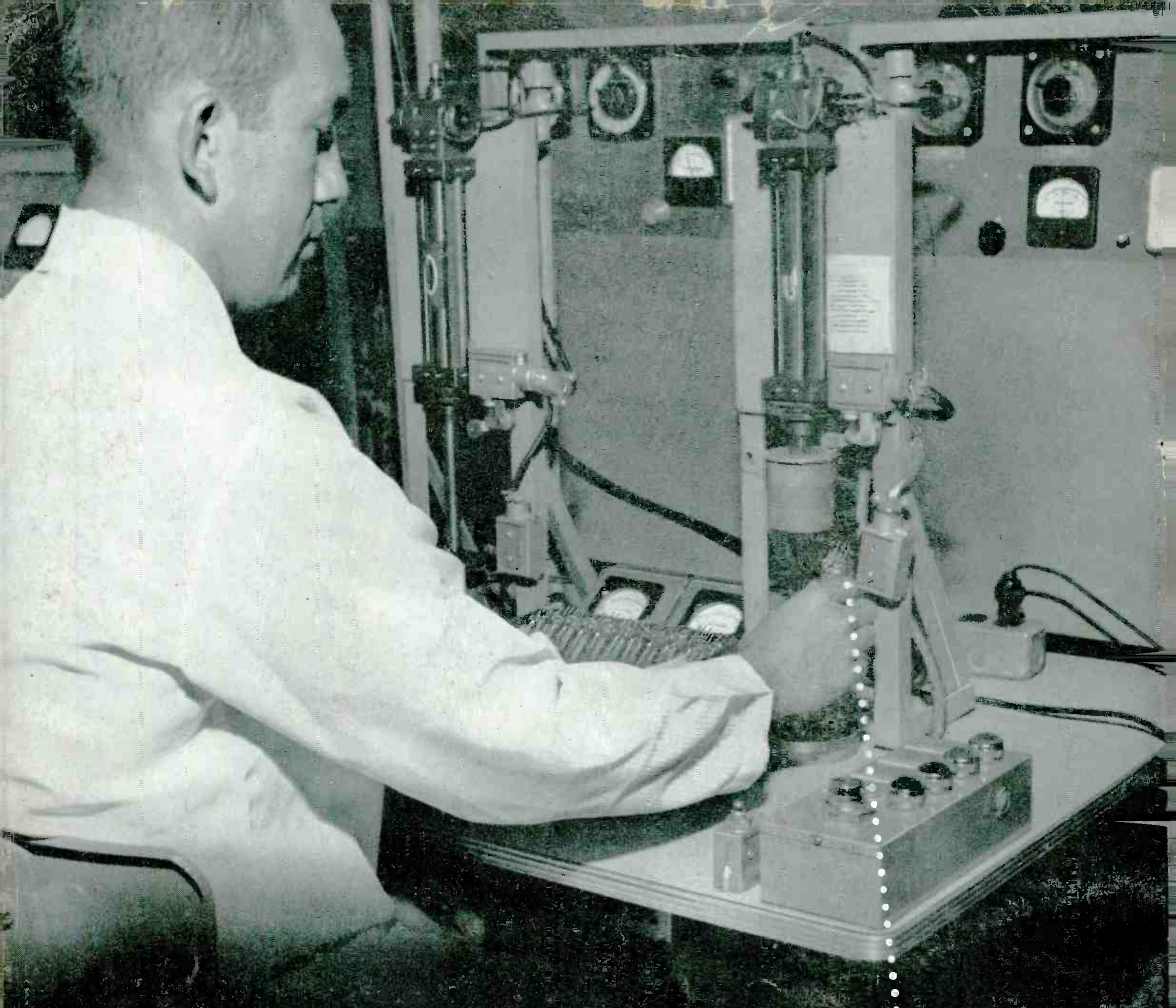

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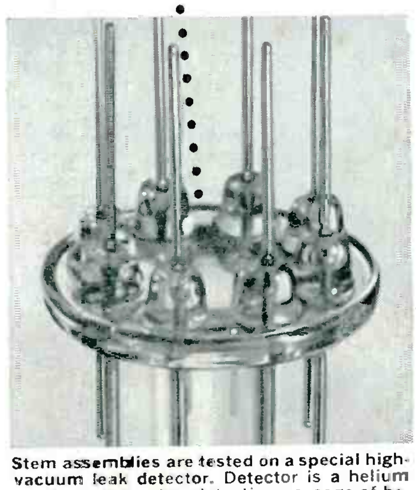

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