OCTOBER

# Radio-Electronics

TELEVISION • SERVICING • HIGH FIDELITY

HUGO GERNSBACK, Editor-in-chief

## Directory of FM Multiplex Equipment

An up-to-the-minute listing of receivers and adapters. Features important characteristics and differences between the various units. See page 38.

## New FM Multiplex Receivers and Adapters

## Other Articles On FM Stereo

## Horizontal Oscillator Drifting

The culprit in too many TV service callbacks. Wayne Lemons shows how to spot and cure drift troubles quickly. See page 50.

## Build a Better Light Meter

An easily constructed unit so sensitive it will give accurate readings at light levels so low as to require 30-second exposures. Uses a cadmium sulphide cell. See page 43.

## Test Equipment For Industry

Matt Mandl shows where industrial test apparatus is like radio—TV servicing gear, and where it differs. Also what new pieces of equipment the service technician will have to understand and use. See page 63.

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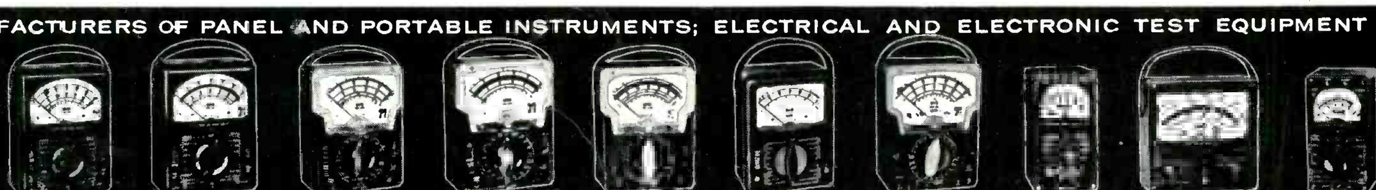

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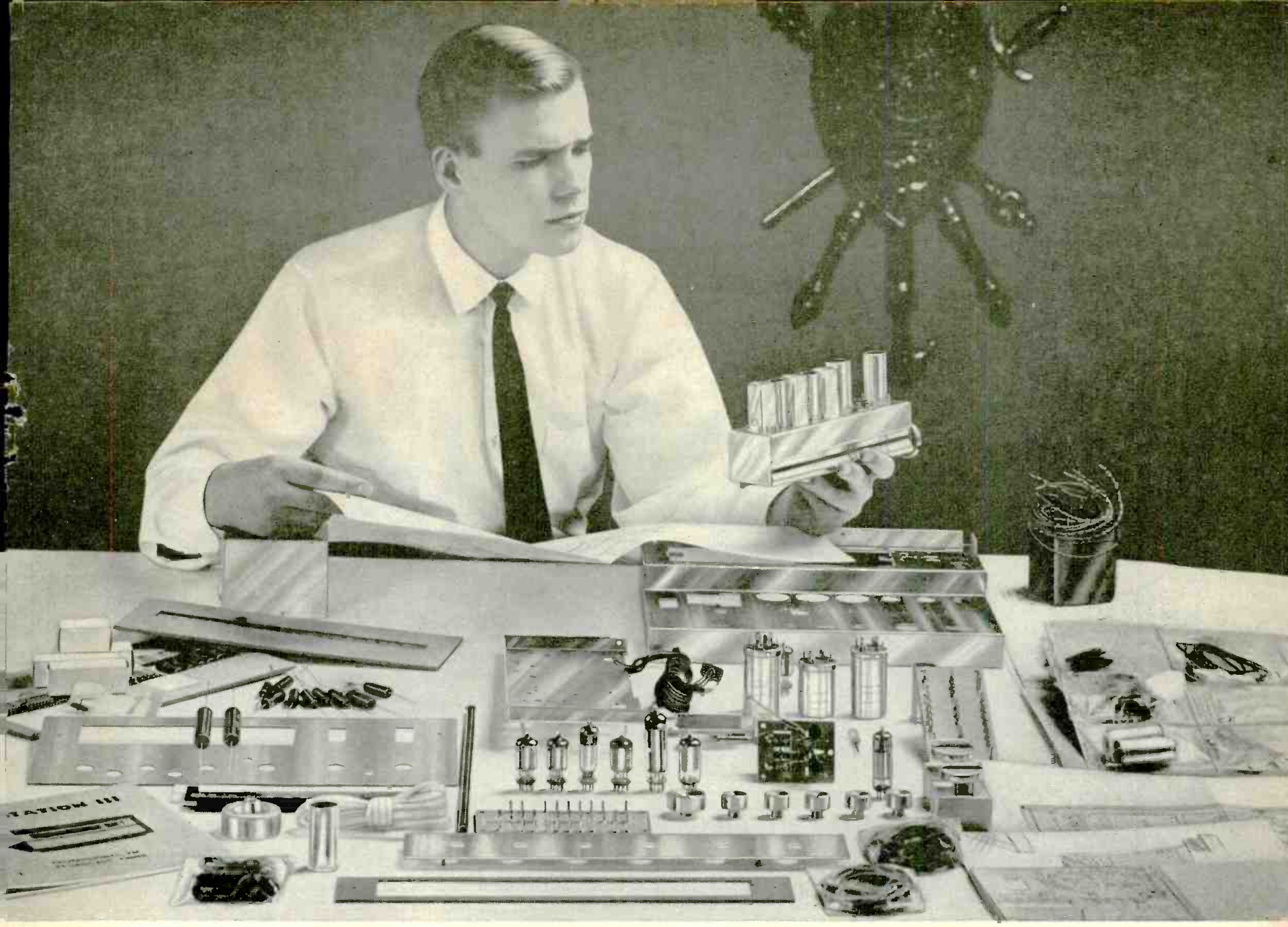

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# Radio-Electronics

OCTOBER 1961
VOL. XXXII No. 10

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



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## —on the cover—

(Story on page 38)

The young lady is keeping company with some of the FM Stereo units listed in our directory. For a quick identification of the sets see page 62.

Color original by Irving Kaufman


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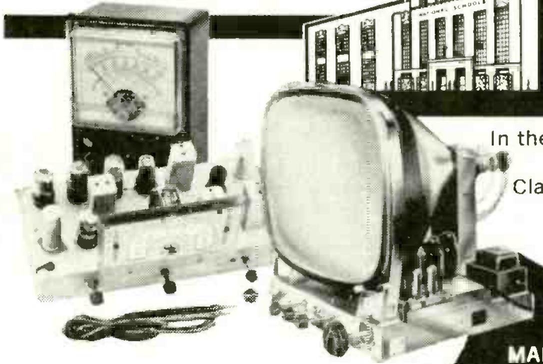

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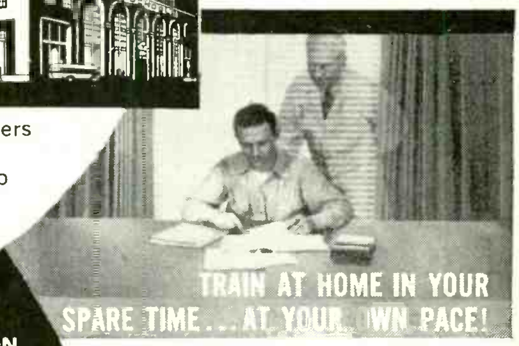


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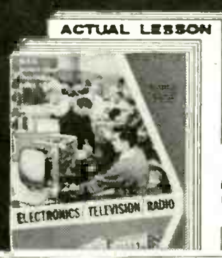


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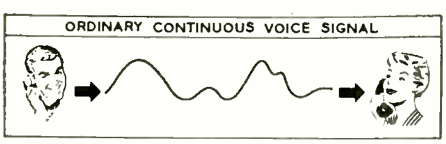
# News Briefs

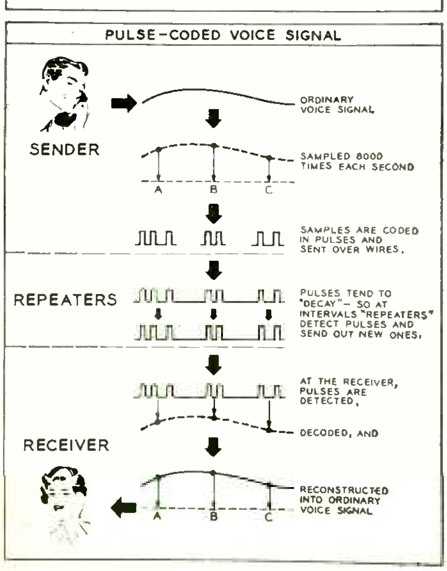
## Now We Can Talk in Pulses

Phone users in the Newark–Passaic, N. J., area have unknowingly been taking part in a synthetic speech experiment—every time they pick up their phones. Instead of going out over the lines in original audio form, their words are broken down into the language of computers; the transmission is by *pulse code modulation.*

This is the first regular use of the system, which was developed by the Bell Laboratories and demonstrated some years ago (RADIO-ELECTRONICS, February 1948). It has been named T-1 by the phone company. The speaker's voice is "sampled," tiny bits being taken 8,000 times a second. The level of each sample is measured and given a number in binary code, 1, 2, 4, 8, etc. up to 128. At the receiving exchange the message is decoded and each binary number replaced by an audio pulse of the correct strength. The result is a reconstituted signal not distinguishable from the original in ordinary phone conversation.

Since a large number of pulse-coded conversations can be carried on the same pair of wires, the new system is expected to be particularly useful in large cities such as New York, where congestion below ground has often made it difficult to find room for additional telephone conduit.




To install T-1, telephone companies will not have to dig up city streets. Instead, using existing cable, they can connect terminal equipment in telephone buildings at each end of the route, and repeater equipment in manholes or on poles along the way.

Another advantage is that each repeater station *reconstitutes* the signal instead of simply relaying it. If the message is distorted, but still intelligible, the relay station, instead of amplifying it with the distortion, sends out a perfectly formed new set of code pulses. Thus, as long as the pulses can all be interpreted correctly, the signals will be as clear after several repeaters (they are spaced about every mile along the transmission route) as after the first.

## Pay TV for Little Rock

Midwest Video Corp. has been authorized by the Public Service Commission to set up a pay television system in Little Rock, Ark. Midwest is operating under franchise from International Telemeter, the company now operating a pay-TV setup in Etibicoke, Ontario. The system brings the program on a cable, and a coin box is used to collect the fees for each attraction.

Midwest Radio plans to begin operations in the southwest portion of the city, an area containing about 10,000 homes. No definite target date was announced. There is some opposition by the local theaters, and one spokesman suggested that the authorization may be appealed in the courts.

## CHU Corrects Time

The time signals of the Dominion Observatory station at Ottawa, Canada, were advanced 50 milliseconds Aug. 1, reported Malcolm Thompson of the Observatory. This change was made to bring the signals exactly to Universal Time. Station MSF at Greenwich made the same change at the same time. CHU transmits continuously on 3.33, 7.335 and 14.67 mc.

The signals of CHU are widely used throughout the United States as well as Canada, and have become practically the standard at sports-car rallies, due to CHU's practice of announcing the time by voice every minute, instead of every 5 minutes as does WWV.

## Ultrasonics Affects Health?

Workers exposed to intense ultrasonic waves and high-frequency noises show definite physical reactions, reports the Russian magazine *Hygiene and Sanitation.* The general effect, the article reports, is fatigue, irritability, headache, moderate loss of weight, decreased work output and frequently, reduction of blood pressure. Industries that use ultrasonic devices should provide periodic medical examination for their workers, the magazine advises.

## Optical Maser New Light Source

Optical maser is being used as "an ideal light source for short-exposure, high-magnification photomicrography, and for shadowgraph and schlieren work," according to Bell Labs. The ruby-red spot, 10,000 times brighter over a given area than the sun, may make the optical maser as important to the photographer as to the communications engineer.

## TV Set Shortage Coming?

Television receivers are selling faster than they are being manufactured, recently warned Frank Mansfield, EIA's top market researcher. If production does not come up, there may be an actual shortage of sets on the retail market in the late fall.

Mansfield estimates that at least 6,220,000 TV sets will be sold in 1961, a slight increase over 1960. Inventories are lower than they have been since 1954. So unless production is stepped up rapidly, there will not be enough sets on hand to meet the year-end demand.

## New "Banana" Tube for Color

British Mullard has announced a type of tube using principles altogether different from the shadow mask, Lawrence or others now in development. The tube is a cylinder about 4 inches in diameter, with three equally spaced cylindrical rods running along its length. The screen

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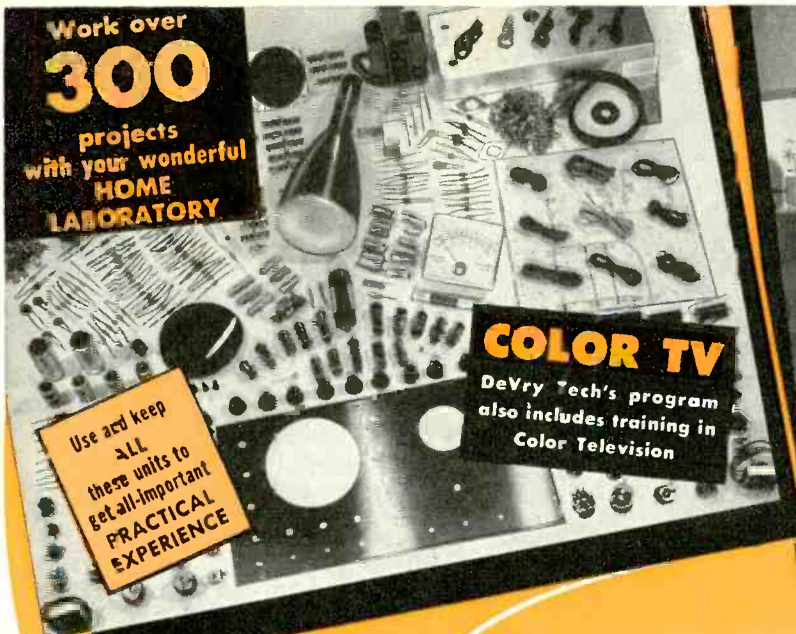


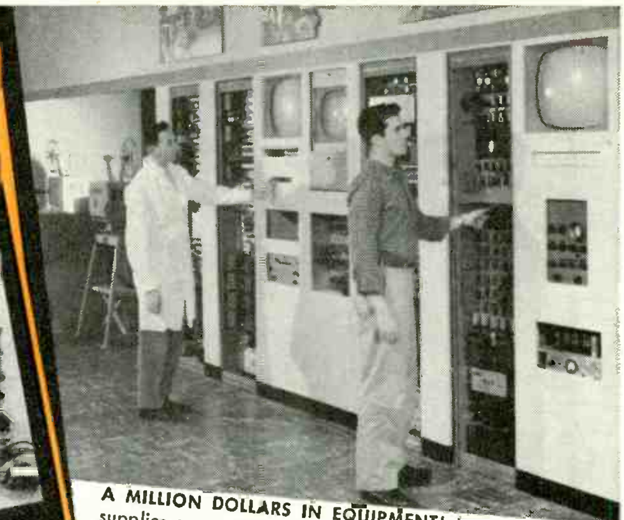

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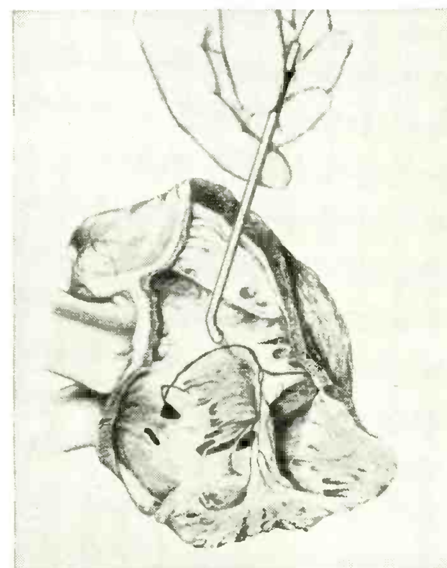
## Audio Surgical Instrument Combats Heart Block

An electronic depth probe makes it easy for the surgeon to locate vital heart tissue—the "bundle of His"—during open heart operations and thus oriented, work with the minimum likelihood of surgical heart block.

The probe, which uses tri-axial



gold electrodes, is attached to a "tone box" which produces a buzz that varies according to the conductivity of the matter reached by the probe. When contact with the bundle of His is made, the pitch changes noticeably.

The instrument, manufactured by Medtronic Inc., of Minneapolis, uses a transistor circuit with rechargeable battery. It is called the Medtronic Conduction System Locator.

## Gallium Arsenide Phototube Is Highly Sensitive

The Lansdale Div. of Philco reports a new gallium arsenide phototube that is one or two orders more sensitive than conventional photodiodes. It can also operate in daylight without sensitivity degrada-

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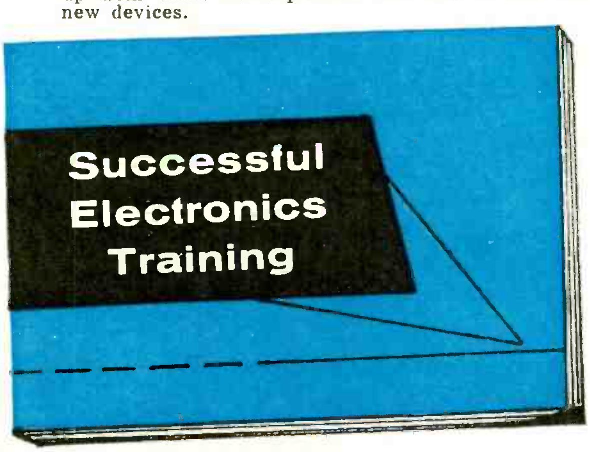


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tion, unlike earlier units, and will work at temperatures approaching 120°C.

The new phototube works at the red end of the spectrum, operating on both visible and near-infrared light. It is designed to work between 0.4 and 0.9 micron, with a peak sensitivity at 0.85 micron. Applications for the new photodiode, according to Dr. Sutcliffe of the Lansdale Div., will include celestial body sensing, missile tracking, space vehicle guidance, and applications in the computer and inertial guidance fields. At its present price of $100 each, its use will be confined to areas where cheaper and less sensitive phototubes will not work.

## Quality Control Now Automated

Computers now not only direct machines but can look into the future and anticipate manufacturing mistakes or drifts toward tolerance limits before they happen. This is now being done on a production line that turns out resistors for Western Electric at Winston-Salem, N. C.

Military necessity—the need to turn out deposited-carbon resistors that would operate 200,000,000 hours without failure in the Nike-Zeus anti-missile missile system—sparked the program. A wholly new manufacturing philosophy emerged—a production procedure that omits final inspection, the costly process of sorting out and junking defective products.

First, the W-E engineers built a conventional automated line to make resistors under the control of a digital computer. Sensing devices were then installed at strategic stations along the line to detect trends in machine performance and tendencies on the part of the product to depart from specified values. Based on this information, supplied by the sensors, the computer continuously predicts future process trends and feeds correcting information to the automated line that heads off manufacturing errors before they occur. Hence, only good resistors are made.

## FCC Moves on TV Allocations

Proposals for rules issued by the Federal Communications Commission would make several regions all-uhf and would drop in short-range vhf stations in a number of others. The FCC also proposes to continue to push for all-channel-set legislation, ease technical requirements for uhf TV transmitters, permit dual vhf–uhf operation by existing vhf stations, use uhf translators to fill in dead spots in a station's service area, and earmark certain uhf channels for educational TV.

The areas the FCC proposes to de-intermix and make all-uhf are Madison, Wis.; Champaign and Rockford, Ill.; Hartford, Conn.; Erie, Pa.; and Binghamton, N. Y.; Columbia, S. C., and Montgomery, Ala.

The FCC also took three final actions, alloting channel 13 to Grand Rapids, Mich., channel 9 to Syracuse, and channel 9 to Rochester, N. Y.

### Calendar of Events

**ISA Instrument Automation Conference and Exhibit,** Sept. 11–15, Los Angeles Memorial Sports Arena, Los Angeles.

**EIA Fall Conference,** Sept. 12–14, Biltmore Hotel, New York.

**IHFM High Fidelity Show,** Sept. 13–17, Trade Show Building, New York. Radio-Electronics will exhibit in Room 525.

**AIEE-IRE Engineering Management Conference,** Sept. 14–15, Roosevelt Hotel, New York N.Y.

**IRE Symposium on Engineering Writing and Speech,** Sept. 14–15, Bellevue-Stratford Hotel, Philadelphia, Pa.

**National Exhibition of Radio and TV,** set for Sept. 14-25, Parc Des Expositions, Paris, France.

**Instrument Society of America–AIEE–IRE Industrial Electronics Symposium,** Sept. 20–21, Bradford Hotel, Boston, Mass.

**IRE National Communications Symposium,** Oct. 2–4, Utica, N.Y.

**IRE Canadian Electronics Conference,** Oct. 2-4, Automotive Bldg., Exhibition Park, Toronto, Canada.

**IRE Annual Broadcast Symposium,** Oct. 6–7, Willard Hotel, Washington, D.C.

**IRE–AIEE National Electronics Conference,** Oct. 9–11, International Amphitheatre, Chicago.

**Audio Engineering Society Fall Convention and Technical Exhibit,** Oct. 9-13, Hotel New Yorker, New York.

**IRE National Symposium on Engineering Writing & Speech,** Oct. 16–17, Michigan State University, East Lansing, Mich.

**IRE Symposium on Electronics Engineering and Education,** Oct. 19–20, Greensboro Coliseum, Greensboro, N. C.

**IRE New York Conference on Electronic Reliability,** Oct. 20, New York University College of Engineering, New York.

**IRE East Coast Conference on Aerospace & Navigational Electronics,** Oct. 23–25, Lord Baltimore Hotel, Baltimore, Md.

**URSI-IRE Fall Meeting** Oct. 23–25, University of Texas, Austin, Tex.

**Armour Research Foundation 1961 Computer Application Symposium,** Oct. 25–26, Morrison Hotel, Chicago.

**IRE Electron Devices Meeting,** Oct. 26–28, Sheraton Park Hotel, Washington, D. C.

**ERA Mid-Lantic Chapter Hi-Fidelity Show,** Oct. 27–29, Benjamin Franklin Hotel, Philadelphia, Pa.

**EIA-IRE Annual Radio Fall Meeting,** Oct. 30–Nov. 1, Hotel Syracuse, Syracuse, N. Y.

**IRE–AIEE Conference on Nonlinear Magnetics,** Nov. 6–8, Statler Hilton Hotel, Los Angeles.

**IRE Conference on Radio Interference Reduction and Electronic Compatibility,** Nov. 7–9, Illinois Institute of Technology, Chicago.

**AIEE–IRE Conference on Magnetism and Magnetic Materials,** Nov. 13–16, Hotel Westward Ho, Phoenix, Ariz.

**IRE Northeast Research and Engineering Meeting,** Nov. 14–16, Somerset Hotel & Commonwealth Armory, Boston.

**IRE Symposium on Electronic Systems Reliability,** Nov. 14, Linda Hall Library Auditorium, Kansas City, Mo.

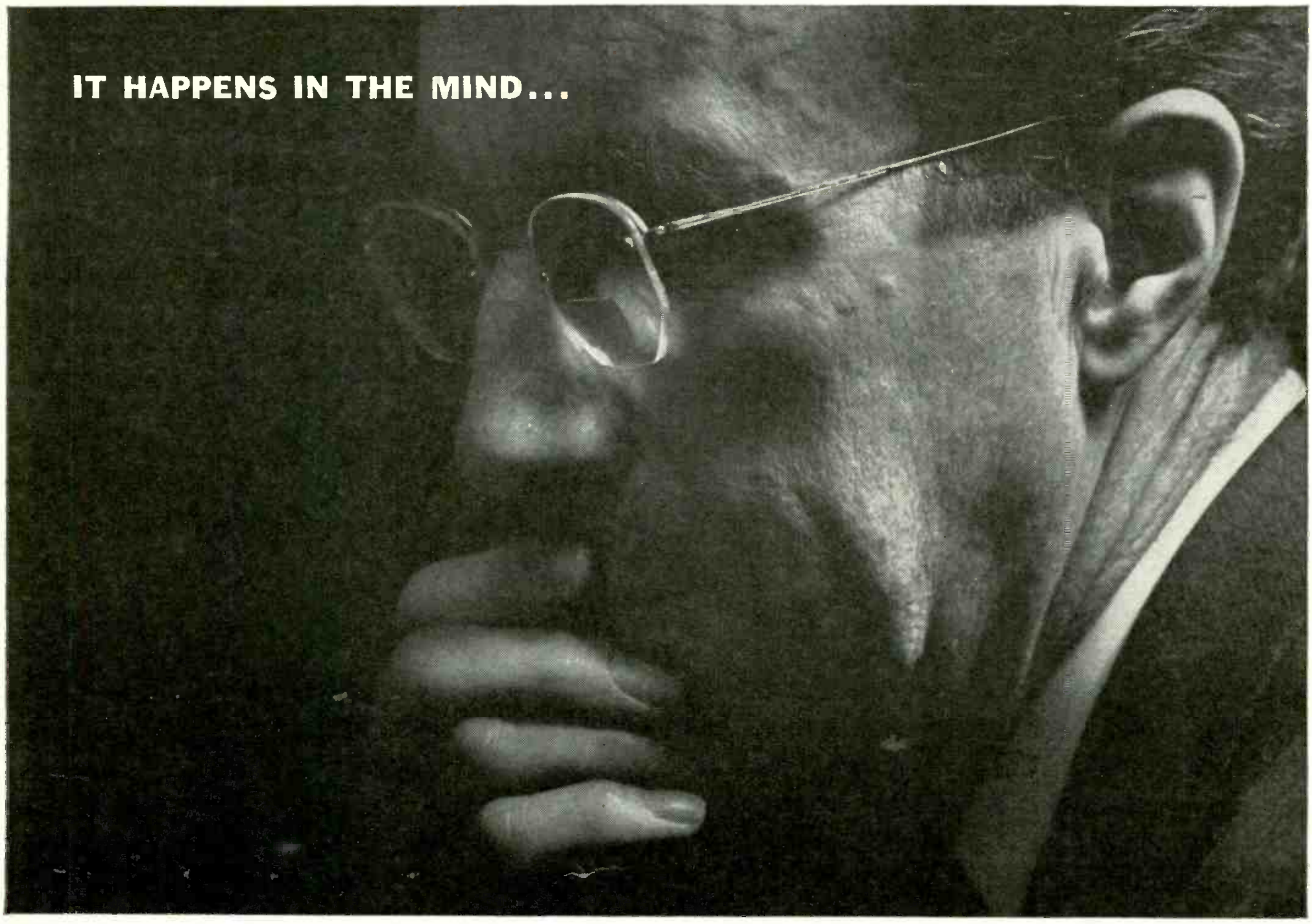
## Medical Electronic Progress Reported at Convention

Electronics is already playing an important part in practical medicine, delegates to the Fourth International Conference of Medical Electronics reported. The conference was held in New York, with Vladimir K. Zworykin presiding.

The use of computers was possibly the most impressive advance. Dozens were exhibited at the conference, some capable of analyzing and correlating data on as many as 800 symptoms and 100 diseases for the benefit of the doctor making a diagnosis.

(*Continued on page* 16)

At Bell Telephone Laboratories, mathematician Sidney Darlington has contributed notably in developing the art of circuit analysis.




*. . . It is essentially a thing of the mind for it works through concepts, symbols and relationships . . . it helps man to analyze and synthesize the complex phenomena of the universe and himself . . . it works in many ways to advance electrical communications:*

## IT IS CALLED MATHEMATICS

At Bell Telephone Laboratories mathematics works powerfully to solve problems involving complex data. For example, engineers must design and synthesize complex systems to process specific signals in precisely controlled ways. At the same time the technology provides a wide choice of circuits and components. Mathematical circuit analysis reveals the circuits which can do the job most efficiently and economically.

Intriguingly, too, the mathematical approach leads to basically new knowledge. For example, it led to the invention of the electric wave filter . . . disclosed a kind of wave transmission which may some day carry huge amounts of information in waveguide systems . . . foretold the feasibility of modern quality control . . . led to a scientific technique for determining how many circuits must be provided for good service without having costly equipment lie idle.

In the continuing creation of new devices, technologies and systems, Bell Laboratories utilizes whatever serves best—mathematical analysis, laboratory experimentation, simulation with electronic computers. Together they assure the economical advancement of all Bell System communications services.

**BELL TELEPHONE LABORATORIES**

WORLD CENTER OF COMMUNICATIONS RESEARCH AND DEVELOPMENT

(*Continued from page* 13)

Other devices exhibited were new types of radio pills, which telemeter information from the stomach or intestinal tract when swallowed by the patient. Other devices included television cameras so small as to permit photographing surgical procedures formerly inaccessible to the camera, a continuous-recording electroencephalograph and monitoring devices that make it possible for a nurse at a single desk to observe continuously the temperature, pulse, respiration and bodily movements of a ward of a dozen patients.

## Battery TV's Arrive

The 8-inch Japanese transistor battery portables reported in this and other magazines nearly a year ago were placed on sale in the New York market late in June. The sets are made by Sony, well known for its transistor radios, and are selling at $249.95.

## Silicon Rectifiers Replace Tube Types in Transmitters

Frank Marx, vice president in charge of engineering of the American Broadcasting Co. has announced that silicon rectifiers will replace tube rectifiers in all its owned and operated radio stations. Marx stated that 35% to 40% of the troubles that caused disruption of service have been due to mercury rectifier arcbacks, and that these are the largest single cause of serious transmitter troubles. The development of high-voltage semiconductor rectifiers, he says, offers a means of eliminating this source of transmitter trouble, and of "assuring our stations of continuous, dependable service."

## TV City Guide for Tourists

An application filed with New York City authorities for a closed-circuit television system would provide TV information on New York's entertainment and shopping facilities to the guests in 200,000 hotel rooms.

The city guide programs, according to the backers of the proposal, Sterling Information Services, would be piped in on one of the vacant channels, and would be 1 hour long with 1 minute of commercials for each 5 minutes of noncommercial time. Existing ducts belonging to the telephone company would be used to transmit the programs.

## Electronics Spots Hurricanes

Hurricanes this season are being kept under closer control than ever before, the Weather Bureau reports. Last year, the bureau states, hurricane Donna was kept under close watch by the new weather radar being tried out at Miami, Key West, Daytona Beach and Tampa. This year additional stations have been installed at Brownsville (Tex.), New Orleans, Charleston (S.C.), Washington and New York, while useful

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radars will also be working on Nantucket and Cape Hatteras. The radar stations will probably receive some aid from weather satellites, which can observe and plot the path of a storm directly. Ordinary radio will also play its part, as weather planes close to the hurricane send back detailed reports.

### Briefer Briefs

All capacitors and resistors made by Aerovox and sold through all industry markets are now covered by a 2-year warranty. The new policy, the company states, is the result of the increasing recognition of product reliability and dependability. No immediate increase in prices is seen as a result of the longer warranty.

---

Radio Corporation of America announces that its millionth nuvistor has been produced. The small-size, low-noise tube is used especially in TV tuners to improve signal–noise ratio in fringe areas. Nuvistors are now available in five types: two general-purpose industrial triodes, a general-purpose industrial sharp-cutoff tetrode, and two high-mu entertainment triodes.

---

Normal metals may act like superconductors at very low temperatures, according to scientists of the Arthur D. Little laboratories in Cambridge, Mass. Normal metals in thin film form, they find, can be made to act as superconductors by placing them in contact with a superconducting metal film at the proper temperature.

---

The FCC proposes to amend its Rules and Regulations so that the seal certifying that a television receiver complies with FCC radiation limits will be visible. The proposed rule provides that the seal shall be affixed to the back panel, shall be 1 x 3 inches in size and shall contrast with the color of the cabinet finish.

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New transistorized image orthicon TV camera developed by Admiral for the Signal Corps is so sensitive that it is "capable of observing persons and objects from a distance of several hundred yards in virtually total darkness." The camera measures 5 x 10 x 30 inches and weighs 35 lb.

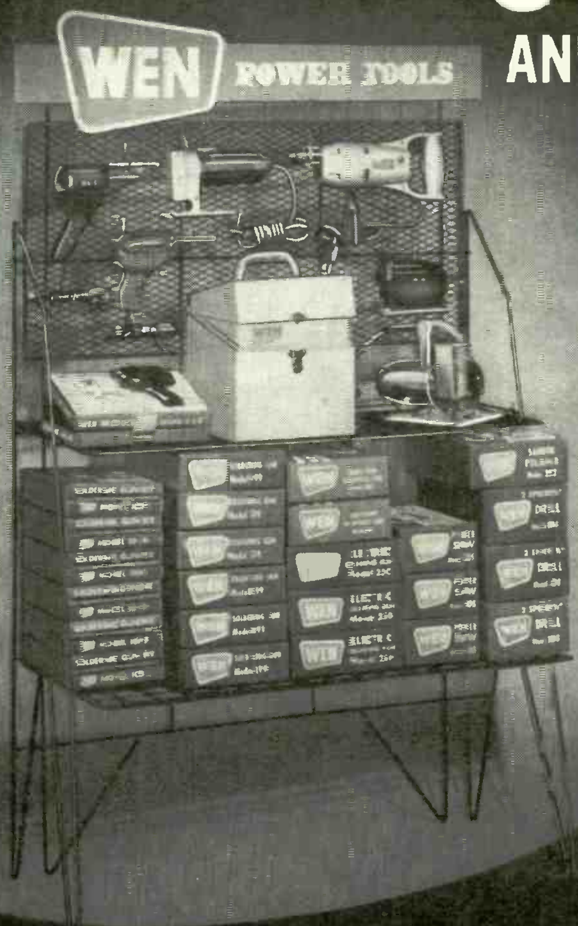
---

Sylvania has joined the ranks of the color TV producers, with a 21-inch set that will be available at a suggested list price of $825.

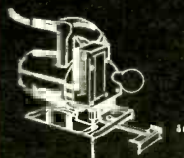
---

New Canadian 1,300-mile microwave communications system stretches from Grand Prairie, Alta., to Mount Dave on the Yukon–Alaskan border. It vastly improves telephone and telegraph communications along the length of Canada's Alaska Highway, and forms a link in a high-quality communications system between the United States and Alaska. END

# STOP
## AND SHOP




Look for this convenient display at your Electronic Parts Distributor (listed in the column at right). A full assortment of famous Wen power tools awaits your inspection. Step up to Wen quality—factory guaranteed to perform to professional standards.



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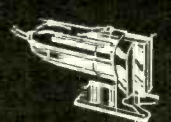

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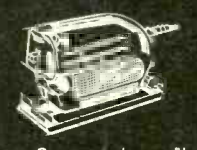

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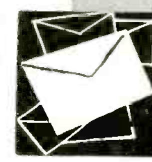
# Correspondence



### CORNER SPEAKERS BEST!

*Dear Editor:*

Corner placement of a sound reproducer results in the longest path before the first reflection, oblique angles of incidence, and an apparent increase in room size, compared to wall-located speakers. There is a common and widespread fallacy that corner placement excites more room modes or resonances. A study of the principle of mirror images shows that a corner speaker does exactly what a double-size wall speaker would do in a room twice as large.* This is true whether actuation is by open cone, horn, modulated air blast, electrostatic or ionized air. Corner placement results in the lowest measured peak-to-trough sound pressure ratios. It usually results in an octave extension of the bass range. It always reduces distortion by reducing the required diaphragm excursion for a given power and sound pressure output.

Whatever the actuating principle, the power levels and diaphragm excursions always have to be considered. For example, taking Frank Massa's 100 dynes per square centimeter as "necessary to secure realistic musical reproduction" and a room of 3,000-cubic-foot volume and 0.8-second reverberation time leads to the need for one acoustic watt of power. At low frequencies this requires moving large volumes of air. If modulation distortion limits air-sheet motion to 1/16 inch, a radiating area of about 20 square feet is required to radiate 1 acoustic watt at 32.7 cycles per second. This much area for the bass would result in severely anomalous polar or spatial radiation patterns at the middle and high frequencies. There still remains a desirable separation of spectrum, with large speakers radiating the long wavelengths and small ones radiating short wavelengths.

PAUL W. KLIPSCH

*Klipsch & Assoc. Inc.*
*Hope, Ark.*

### ANTI-PLANE COLLISION

*Dear Editor:*

Your editorial "Anti-Plane-Collision Radar" in the March 1961 issue, is of interest. I believe that a few words on the Federal Aviation Agency program, and the difficulties inherent in collision prevention devices, will make a useful epilogue.

The development of positive collision avoidance devices was first undertaken

*Paul W. Klipsch, "Room Dimensions for Optimum Listening and the Half-Room Principle", *IRE Trans. Audio.* Vol. AU-6, No. 1, Jan.–Feb. 1958, pp. 14–15.

in 1955. The firm requirement was established that only self-contained noncooperative operation was acceptable. After several years' work by outstanding engineering organizations, it was determined that this requirement could not be met by state-of-the-art techniques.

The FAA program for developing collision-prevention devices started under the Airways Modernization Board in late 1958. The first technique tested was that of ground reflection ranging with altitude communicated, and the threat criteria of time to nearest approach. Flight tests were run in December 1960, using a completely instrumented but extremely developmental installation. Additional tests will be conducted within the next several months.

Other techniques under consideration for collision avoidance are in such early stages that little should be said of their potentiality. Infrared techniques for collision prevention, unlike some military applications, suffer from the very low radiant intensity of general aviation aircraft.

Very carefully controlled tests of noncooperative systems were performed by the Navy Ordnance Test Station, China Lake, California, at the request of the Federal Aviation Agency. The possibility exists that a cooperative infrared proximity warning indicator (PWI) can be devised using a modified rotating light beacon, but infrared PWI will be strictly a good-weather device and useful only on planes flown under visual flight conditions. Preliminary tests of this equipment were conducted in June 1961.

The operational use of collision-avoidance systems in the Air Traffic Control System will require the solution of several difficult problems to insure that a pilot is not instructed or his aircraft maneuvered into a more hazardous position. It is for these reasons that it appears at this time that the most promising way of decreasing the likelihood of mid-air collisions is by making large improvements in the Air Traffic Control System.

N. E. Halaby

*Administrator*
*Federal Aviation Agency*
*Washington 25, D. C.*

## MEDICINE AND ELECTRONICS

*Dear Editor:*

Medical electronics is gaining more and more attention. Your article "Electronics in the Psychology Lab" is another example of this. But I would like to comment on this article.

E.K.G. is the German abbreviation for Electrocardiogram. Our abbreviation is E.C.G. However, we often use the German abbreviation to avoid verbal confusion between E.E.G. and E.C.G.

The E.K.G. in Fig. 2 is upside down. I believe it is electromechanically produced rather than recorded from a human subject because of the triangular slow wave complexes that represent auricular depolarization and ventricular

repolarization. Human hearts and all animals that I know of give off rather round-shaped waves. This is with the exception of the ventricular depolarization wave which is tall and sharp as you have it pictured.

Your E.E.G. samples in Fig. 1 are excellent for getting across what you wanted to get across. May I suggest, though, that Fig. 1-c "c" is not a recording during an epileptic seizure, but more likely a recording during a subclinical epileptic discharge that probably reflects the patient's tendency toward seizures.

Thank you for this useful article and for many others.

JIM STEPHEN
E.E.G. Technician
*Regina, Saskatchewan, Canada*

[Thank you too for letting us know what you like in RADIO-ELECTRONICS. —*Editor*]

## KEEP THEM COMING

*Dear Editor:*

Louis B. Henry has something on his side in his letter "I'd Buy A Kit" in the July Correspondence column. But when he says "such articles are quite useless except as purely and strictly reading material," I definitely disagree with him.

How about "Wind Your Own Ferrite-Core Antenna"? If I'd been using a transistor radio, I would have been winding and trying that one right away.

I look over all construction articles with interest. And when you build something entirely yourself, turn on the juice and she works—brother, you really live for a while!

So just keep those construction projects coming.

JOHN IALE
*Eureka River, Alberta, Canada*

## I LIKE TO BUILD-IT-MYSELF

*Dear Editor:*

In your July correspondence column, construction projects were mentioned. Allow me to include myself among the many who buy RADIO-ELECTRONICS primarily for them alone! Should they disappear or be reduced in number, I would have no reason to continue reading R-E.

My only complaint is that some of your projects are too sophisticated, while others of more interest are too simple.

I have built, and no doubt will build more kits, but they are usually items of test equipment whose accuracy and calibration would be difficult for the home constructor. But by far the majority of the equipment I have is home-made, and some of it I think far superior to similar items available commercially.

HAROLD L. STEPHENS
*Biloxi, Miss.*

[The above two letters are typical of our readers. They like and respect kits but get something extra out of building a complete device from scratch, all by themselves.—*Editor*] END

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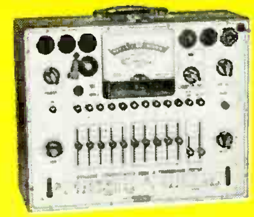

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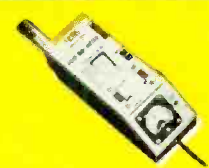

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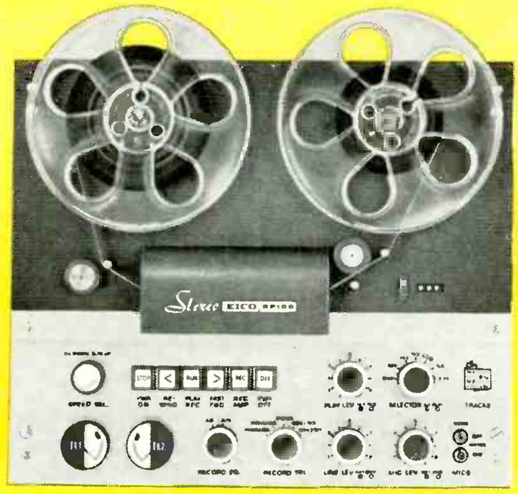

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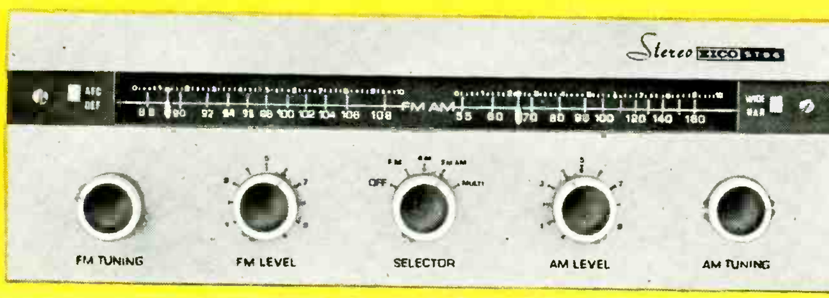


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**Radio-Electronics**
Hugo Gernsback, Editor-in-chief

# EXTRA-TERRESTRIAL TV

*. . . The Great New Uses of TV Are About to Unfold . . .*

PERHAPS the most important applications of television will be made during the next few decades. It would appear certain that these applications will not be on earth but outside our planet.

Already a number of such uses have been made, chiefly in weather satellites. Special TV cameras scan cloud covers, record the result on tape and, on command from earth, transmit the result to our meteorologists for analysis.

In a like manner, the Russians, on Oct. 18, 1959, for the first time in history scanned the far side of our natural satellite, using one of their rockets to circumnavigate the moon. The rocket then transmitted the pictures to Russia on command of their scientists, by radio impulses from earth.

In the January, 1951, issue of this magazine, the writer forecast a new weapon, the *Television Bomb*. A television camera, built into the nose of a bomb, could be dropped accurately despite rain, fog or night, on its target.* The TV bombardier would watch on his TV screen the exact progress of the falling bomb's flight. By radio control he could so manipulate the bomb that he could guide it exactly onto the target.

This was before the intercontinental ballistic missiles. The same principle can be used with them—it will take some of the present inaccuracy out of these long-distance missiles. If such missiles were equipped with television, advanced ground stations or special instrumented planes could follow the progress of the bomb-carrying ICBM via its TV transmitter. When the bomb reaches its apogee, hundreds of miles above the earth, it starts its descent. It may, however, be off target. The computers at the watching ground or air station would be able almost instantly to calculate the correct angle at which it should fall to hit the target. Then, via radio control, an *auxiliary lateral correcting rocket* would be fired from the falling missile. This will deviate its flight sufficiently to assure a bull's-eye hit on target.

In 1951, the author, in an illustrated article "Celestial Television,"† foresaw how the world could watch extraterrestrial events. By means of TV cameras on board a space ship 15,000 miles distant from earth, TV watchers would see how our whole planet appears from space and also watch the breathtaking spectacle of our flaming sun (viewed through special filters) with its miraculous streaming corona, in a black sky, with millions of brilliant stars surrounding it.

Such unusual broadcasts are perfectly feasible even today. We need not wait for manned space vehicles. If the money is available, a satellite can be built now, carrying special remote-control TV camera broadcast equipment.

As this is being written, at Harvard-Smithsonian, two TV orbiting telescopes are being developed. Also under development is a lunar orbiter that should soon be ready for firing. It should be very dramatic because it will give large-scale pictures of the rugged lunar surface.

During the next 10 years it will also be possible to solve one of the greatest astronomical puzzles that has vexed our scientists for generations.

We know next to nothing of our nearest planet in space, Venus. We have never even seen it. All we can see is its perpetual cloud cover—never its surface. Hence we do not know whether it is completely or partially covered with water, or whether it has any continents. Nor do we know the length of Venus' day, or whether it turns one side to the sun perpetually, as the moon does to our earth.

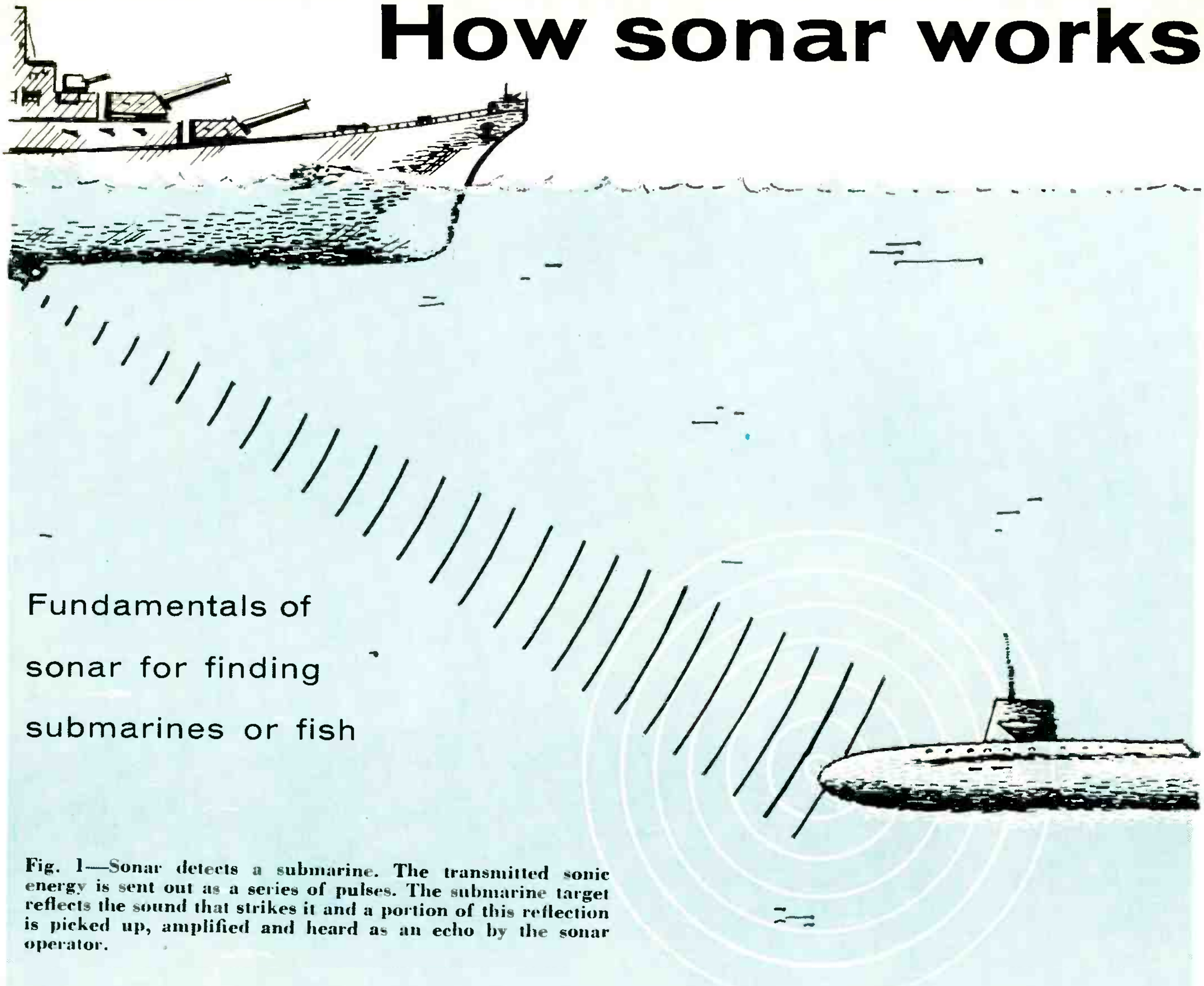
This irritating problem may be solved during this decade by the use of a special radio-controlled, unmanned, TV-equipped rocket. It would circumnavigate Venus in a continuous tight spiral, descending slowly into the planet's thick cloud-covered atmosphere, until it emerges below it, televising its daylit surface without interruption. The TV signals would then be sent earthward and be recorded there. During opposition of earth and Venus, the distance separating the two planets is some 25,000,000 miles. This means that it takes the signals 2 minutes and 18 seconds to reach us, since radio waves travel at the rate of 186,000 miles a second. What happens to the Venus TV rocket? The first ones may not be recovered—they probably will crash on Venus; later and better ones will return to earth intact. This would be more desirable, as they would also take TV tape records scanning the entire visible Venus panorama. This is a superior method to the 25,000,000-mile long-distance TV signals (of the pioneer rockets), which are also influenced adversely by outer space radio-astronomical disturbances. Incidentally, the idea of such a rocket is not new—it originated with the writer in 1953 in his illustrated article "Television Guided Spaceship."** In this article the rocket, however, circumnavigated the moon.

Television on our nearest neighbor in space will be an extensive chapter by itself. Many unmanned lunar rockets, long before man sets foot onto the moon, will be TV-equipped to better guide the rockets in televising their approach and viewing the moon's surface from several hundred miles up. It takes only 1.2 seconds for TV signals to reach the earth, thus in 2.4 seconds we can reach the rocket by radio before it makes its final descent. Therefore, radio manipulation of the rocket's auxiliary *retro-rockets* is quite feasible on the moon.

Unmanned lunar vehicles will be TV-equipped routinely for easier moon exploration and surveying. Later on, manned expeditions will carry TV cameras as a matter of course. The earth, as seen from the moon, 238,000 miles away, will make exciting TV programs, as will the sun. So will closeup views of the colossal lunar mountains, as well as the vast moon craters. Then will come TV spectacles of the moon's far side, as well as TV exploration of the titanic lunar caves—the inside of the many-billion-years-old airless, vacuum-immersed dead world. —*H.G.*

*See also "The Radio-Controlled Television Plane" (bomb-dropping war plane), by H. Gernsback, *The Experimenter*, page 22, November, 1924.
†*Forecast 1952*, annual.
***Forecast 1954*, annual.

# How sonar works



Fundamentals of sonar for finding submarines or fish

**Fig. 1—Sonar detects a submarine. The transmitted sonic energy is sent out as a series of pulses. The submarine target reflects the sound that strikes it and a portion of this reflection is picked up, amplified and heard as an echo by the sonar operator.**

**By A. N. GLENNON**

**Sonars are electronic devices which use underwater sounds to locate submarines. They can also be used to find fish and chart the ocean bottom.**

To detect submarines, sonars transmit a high-powered pulse of sound, called a *ping*, then listen for an echo. A submarine within detection range will return an audible echo. The sound of the echo depends on the frequency and pulse length of the ping, but is usually short and sharp with a metallic quality. The echo can also be made to show up as a bright spot on a PPI scope or as a deflection of an A-scope trace.

The Navy does not have exclusive use of sonars. They are used by merchant ships, fishing boats and yachts, too—not to look for submarines, but to tell how deep the water is or to find fish. Sonars built for these purposes are often called echo sounders.

A modern echo-ranging sonar can spot a submarine several miles away, under good conditions. It is usually mounted on a destroyer, with the operator in a protected location within the hull, and transducer mounted near the forward end of the ship, underwater on the keel.

To detect a submarine, the sonar sends out a short pulse of sound, concentrated into a narrow conical beam (Fig. 1). The ping travels through the water, strikes the submarine and a small portion bounces back. This echo is picked up by the transducer, amplified and presented to the operator.

A sonar transducer converts electrical energy to acoustic energy the same way a radio loudspeaker does. Like a loudspeaker, it will also convert acoustic energy back into an electrical signal, so the same transducer can be used for both transmitting and receiving. Since an echo can be down 120 db or more from the outgoing ping, sonar transducers must have a wide dynamic range.

## Echo-ranging sonar

The block diagram in Fig. 2 shows a typical echo-ranging sonar. There are five major assemblies: the operator's console, transmitter, transducer, amplifier and receiver.

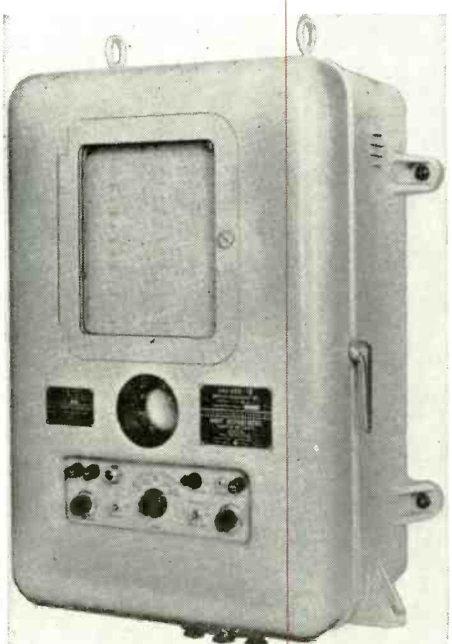
The operator's console normally controls the outgoing power. A transmission pulse generated in the console triggers the transmitter's oscillator. At the same time, a keying pulse goes to the transmit–receive (T-R) switch in the amplifier, to disconnect the receiver for the duration of the ping. The transmitter pulse then proceeds through the T-R switch to the transducer.

A keying pulse also goes to the receiver. This helps protect the operator from reverberations, which are very strong for a second or two after each ping. The keying pulse reduces receiver gain, then lets it recover slowly as reverberations die away.

Once the ping is transmitted, the T-R switch reconnects the preamplifier to the transducer. Received signals then proceed through the preamp to the receiver, where they are processed for presentation to the operator.

The recorder indicated in the diagram uses chemically sensitized paper and a stylus to show the results of every ping. When a submarine has been detected, the recorder can be used to control the pinging rate. The keying pulse then originates at the recorder, instead of the console.

The audio and video receivers for this sonar are similar. Fig. 3 is a block diagram of the audio section. In addition to the reverberation gain control, which is automatic, the operator's master gain control manually sets the final volume of the audio signal from the speaker or phones. Aside from the reverberation gain control circuits, the receivers are straightforward superheterodyne designs.



*EDO Corp.*

**Small echo sounder records ocean depth on sensitized paper.**

## Sonar headaches

Although sonars have improved tremendously since the end of World War II, there are still, and always will be, problems associated with them. Even the best equipment is unable to cope with some of the phenomena of underwater sound transmission.

To receive a useful echo, enough sound must be put into the water to compensate for losses in transmission. The most important losses are caused by refraction, spreading and absorption.

Of all the factors that influence underwater sound, sea temperature has the greatest effect: sound travels faster in warmer water. Sound velocity in water is usually between 4,800 and 5,100 feet per second. The fact that it varies even over a small range of values presents problems, because any small change of velocity will cause enough

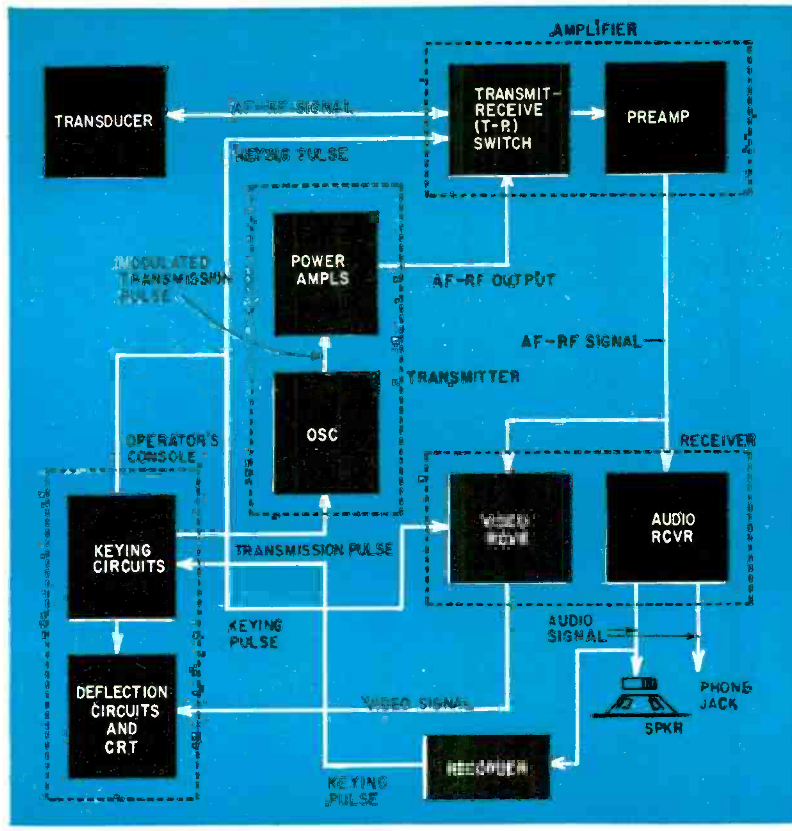
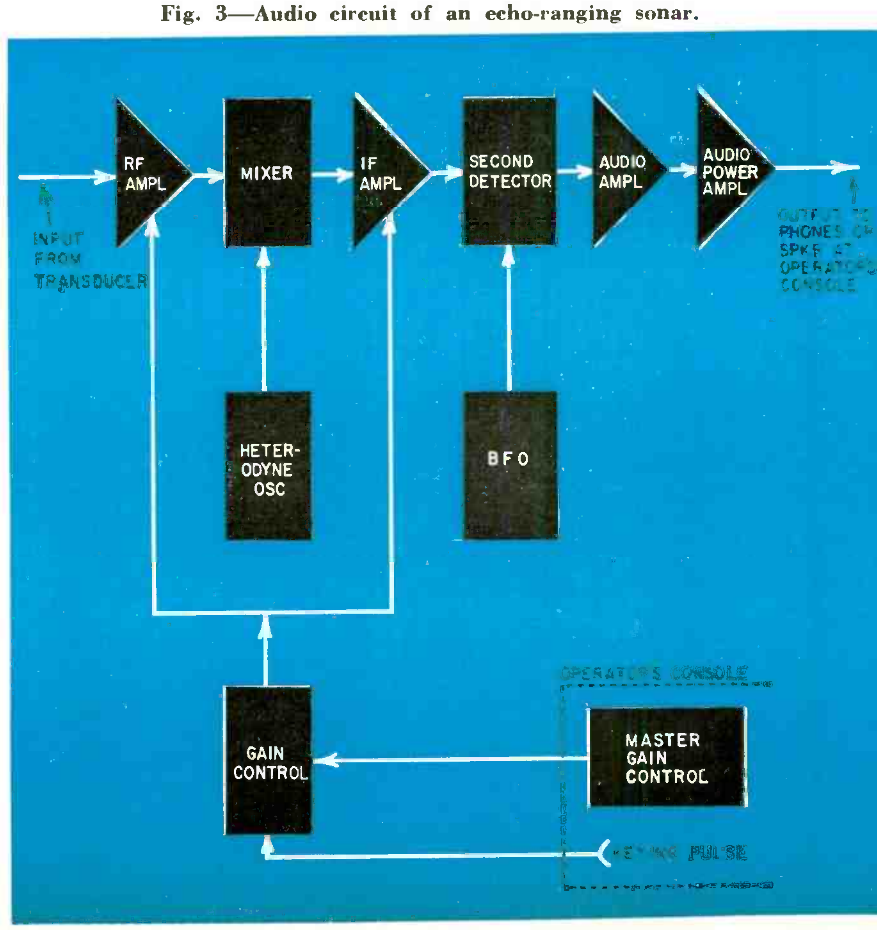



**Fig. 2—Simplified block diagram of a typical echo-ranging sonar.**

**Fig. 3—Audio circuit of an echo-ranging sonar.**



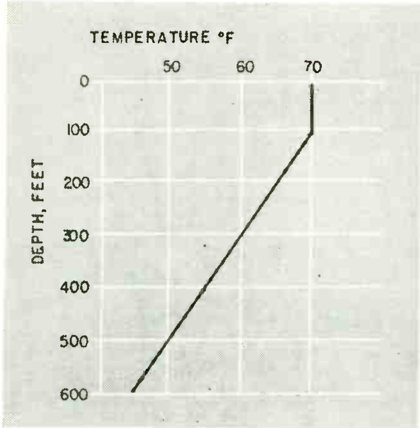



Fig. 4—Typical temperature-depth distribution for deep ocean areas.

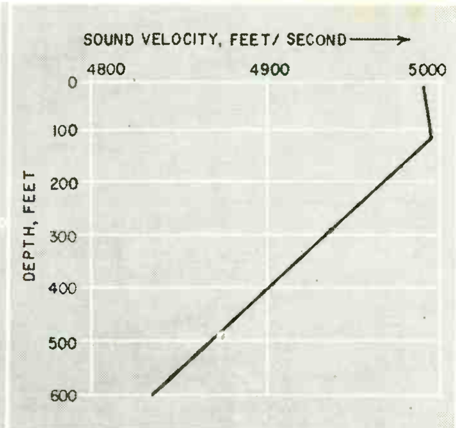



Fig. 5—Sound-velocity distribution arising from temperatures in Fig. 4.

refraction to handicap underwater communications or search.

In point-to-point transmissions, which includes echo ranging, refraction reduces the intensity of received sound by bending sound beams away from where they are aimed, toward regions of slower velocity. The effect is so common that straight-line paths for sound are almost nonexistent. The severity of refraction varies from day to day, and communication or detection ranges can vary from several hundred yards to several thousand yards because of bending.

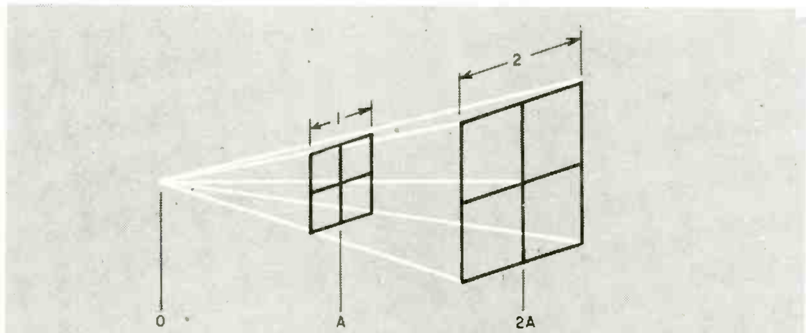
In deep ocean areas, temperature varies considerably with depth. A fairly common temperature structure is shown in Fig. 4. Here, temperature is constant near the surface, then steadily decreases as depth increases. This structure causes velocity to vary as shown in Fig. 5.

Velocity characteristics of this sort distort a sonar beam as shown in Fig. 6. Because there is a low-velocity region near the surface as well as a deep one, the beam splits into two parts, one bending toward the surface while the other is bent severely downward. Under these conditions, a very deep submarine, or one at periscope depth, might be picked up at a range of over 4,000 yards, while one at 100 feet depth could escape detection until the range was about 2,000 yards. In the "shadow zones," almost the entire signal is lost by refraction. Although some sound will scatter into the zone, the amount is negligible.

As sound spreads out from its source, it gets weaker. The sound passing through a particular area in one place (Fig. 7) has to cover four times that area when it has gone twice as far from the source. This means a loss of 6 db each time the distance doubles. It is most severe near the source of the ping, amounting to 60 db in the first thousand yards but, as Fig. 8 shows, the effect decreases as distance increases.

Absorption loss is created by molecular effects. Part of it is due to friction, part to molecular excitation. It increases with increasing frequency, and at 10 kc is about 2 db per thousand yards.

Reverberations do not attenuate sound, but reduce the amount of useful echo by raising the background noise level. They are caused by backscattering of sound from the surface or bottom, or from minute particles in the water. The effect is most serious in the first few seconds after a ping. In tracking a close-in target, reverberations can be high enough to blank the echo out completely.



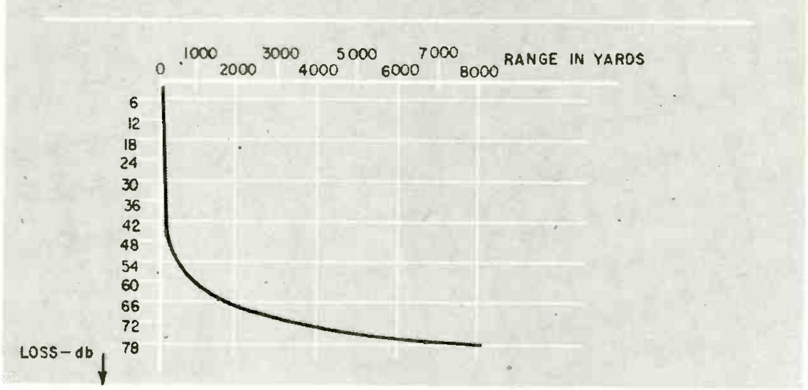
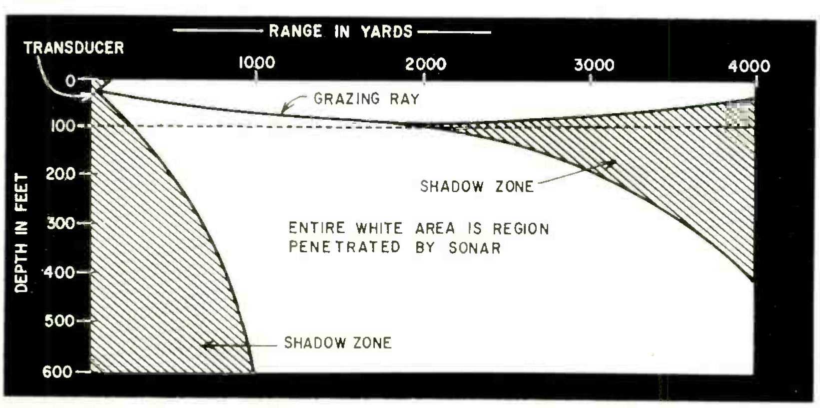




Fig. 7 (Top)—The effect of spreading. Sound which starts from source as O has spread to pass through an area 1-unit square at distance A. At distance 2A, the sound covers an area four times larger. Accompanying reduction in sound intensity is 6 db.

Fig. 8 (bottom)—Spreading loss. There is a 6-db loss each time distance traveled doubles.

Fig. 6—Sound-ray pattern generated by the velocity structure of Fig. 5. Part of the beam is bent upward, the rest downward, leaving shadow areas not scanned by sonar.




Acoustic echo ranging is a slow process. Sound travels about 1,600 yards a second in water, compared to 186,000 miles a second for rf energy in air. Since the ping has to make a round trip between transducer and target, sonar range is measured at a rate of 800 yards a second.

A time-base sweep is provided to measure range. Accuracy is difficult to obtain, because of the variations that always occur in sound velocity. Velocity

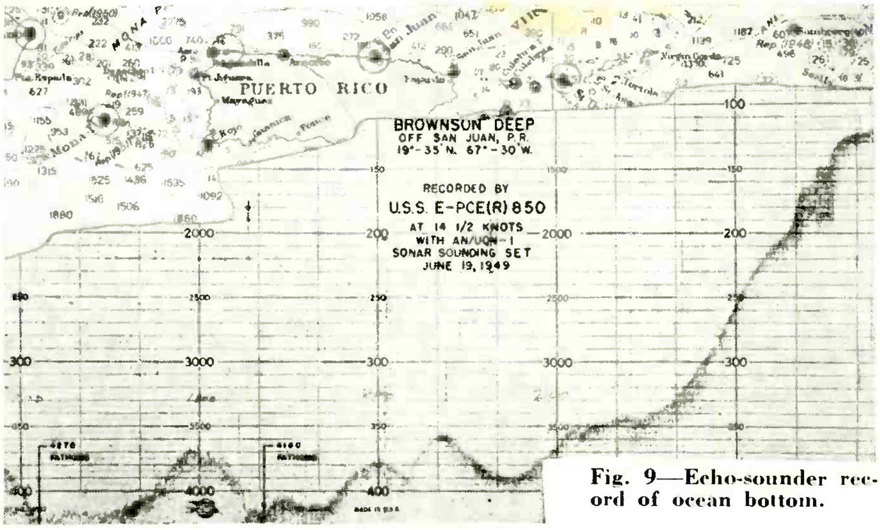



**Fig. 9—Echo-sounder record of ocean bottom.**

not only varies with depth, but also from place to place within the ocean, from day to day and throughout each day. This continuous variation makes it difficult to pick out one number to use as the velocity of sound. Sonar operators are forced to choose an aver-

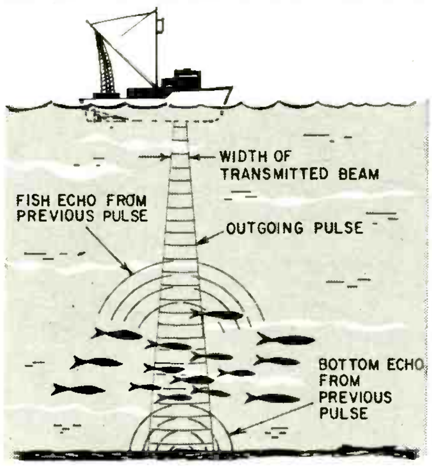



**Fig. 10—Fishing boat locating fish with vertical-beamed sonar.**

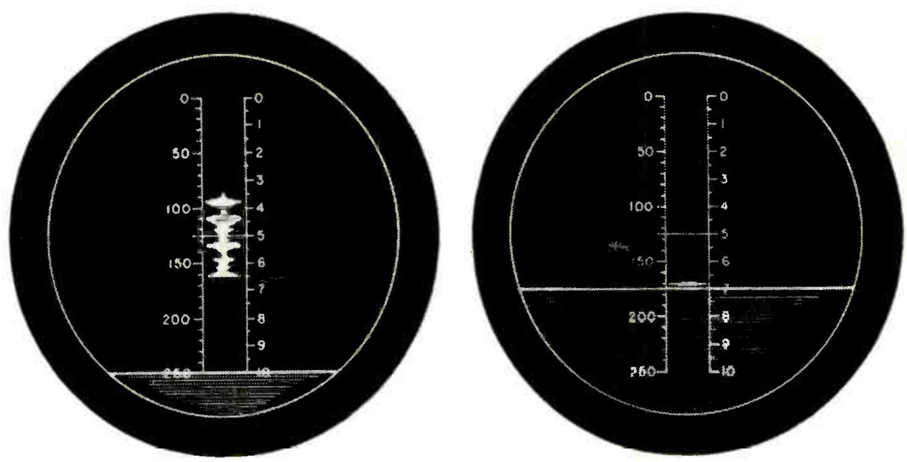
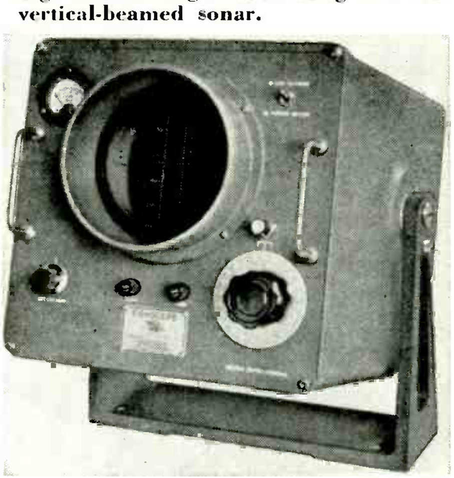


**Fig. 11—Fish-finder scope pattern showing fish 5 fathoms above the bottom. Difference between patterns is result of using different scales.**



*EDO Corp.*

**Fishscope is compact unit used by commercial fisherman to locate fish.**

age, based on the local velocity structure. With a properly chosen average set into the range unit, range errors due to velocity error will not be harmfully large.

### Depth finders

Echo sounders aren't affected greatly by the factors that create so much trouble in submarine detection. Since the beams are aimed straight down, refraction is no problem. Spreading and attenuation are compensated for by the hugeness of the bottom as a target. Echo sounders, as a result, are small and compact, and operate at low power. Even so, they must have all the components of a large sonar, or at least provide the same functions.

The echo sounder shown in the photo is completely contained, except for the transducer, in a small cabinet that can be bulkhead-mounted. It was developed for the Navy as the AN/UQN-1B echo sounder, and has now been released for civilian use. It presents a permanent record of depth information on sensitized paper (Fig. 9).

This sort of equipment is useful in ocean survey work, and is also a valuable tool for navigators. In a fog, for example, echo-sounder information can be used to pilot ships within sighting distance of shore or navigational markers.

Another small sonar is the Edo Fishscope. It does not give a permanent record, but provides an A-scope indication of water depth, and the depth of any fish that are within the beam. Fig. 10 shows a fishing boat about to receive echoes showing a school of fish just over the bottom. With this information, the fishermen can cast their nets where they know there are fish, and set the nets to the right depth to catch them. By using their Fishscope, they make more productive cruises.

The instrument has two scales for presentation of its information. One shows all the water directly beneath the boat, to a depth of 250 fathoms. The other scale, available at the flip of a switch, shows any selected 10-fathom sector of this water. In Fig. 11, the Fishscope is indicating a school of fish about 5 fathoms from the bottom, as it appears on each of the two scales. END

# Checking power transformers

We often run into a power transformer whose proper lead connections are unknown. It is dangerous to wire up such a transformer and try it out as the manufacturer may use a nonstandard color code for his leads, and you might connect the power line to the wrong ones. (It cost me one blown fuse to discover that, on one transformer, the black leads went to the filament winding and not the primary.) An ohmmeter often cannot deliver useful information, especially on larger units where all windings have fairly low resistances.

Therefore, I recommend the following method for testing a new transformer:

Take a source of low ac voltage (say, 6.3 volts) and connect it to the leads you believe connect to the filament winding of the corresponding voltage. Then measure the ac voltages at the other leads and compare the readings with what you expect. If they coincide, then your assumed assignment of leads is correct. If not, try some other leads till you hit the right ones. With this method, a wrong guess can do no damage.—*Charles E. Cohn*

# FM STEREO COMPONENT DIRECTORY

By LARRY STECKLER
ASSOCIATE EDITOR

FM STEREO HAS REALLY ARRIVED. THE SYSTEM HAS BEEN SELECTED and approved. Some FM stations are already transmitting stereo programs and others will soon follow. To receive these stereo broadcasts, FM stereo (multiplex) equipment is needed.

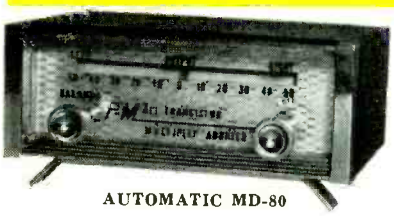
Hi-fi component manufacturers are bringing FM stereo receivers to the market as fast as possible. There are adapters for converting existing FM tuners. And there are all-new FM stereo tuners and receivers.

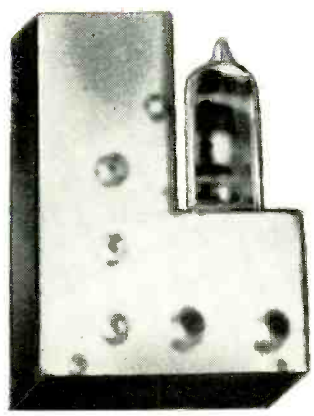
In an attempt to unravel some of the confusion, we queried all hi-fi manufacturers. We asked them about their existing and planned FM stereo gear. This directory is the result of these questions. It lists every hi-fi FM stereo adapter, tuner and receiver known at the time of writing.

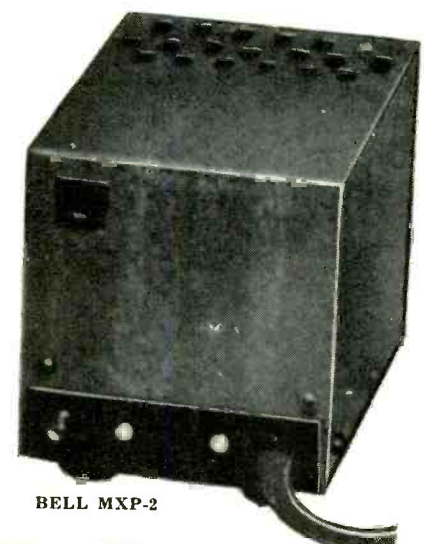
Most of the units described are already on the market or will be by the time this article is published. Wherever possible, a photo of the unit is included with the capsule report on its specifications. In some cases photos are not yet available. Some manufacturers have only prototype units that are not suitable for illustration. But it is just a matter of time before they will be coming off the production line.

On the specification end, we have attempted to abbreviate the data now available, picking out the important facts. Where a specific bit of information is given in one listing and not in the next, it just wasn't available for that next unit.

A number of circuits are used in these adapters and tuners. These will be presented and discussed elsewhere. The Crosby schematic appears this month. Others will appear in future issues.


AUTOMATIC MD-80


BELL MXA-1


BELL MXP-2


ADMIRAL AMX100

## ADMIRAL AMX100

Admiral Corp., 3800 Cortland St., Chicago 47, Ill.

**FM Stereo Adapter**

Self-powered unit is transistorized. For use with Admiral AM/FM tuners made during 1960, 1961 and 1962. Has gain of 1; frequency response, 20–20,000 cycles. 38-kc signal is suppressed 40 db. All controls are preset. Channel separation better than 26 db. 8-1/16 x 4¾ x 4 inches.

## ALTEC-LANSING 359-A

Altec-Lansing Corp., 1515 S. Manchester Ave., Anaheim, Calif.

**FM Stereo Adapter**

Self-powered adapter for Altec 353A, 309A and 312A receivers and tuners. Adapter has 3-volt low-impedance output. It has no controls and is designed to be located out of sight behind the tuner chassis.

## AUTOMATIC MD-80

Automatic Radio, 122 Brookline Ave., Boston 15, Mass.

**FM Stereo Adapter**

All-transistor FM stereo adapter for use with companion FM tuner. Operates off 9 volts from tuner or separate battery. On–off and balance controls.

## BELL MXA-1

Bell Sound Div., 555 Marion Rd., Columbus 7, Ohio

**FM Stereo Adapter** $39.95

Piggyback unit uses three tubes and two diodes. Becomes integral part of Bell tuners. Can be used with other tuners with response to 53 kc. Adapter output 1 volt. High impedance. Response 20–15,000 cycles ±3 db. Hum and noise 50 db down. 38-kc carrier and harmonics 60 db down. No controls. Channel separation, 30 db.

## BELL MXP-2

**FM Stereo Adapter**

Self-powered version of the MXA-1. Designed for use with Bell tuners, it can also be used with other tuners that have high-frequency response to 53 kc and provision for a multiplex output jack. All other characteristics the same as the MXA-1.

## BOGEN PX60

Bogen-Presto Co., PO Box 500, Paramus, N.J.

**FM Stereo Adapter** $69.50

Self-powered unit for Bogen tuners and other makes that have wide bandspread and good if linearity. Adapter output 1 volt, from low-impedance cathode follower. Response flat 50–15,000 cycles. Hum and noise 60 db down. Power, mono–stereo, stereo dimension, separation controls. 24-db channel separation. 9 x 4½ x 4½ inches.

## BOGEN RP40A

**Stereo Receiver** $399.95

Complete AM/FM stereo, tuner, preamp and dual 22-watt amplifier, with built-in multiplex. Circuit of multiplex section has same general characteristics as the Bogen PX60 adapter. Channel separation better than 20 db. 16 x 6 x 13½ inches.

## BOGEN RP200

**Stereo Receiver** $299.95

Complete AM/FM tuner, stereo preamp and dual 20-watt amplifiers. Channel separation for FM stereo better than 20 db. Multiplex section has same general characteristics as the Bogen PX-60 adapter. 16½ x 5½ x 14 inches.

## BOGEN TP60

**Stereo Tuner** $269.95

Complete AM/FM tuner with built-in multiplex section. Channel separation better than 20 db. Multiplex circuitry has same general characteristics as the Bogen PX60 adapter. 16 x 6 x 9 inches.

## BOGEN TP200

**Stereo Tuner** $199.95

Complete AM/FM tuner with built-in multiplex. Response 20–18,000 cycles ±0.5 db. 38-kc carrier and harmonics are suppressed. General multiplex characteristics same as Bogen PX60 adapter. 15 x 4¾ x 12½ inches.

## DEWALD P-400

DeWald Radio Mfg., 35-15 37th Ave., Long Island City 1, N.Y.

**FM Stereo Adapter** $47.95

Self-powered FM stereo adapter for DeWald and other wide-band FM tuners. Output 3 volts. Response 50–15,000 cycles. Hum and noise 75 db down. On–off, stereo–mono switches; stereo blend control. 4½ x 9⅛ x 3⅝ inches.

## DEWALD R-1103

**Stereo Tuner**

FM tuner with built-in multiplex circuitry. Multiplex section has same general specifications as the DeWald F-400 adapter. Complete 13½ x 4⅛ x 11½ inches.

## DYNACO FMX-3

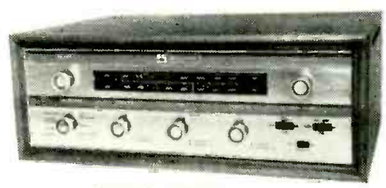
Dynaco Inc., 3912 Powelton Ave., Philadelphia 4, Pa.

**FM Stereo Adapter** $29.95

Stereo FM adapter designed to work only with the Dynatuner. Adapter output 1 volt. Response 20–15,000 cycles. Hum and noise 60 db down. Unit draws power from tuner. Separation control. Available November 1961.

BOGEN TP200

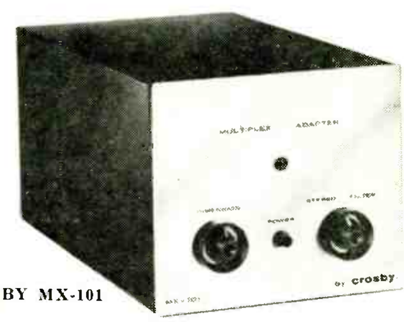

BOGEN PX60



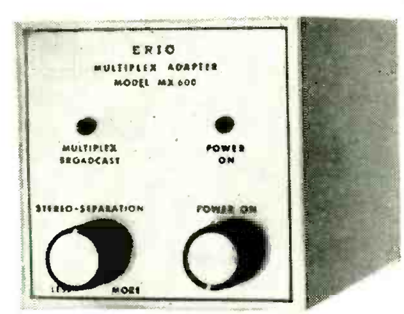
BOGEN RP200

EICO MX99

BOGEN RP40A




CROSBY MX-101




ERIC MX600-D

## CROSBY MX-80

Crosby Electronics Inc., 135 Eileen Way, Syosset, N.Y.

**FM Stereo Adapter** $49.95

Adapter is specifically designed for R-80 AM/FM stereo receiver. Adapter powered by receiver. Receiver has stereo FM controls already mounted on front panel. Adapter has the same specifications as the MX-101 adapter. 6 x 4 x 4 inches.

## CROSBY MX-101

**Universal FM Stereo Adapter** $69.95

Self-powered unit uses four tubes and two semiconductor diodes. Will work with almost any FM tuner that has a multiplex output. Dimension control varies separation with maximum of at least 20 db over the entire audio range of 30–15,000 db cycles. 5½ x 4¼ x 9 inches.

## CROSBY 650MX

**Stereo Receiver** $249.95

Complete FM tuner, stereo preamp and dual 14-watt amplifiers. Built-in multiplex section has same general characteristics as MX-101 adapter.

## EICO MX99

Electronic Instrument Co., 33-00 Northern Blvd., Long Island City 1, N.Y.

**FM Stereo Adapter** wired $64.95
kit $39.95

Self-powered adapter for use with all Eico FM equipment and any other component FM tuners that use a ratio detector and have a multiplex output jack. Filters out 67-, 38- and 19-kc carriers. Indicator lamp lights when unit is receiving stereo program. 35-db separation between channels over entire audio range. 9⅛ x 6⅜ x 3⅞ inches.

## ERIC MX600-D

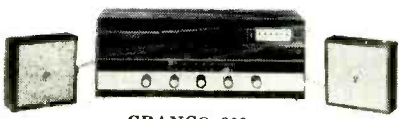
Eric Engineering, 8270 Santa Monica Blvd., Los Angeles 46, Calif.

**FM Stereo Adapter** $59.95

Self-powered unit can be used with all Eric tuners and most other makes that have wide bandwidths. Indicator lights when FM stereo program is being received. Uses Compactron tubes. On–off, stereo separation controls. 4½ x 4½ x 8⅛ inches.

FISHER MPX-100

G-E MA-2G



GRANCO 809

GROMMES 101GTA

GROMMES 500

## FISHER MPX-100

Fisher Radio Corp., 21-21 44th Dr., Long Island City 1, N.Y.

**FM Stereo Adapter**

Self-powered adapter for use with all Fisher FM tuners receivers and other tuners having ratio detectors and multiplex outputs. Stereo balance and selector switches. Stereo beacon lights to indicate stereo program is being received. 4⅞ x 4⅞ x 12 inches.

## G-E MA-2G

General Electric, Electronics Park, Syracuse, N.Y.

**FM Stereo Adapter**

Unit is self-powered. Requires input of 1 to 1.5 volts rms corresponding to 75-kc deviation. Hum and noise 60 db down. Response 50–15,000 cycles ±3 db. 10 x 2¼ x 3 inches.

## GRANCO 809

Granco, 83-30 Kew Gardens Rd., Queens, N.Y.

**Stereo Receiver**

Complete stereo receiver (AM/FM tuners, stereo preamp, dual amplifiers) with built-in multiplex circuitry.

## GROMMES 101GTA

Precision Electronics Inc., 9101 King St., Franklin Park, Ill.

**Stereo Tuner** $129.90

FM tuner with optional built-in multiplex circuitry. No stereo specifications available.

## GROMMES 500

**Stereo Receiver** $339.90

FM/AM tuner, stereo preamp, dual 20-watt amplifiers. Has built-in multiplex as an option. No multiplex specifications available.

## GROMMES 103GTA

**Stereo Tuner** $299.90

FM/AM tuner with optional built-in multiplex circuitry. No data available on multiplex section.

GROMMES 103GTA

HARMAN-KARDON T300X

## HARMAN-KARDON CITATION IIIMA

Harman-Kardon Inc., Ames Court, Plainview, N.Y.

**FM Stereo Adapter** (wired) $89.95

Mounts on and powered by Citation III FM tuner. New escutcheon for tuner allows for adapter controls. Tuner chassis already has holes for mounting controls. Wired unit available about Oct. 1. Kit version should be available before end of year.

## HARMAN-KARDON MX500

**FM Stereo Adapter**

Plug-in adapter uses two tubes and two semiconductor diodes. For use with manufacturer's F500, ST360A, ST360 and ST350. 38-kc notch filter drops out 38-kc carrier to avoid interference with bias oscillator of a tape recorder when one is used.

## HARMAN-KARDON MX600

**FM Stereo Adapter** $49.95

Snaps onto back of tuner and draws power from it. For use with TA230, TA224 and TA260 receivers. Consists of two-stage subcarrier main amplifier followed by a 19-kc synchronous oscillator. Output level 1.25 volts. Distortion less than 1%. Frequency response 15–15,000 cycles ±1 db.

## HARMAN-KARDON MX700

**FM Stereo Adapter**

Self-powered adapter for use with all Harman-Kardon tuners and receivers that have multiplex outputs. Same circuitry as the MX-600 with additional power supply.

## HARMAN-KARDON T300X

**Stereo Tuner** **$149.95**

AM/FM tuner with a built-in multiplex section. Multiplex circuitry is same as in MX-600 snap-on adapter.

## HEATHKIT AC-11, ACW-11

Heath Co., Benton Harbor, Mich.

**FM Stereo Adapter** **Kit $32.50**
**Wired $56.25**

Self-powered adapter plugs into multiplex output jack of quality FM tuners. Three-tube circuit insures low distortion with simplified balanced-diode detector. Controlled signal matrixing for maximum channel separation. Frequency response 50–15,000 cycles. 3⅜ x 3½ x 9⅞ inches.

## KARG MX-4

Karg Laboratories Inc., 132 Ely Ave., S. Norwalk, Conn.

**FM Stereo Adapter** **$64.50**

Self-powered unit will work with tuners that have a 100% modulated output between approximately 0.2 and 1 volt.


HEATHKIT AC-11, ACW-11


KNIGHT KN-MX

Adapter output 2 volts, impedance 10,000 ohms. Response 40–15,000 cycles ±2 db. Hum and noise 55 db down. 38-kc signal and harmonics 40 db down. On–off and separation controls. Channel separation 28 db. 5 x 5 x 8 inches.

## KNIGHT KN-MX

Allied Radio, 100 N. Western Ave., Chicago 80, Ill.

**FM Stereo Adapter** **$39.95**

Self-powered adapter will work with FM tuners that have wide-band if's and discriminator—to 250 kc. Audio output at least 0.4 volt at 30% modulation. Adapter output 2.5 volts. Frequency response 50–15,000 cycles. Hum and noise 50 db down. 38-kc signal and harmonics suppressed 20 db. Separation and power controls.

## KNIGHT KN-125M

**Stereo Tuner** **$179.95**

FM/AM tuner with built-in multiplex circuitry for receiving stereo FM broadcasts. Characteristics of the multiplex section are similar to the Knight KN-MX adapter.

## KNIGHT KN-136M

**Stereo Tuner** **$119.95**

FM/AM tuner has built-in multiplex circuitry with characteristics similar to the Knight KN-MX adapter.

KNIGHT KN-125M

KNIGHT KN-136M

KNIGHT KN-150M

KNIGHT KN-250M

KNIGHT KN-310M

## KNIGHT KN-150M

**Stereo Tuner** **$149.95**

Tuner with built-in multiplex circuitry. Characteristics of multiplex section similar to Knight KN-MX adapter. Has indicator light to show when stereo program is being received.

## KNIGHT KN-250M

**Stereo Tuner** **$139.95**

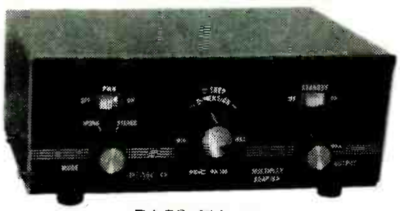
All-transistor FM tuner with built-in multiplex circuitry for receiving FM stereo broadcasts. Characteristics of the multiplex section are similar to the Knight KN-MX adapter.

## KNIGHT KN-310M

**Stereo Receiver** **$239.95**

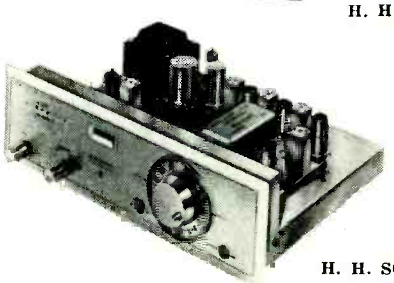
All-transistor unit has FM tuner, multiplex built-in, stereo preamp and dual 20-watt amplifiers. Characteristics of multiplex circuitry similar to Knight KN-MX adapter.

LAFAYETTE LA-215



PACO MA-100

H. H. SCOTT 335



H. H. SCOTT 350


SHERWOOD S3MX

SHERWOOD S-3000 IV

## LAFAYETTE LA-215

Lafayette Radio & Electronics, 165-08 Liberty Ave., Jamaica 33, N.Y.

**FM Stereo Adapter**

Self-powered unit will work with all tuners that deliver 0.7 volt at 100% modulation at their multiplex output. Adapter output 1 volt. Response, 20–20,000 cycles ±1 db. 38-kc signal and harmonics suppressed 50 db. Function and separation controls. Channel separation better than 30 db.

## PACO MA-100

Paco Electronics Co. Inc., 70-31 84th St., Glendale 27, N.Y.

**FM Stereo Adapter**

Self-powered adapter for Paco ST-45 and ST-25 tuners. Can also be used with many other wide-band tuners. Dimension and volume controls, mono–stereo switch. 19- and 38-kc signals are suppressed.

## PILOT 100

Pilot Radio, Corp., 3706 36th St., Long Island City, N.Y.

**FM Stereo Adapter** — **$49.50**

Self-powered adapter designed for Pilot receivers but will work with tuners that have wide-band circuits, 0.2–2 volts output at 100% modulation at their multiplex output. Adapter has 2-db gain, low-impedance output. FCC standards as to frequency response and channel separation. 5 x 3 x 12 inches.

## PILOT 200

**FM Stereo Adapter** — **$79.50**

Self-powered adapter works with wide-band tuners whose multiplex output is between 0.2 and 2 volts, with 100% modulation. Same general characteristics as the Pilot 100 but automatically switches in and out. FM stereo 19-kc pilot carrier turns adapter on. When 19-kc signal is absent, adapter goes off. 5 x 3 x 14 inches.

## H. H. SCOTT 335

H. H. Scott Inc., 111 Powder Mill Rd., Maynard, Mass.

**FM Stereo Adapter** — **$99.95**

Adapter is designed to work with Scott tuners. Output is 2 volts at 90% modulation. Frequency response 20–15,000 cycles ±1 db. 38-kc carrier and its harmonics suppressed at least 50 db. Selector, noise filter, level and adapter in–out controls. Channel separation approximately 35 db. Separate outputs for tape recorder. Indicator lights when stereo program is received. 4⅜ x 6½ x 12¼ inches.

## H. H. SCOTT 350

**Stereo Tuner** — **$199.95**

FM tuner with built-in multiplex circuitry. Frequency response 20–15,000 cycles ±1 db. Hum and noise 60 db down. 38-kc carrier and its harmonics suppressed at least 50 db. Stereo indicator lights when stereo program is being received. Channel separation 35 db or better. 4⅜ x 15 x 10 inches.

## SHERWOOD A3MX

Sherwood Electronic Labs., 4300 N. California Ave., Chicago 18, Ill.

**FM Stereo Adapter** — **$49.50**

Plug-in unit is powered by tuner it is used with. Designed specifically for S2200 and S-30000III. Two-tube circuit is similar to S3MX but does not have hiss filter and 69-kc filter is in circuit at all times.

## SHERWOOD S3MX

**FM Stereo Adapter** — **$69.50**

Self-powered unit can be used with Sherwood FM tuners that have multiplex output and wide-band detector. Adapter circuitry uses four tubes plus rectifier. Hum and noise 60 db down. Output 2 volts with less than ½% distortion. Filter circuits remove 19-kc pilot carrier and 67-kc subchannel transmission. Frequency response 20–15,000 cycles ±1 db. 5¾ x 10½ x 4 inches.

## SHERWOOD S-3000 IV

**Stereo Tuner** — **$160.00**

Complete FM stereo tuner. Adapter circuitry has phase-locked synchronous oscillator to reinsert multiplex carrier. Filter circuits remove 19-kc pilot carrier and 67-kc subchannel transmission. Frequency response of adapter section is 20–15,000 cycles ±1 db.

## SHERWOOD S-8000

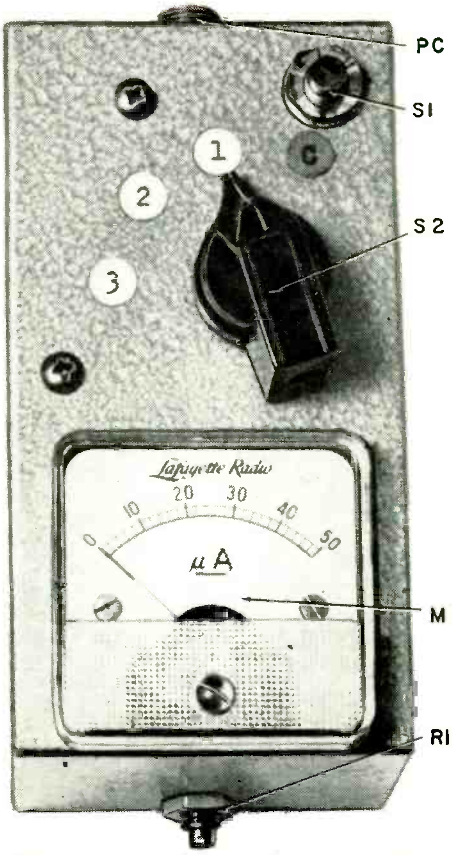
**Stereo Receiver** — **$299.50**

Complete FM stereo tuner, preamp and amplifier. FM section has controlled frequency and phase response of the if amplifier, limiters and discriminator, flat to 75 kc, for minimum distortion and maximum separation of the multiplexed signal. Multiplex circuitry same as A3MX plug-in adapter. 16¼ x 14 x 4½ inches. END

# ULTRASENSITIVE PHOTOGRAPHIC LIGHTMETER

*The photographer's dream, it measures existing light for indoor or night photography*

By ALEN E. GORDON




**Finished unit. Push S1 for light reading.**

**When taking indoor pictures or night shots, where there is a minimum of light, the average commercial light meter is useless. It just isn't sensitive enough to give a reading. But the homemade unit described here is so sensitive that it will give accurate readings for light levels that require exposures as long as 30 seconds. It is also designed to take light readings down the narrow tubes of microscopes and medical instruments. The secret is a cadmium sulphide photocell.**

The man who takes indoor pictures or night photos without flashbulbs uses very sensitive film and fast lenses. For such work, most photographers use regular light meters with a booster cell. Even this booster is often inadequate because it simply does not have enough sensitivity to measure the small amounts of light available.

In my work I take pictures down the tubes of microscopes, bronchoscopes and other medical tools. No light meter was small enough to fit into a ½- to 1-inch diameter tube and read the light accurately. Most commercial units have photocells that are about 1 by 2 inches—much too large for a microscope. Furthermore, this work requires high sensitivity, and the amount of light varies tremendously with microscope diaphragm settings, slide thickness and depth of staining. The only way in the past was to set the exposure by trial and error.

This meter is an excellent tool for all these purposes. It can be hand-held and is small enough to fit in your pocket. Sensitivity is high—it will read the dimmest light in the corner of a room lit by ordinary lightbulbs. The photocell itself is as small as a pencil eraser and, when mounted, it can easily be inserted into a microscope barrel.

## The circuit

The heart of the unit is a cadmium selenide photocell manufactured by Clairex. Use their model CL-4. It is mounted in a plastic case ¼ inch in diameter and ½ inch long. The cell is not like the usual light-meter photocell—it does not generate electricity—but it is infinitely more sensitive. Its resistance varies as the amount of light hitting it changes, adjusting the amount of voltage that can be fed through it to produce a meter reading. This is a disadvantage of the unit, it needs batteries, and the probable reason why it is not used in commercial meters although the battery drain is low, never more than 5 ma.

The circuit (Fig. 1) shows what is basically an ohmmeter for measuring the resistance of the cell. With no light hitting it, the resistance is very high. This drops as increasing amounts of light strike the cell. A 22.5-volt hearing-aid battery powers the unit. The current is read on a miniature 50-μa meter. A less sensitive meter or a lower battery voltage lowers the unit's sensitivity. The opposite is also true. If an even more sensitive meter were needed, you would have to go to high-voltage batteries. If portability could be sacrificed, a high-voltage power pack could be built or a vacuum-tube microammeter used.

The photocell is temperature-sensitive. A temperature change from 50° to 90°F causes a 5% change in the meter reading. For those who are mathematically inclined, the temperature coefficient of resistance at 25°C and 10 foot-candles is 0.25% per °C. However, this has not been a problem.

One thing that definitely has to be kept in mind is the spectral response (Fig. 2). Peak sensitivity is at 6,900 Å, which is the color red. In all ordinary scenes, this can be safely ignored. But, if the scene is pure blue and green with absolutely no color in the yellow–red range, decrease the exposure two or three stops to compensate for the lower meter sensitivity. As you can imagine, scenes composed of only blue and green light are extremely rare. In shooting many rolls of film at night along the streets of New York, I have never yet come across an overexposed shot because of this. Other Clairex photocells

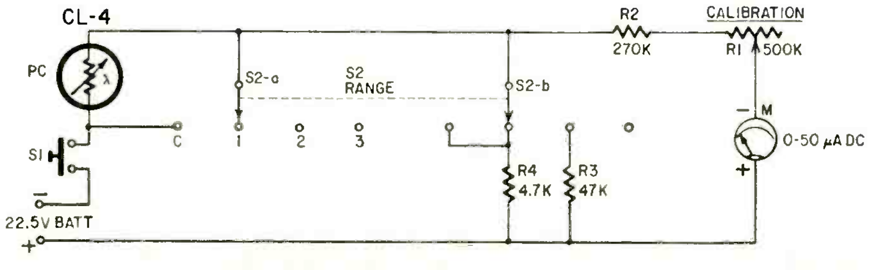
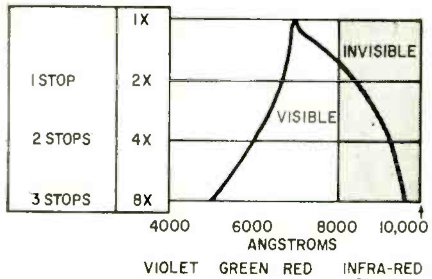



**Fig. 1—Circuit of the sensitive light meter.**

R1—pot, 500,000 ohms, miniature
R2—270,000 ohms, ½ watt
R3—47,000 ohms, ½ watt
R4—4,700 ohms, ½ watt
BATT—22.5 volts (Eveready No. 505 or equivalent)
M—0-50 μa, dc (Lafayette TM-200 or equivalent)
PC—Clairex CL-4
S1—spst normally open pushbutton
S2—double-pole 4-position rotary
Case, 1½ x 2 x 4 inches
Miscellaneous hardware




*Clairex.*

**Fig. 2—Spectral response of the CL-4 photocell.**

(high-impedance models unsuitable for a lightmeter) have peak responses in the blue–green spectrum. The high sensitivity of the CL-4 to infrared light makes this meter useful for infrared photography too.

## Construction kinks

Mount the CL-4 photocell in an ordinary bushing for a ¼-inch shaft. The exact way of mounting the cell depends on your needs. The farther back in the case the cell is, the narrower its angle of light acceptance. This is shown in Fig. 3. This penomenon is useful if you are taking a picture of very light areas with heavy shadows. The ordinary meter has a wide acceptance angle and will read an average from this scene. The only way you could properly expose the film is to get up close and read the light in the bright as well as the dark areas and then determine your exposure accordingly. But what happens if this cannot be done, as in a picture of a valley with shadows in it? Simply use the principle of Fig. 3 to make a meter of very narrow light acceptance and measure both readings from the same spot. In my unit I mounted the photocell in the bushing as deep as I could get it.

The bushing can be extended with a piece of Bakelite tubing. Paint the inside of the bushing or Bakelite tube dull black to minimize reflections. Be sure that the plastic is really lightproof because the meter is extremely sensitive. You cannot even use your finger or palm to block out the light to demonstrate that the meter will return to zero with no light. It will actually read the light coming through your finger, and you must use a piece of metal to block it off.

S1 is positioned so it is directly under the thumb. This spring-return switch is depressed to read the light or to calibrate. In this way no current flows unless S1 is on and you cannot run down the battery by forgetting to turn off the switch. The parts are laid out so S1 is under the thumb of a right-handed person, and everything has to be reversed for the left-handed. Position 1 on the meter is the least sensitive scale and position 3 the most sensitive. Position C is for adjusting the ohmmeter circuit for variations in battery voltage. At this setting the photocell is completely shorted out and resistor R4 is connected across the battery to measure the voltage with a 5-ma current drain. The meter is adjusted to full scale with R2, a miniature unit with a screwdriver shaft I adjust with my fingernail. This adjustment has to be made only rarely and the rheostat could be put inside the case.

Any 2-pole 4-position switch can be used for S2. The battery mounts in a standard aluminum bracket.

## Calibration

Calibration is simple in principle but a little tricky to carry out. In principle, you hold the meter side by side with a meter of known accuracy, and compare readings. Point them toward and away from a steady light source—use a 100-watt lamp. For example: to get the figures shown on the calibration chart in Fig. 4, set the calibrated meter for an ASA film speed of 125 and an aperture of f/2. This way all you have to read is the shutter speed. With the two meters side by side read the speed reading off the calibrated meter. On my unit, when I got an exposure time of 1/125 second, my sensitive meter read 27 μa on range 1. When the calibrated meter read 1/30 second, the sensitive meter read 14 μa on range 1 and 41 μa on range 2.

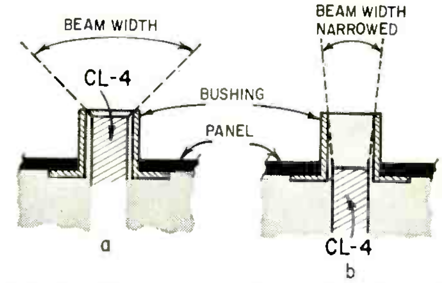



**Fig. 3—How moving photocell back into tube narrows angle of accepted light.**

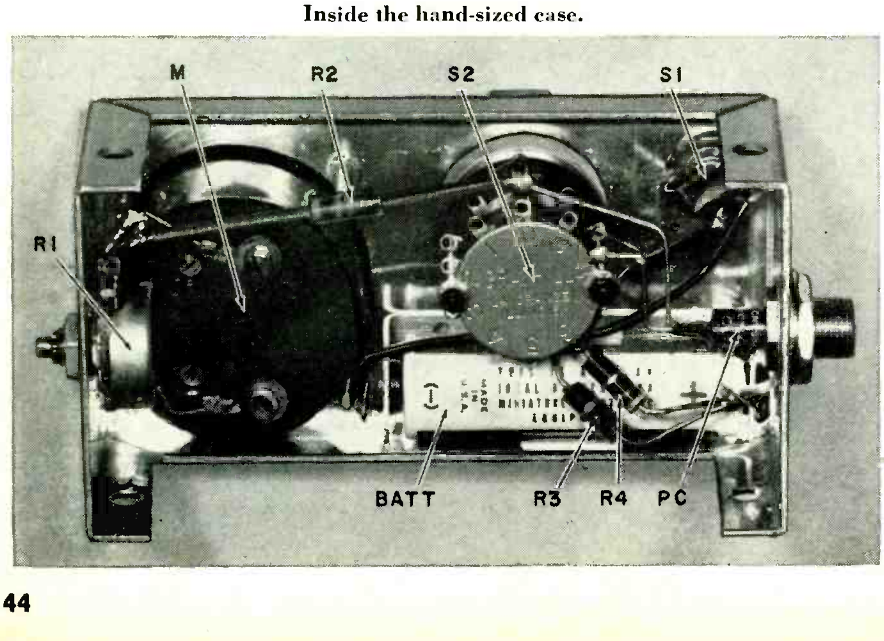
The only problem comes when you reach the lower limits on the scale of the reference meter. Then you will need a neutral density filter of some known value. These filters cut down the amount of light by some known amount and do it consistently over the light spectrum. If you do not already own one, you can pick up a filter for about $2.

Place the filter over the sensitive meter's photocell. Now when you point the two meters toward a light source, subtract the filter factor from the reading on the commercial meter. For example, if the filter has a 5-stop factor and the commercial meter read 1/30-second exposure at f/2 with an ASA film speed of 125, the reading on your sensitive meter (15 μa on range 2 and 40 μa on range 3) is equivalent to a 1/30-second exposure at a shutter opening 5 stops larger than f/2 (f/2, f/2.8, f/4, f/5.6, f/8, f/11). Or since the calibration chart assumes that the ASA stays at 125 and the aperture at f/2, shutter speed is slowed down five steps (1/30, 1/15, ⅛, ¼, ½, 1 second). Do this step by step and you will get calibrated readings that are lower than any possible with the commercial unit.

Do not hold the new and the reference meters in your hand—small angular changes result in large meter-reading changes, and all errors will affect the weaker measurements. Hold the meters firmly on a desk top and make all readings carefully. After several practice runs you will get consistent readings and make a good calibration chart.

The calibration charts for my meter

**Inside the hand-sized case.**




(ASA 125 Film At f/2)

| SPEED IN SECONDS | METER READING RANGE 1 | 2 | 3 |
|---|---|---|---|
| 1/250 | 27 | | |
| 1/125 | 23 | | |
| 1/60 | 18 | 46 | |
| 1/30 | 14 | 41 | |
| 1/15 | 9 | 36 | |
| ⅛ | 5 | 31 | |
| ¼ | | 25 | |
| ½ | | 21 | 46 |
| 1 | | 15 | 40 |
| 2 | | 10 | 34 |
| 4 | | 4 | 27 |
| 8 | | | 21 |

**Fig. 4—Basic calibration chart.**

are shown in Figs. 4 and 5. Fig. 5 is plotted on 5-cycle semilogarithmic paper. The lower scale is the meter reading: 0–50 μa. The left-hand scales are a little unusual. To understand them, you have to know something about the ASA system of rating film. In this system, which is the one used in the United States, the higher the ASA number the more sensitive the film. If you double the ASA number, you need only half the exposure time, all other things being equal.

Not knowing what type of film I was going to use, scale A was set up in "ASA-seconds at f/2." What this means is that your camera is set at f/2, then you read a figure "ASA-seconds." You read off the number, and divide by the ASA number of the film you are using. This gives the exposure time. Let us say you are using Kodachrome with an ASA rating of 10, and the meter reads 27 on the most sensitive scale (METER RANGE 3). For this, scale A at the left reads 500 ASA-seconds. (Follow 27 on the meter reading scale at the bottom of the chart until it intersects the proper METER RANGE scale. Then follow across to the left and read the answer on scale A.) Dividing this by the ASA number, 10, gives an exposure time of 50 seconds. With ASA 800 film, the exposure time is 500/800 or ½ second (the closest shutter speed). With ASA 50 film it is 10 seconds. Scale A is a general scale you can use with any type of film new or old.

To save the work of dividing out the ASA number, I also made up scales to read the exposure time for my two favorite films. Scales B and C have the ASA number divided out so you can read off the exposure times directly. Scale B is labeled "ASA 50." This is the one I use when I shoot with Panatomic X film. Scale C is labeled "ASA 125," the rating of the fastest indoor color film available today, high-speed Ektachrome. You can make up scales like this one or one like Fig. 4. It is exactly the same thing as scale C. It is set up for ASA 125 film and f/2. I then read off the exposure time vs. the meter reading.

You can make up all sorts of scales for these charts. If your camera has a maximum opening of less than f/2, the scales can be altered. In the example above with Kodachrome, if the exposure at f/2 is 50 seconds, then at f/2.8 it is 100 seconds; at f/4, 200 seconds, etc. When you make up new scales, just cut out a strip of the logarithmic paper and write the exposure times on it. Slide it up and down until it is at the right spot on the main chart and then glue it in place. That is how I made scales A, B and C.

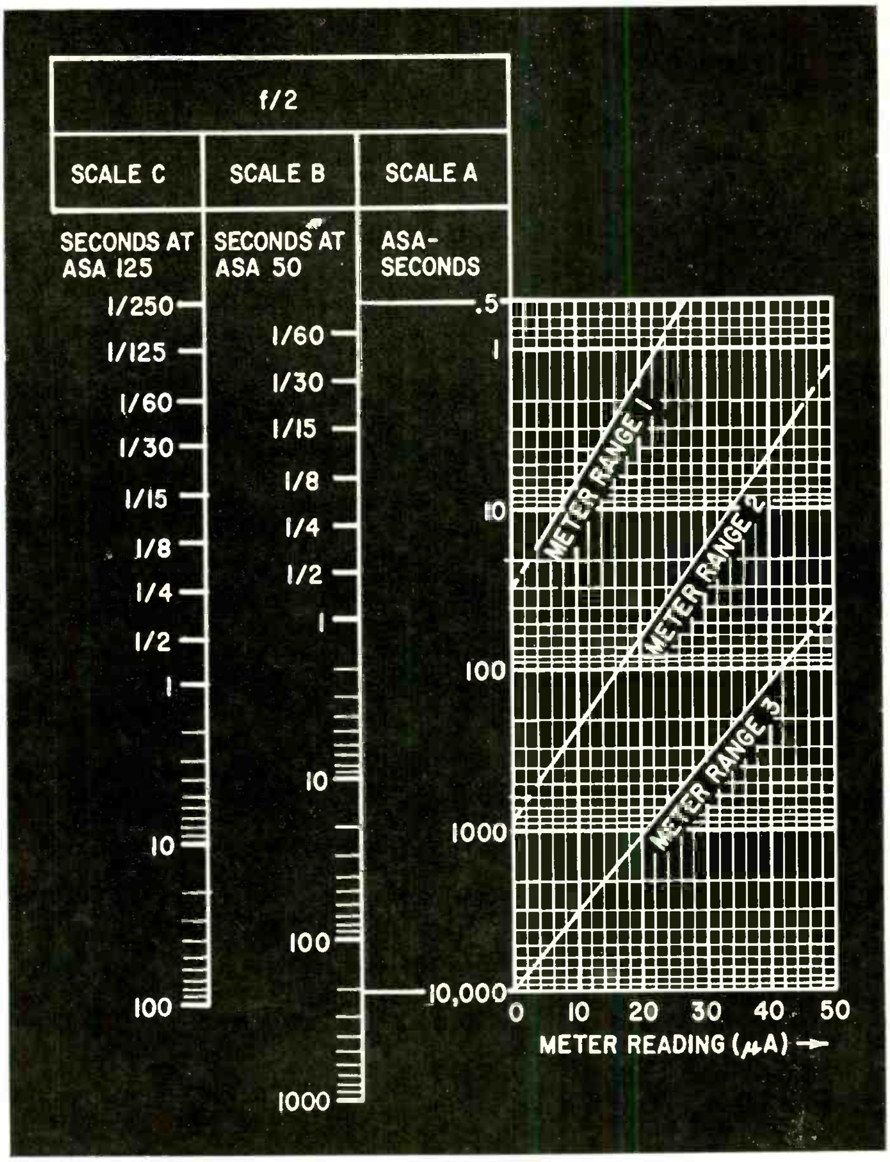



**Fig. 5—Detailed universal calibration chart.**

There are two reasons why all the scales are at an aperture of f/2. One is that this is the speed of the fastest lens I own and the one I use when shooting at night. The second is that these scales work out well when shooting with a microscope without any lens at all. The exposure times on the scales for f/2 give a perfect exposure every time.

When I do available-light photography at night, calibration curves are too cumbersome and hard to read quickly so I use a chart like Fig. 4. I put this on a card and slip it into my pocket. When doing photography of this type you need two people, the meter, the calibration chart and possibly a flashlight to read both. You hold the camera and the other person holds and reads the meter.

One final suggestion: since you will come to prize this meter, do not toss it into a case with the other photographic equipment. The face is plastic and easily scratched. It should be kept in a soft felt-lined bag. END

**NOW IT'S A LAW**

The state of Pennsylvania recently passed a law prohibiting the sale of used or reactivated radio or TV tubes unless clearly labelled. For more than five years it's been standard advertising practice in *Radio-Electronics* that all mail order tube advertisers state so specifically if their tubes are new and unused or if they are seconds or rejects.

# CONVERT TO STEREO

## How, when and where multiplex adapters can be used

By LEONARD FELDMAN*

SINCE APRIL 19, 1961, THE DAY OF THE FCC stereo multiplex decision, we have been literally deluged with inquiries concerning the problems of multiplex conversion of present-day tuners and FM receivers. Naturally, interest is extremely keen, for stereo via FM promises to provide the missing music source for stereo listening and stereo home recording.

### Are all tuners convertible?

Virtually all FM tuners now in the hands of the public can be converted to stereo by adding a multiplex adapter. That does not mean that all tuners will work equally well after conversion. Many inexpensive tuners may, because of their simple ratio-detector type circuits, actually produce better stereo results than some of the more expensive tuners featuring the well known Foster-Seeley limiter high-impedance discriminator circuit, long considered the standard in FM detector design. Problems resulting from the particular tuner design will be dealt with later. For the moment, two degrees of "readiness for conversion" should be considered: tuners that already have a multiplex jack and tuners to which this jack must be added.

### Tuners with multiplex jacks

Almost all tuners built in the last 5 years or so already have a multiplex jack. It is usually located at the rear of the chassis (or on the top of the chassis, adjacent to the ratio detector or discriminator transformer). If a circuit diagram of the particular tuner is not available, trace the actual connection of the multiplex jack to determine whether it is wired to meet FCC-approved standards.

Fig. 1 shows a discriminator circuit that does have a multiplex jack. Nevertheless, if an adapter were connected to this jack, it would not work. You will note a 300-μμf coupling capacitor in series with the MX (multiplex) jack. It was designed into this circuit at a time when it was universally assumed that *two* outputs would be required to feed a multiplex adapter—one from the MX jack, the other from the main tuner output. If such a technique had become standard, the MX jack would have provided only high-frequency subcarrier components to the adapter (easily passed by the 300-μμf coupling capacitor). The main output would have passed normal main-channel audio-frequency components. In the FCC-approved system, *all* frequency components (low-frequency audio plus high-frequency subcarrier sideband components) must be fed to the adapter from the one multiplex jack. Therefore, if you find such a small blocking capacitor, wire a low-value resistor (200 to 300 ohms) *across* the capacitor or short it out completely.

Fig. 2 shows a ratio-detector type circuit. Here, too, a multiplex output jack has been provided and, since no coupling capacitor is shown, this particular circuit is ready for connection to a multiplex adapter.

### Adding a multiplex jack

You can add a multiplex jack to an FM tuner in a few minutes. Locate the discriminator or ratio detector and examine its wiring. You will always find a series resistor, followed by a capacitor to ground whose product of values (in ohms times farads) equals approximately .000075 (75 μsec). For example, a 75,000-ohm series resistor will be followed by a .001-μf capacitor to ground. (In practice, these circuits may have R-C products ranging from 50 to 100 μsec.) This combination of values is known as the "de-emphasis network" and rolls off or attenuates the high audio frequencies which have been *pre-emphasized* at the transmitter. (The resulting audio output, after de-emphasis, has flat frequency response from 30 to 15,000 cycles.)

The multiplex connection should be made *just ahead* of this de-emphasis network (at the end of the 75,000-ohm resistor *away* from the .001-μf capacitor, for example). In locating the de-emphasis network, do not be surprised if the product of the values of R and C is not exactly .000075. In Fig. 2, for example, the resistor is 68,000 ohms while the capacitor is .001 μf, giving an apparent de-emphasis characteristic of .000068. Actually, the manufacturer is depending upon stray capacitance of some of his wiring at this circuit point to contribute the missing μμf. Then, too, certain European tuners and receivers are built to different standards, having a de-emphasis characteristic of .000050 or so.

If more than 6 inches of cable is required between the MX output circuit point and the input to the multiplex adapter, use only low-capacitance shielded cable such as RG-58/U or RG-59/U. Under no circumstances should the distance between tuner and adapter exceed 3 feet. If a phono jack is added to the chassis, use standard pin-type phono plugs at the ends of the cable that connects the tuner and adapter. Some adapter manufacturers provide a fixed

*Director of engineering, Crosby Electronics Inc., Syosset, N.Y.

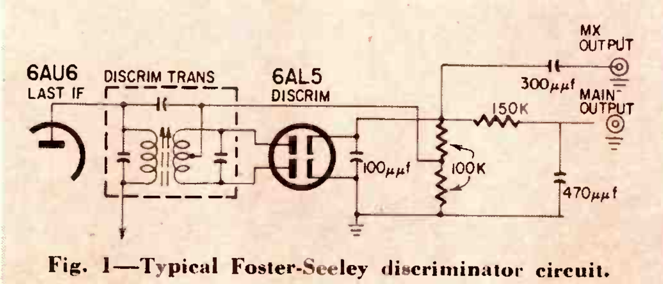



Fig. 1—Typical Foster-Seeley discriminator circuit.

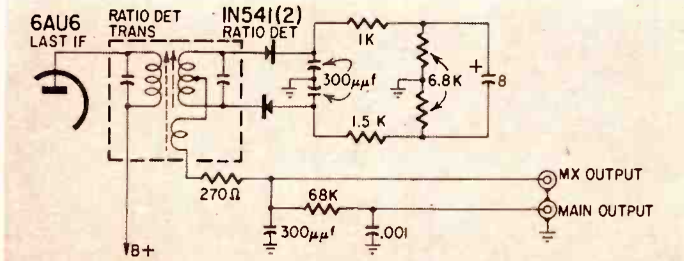



Fig. 2—Typical FM detector circuit ready to accommodate a multiplex adapter.

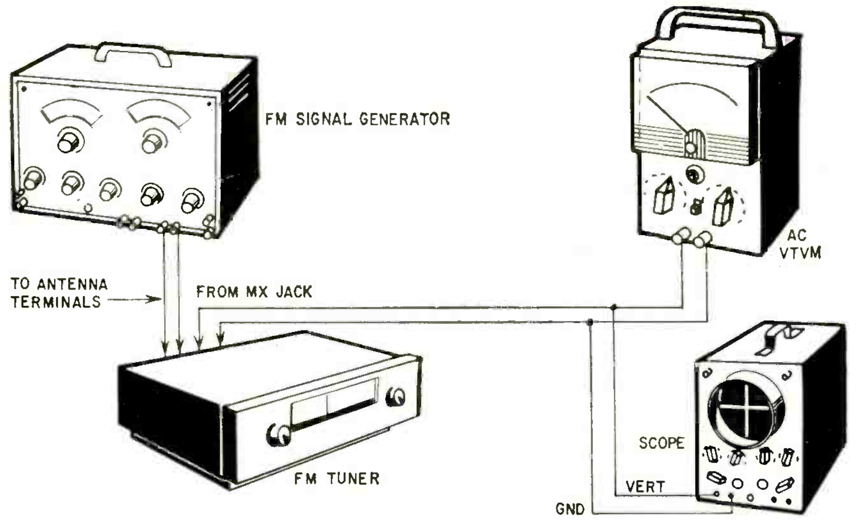



**Fig. 3—Block diagram of setup used to determine available output voltage from tuner to be converted to stereo.**

length of cable, right from the adapter, terminated in the proper pin plug. No extension cables should be added in these instances.

## Tuner output vs adapter input

Adapter manufacturers, with few exceptions, are trying to make their units suitable for use with as many commercially available tuners and receivers as possible. Nevertheless, when one considers the number of tuners and receivers already on the market (over 17,000,000) and the number of variations in their design, it becomes apparent that you must be careful when trying to match a given tuner to a given adapter. The most important consideration is output voltage available from the tuner *at its detector*.

Many tuners have a stage of audio amplification following detecton, to provide high output. This is of no use whatever, since the adapter is connected ahead of any such amplification. To determine available output from a given tuner detector, set up your test equipment according to Fig. 3. Apply an FM signal at 100-$\mu$v 75-kc deviation with 400-cycle modulation to the tuner. If your generator does not have an accurate attenuator, reduce signal strength to the lowest value available. Tune the tuner or receiver to the generator frequency and measure the audio output from the multiplex jack with an ac vtvm.

At this point it is a very good idea to observe the output of the tuner with an oscilloscope. If, at 75-kc deviation and 100-$\mu$v rf input, distortion is seen (Fig. 4), you've got a pretty good indication that the tuner is badly out of alignment. If alignment does not improve the situation, the tuner is not likely to be suitable for multiplex stereo. Check the appearance of the output at even lower levels of rf signal input. Most tuners will start showing distortion of the kind shown in Fig. 4 as the signal strength is reduced, indicating reduced bandwidth at low signal levels.

While adequate bandwidth alone does not insure perfect stereo results after conversion, lack of bandwidth is a sure sign of trouble ahead.

After determining the available output voltage, check the specifications of the adapter to be used. The important specification may appear as input voltage required from the tuner or as pilot-carrier amplitude required for proper operation. If the input voltage requirement is given, it is easy to check for adequate voltage. Where only pilot-carrier voltage required is stated, divide the tuner output voltage by 10 to determine if it is adequate. For example, let's say a tuner produces 1 volt out for 75-kc deviation, and the adapter to be used requires 65 mv of subcarrier pilot. Dividing the 1.0-volt tuner output by 10 yields 0.1 volt (or 100 mv), which is greater than the 65 mv required by the adapter. Thus, this tuner would feed enough voltage to the adapter to actuate its circuits properly.

Some wide-band tuners, while offering very good bandwidth (no distortion of the kind shown in Fig. 4, even at a few microvolts input), may not have enough audio voltage at their discriminator or ratio detector outputs. More elaborate adapters featuring extra stages of amplification have to be used with these tuners. Some manufacturers have indicated that their adapters are suitable only for their tuners, most of which have very low audio output at their MX jacks. Since these manufacturers have added gain to their adapters, there is a possibility that if these adapters were used with more conventional, high-output tuners, the high voltage available might overload this particular form of adapter. Thus, both the minimum and maximum voltage requirements of an adapter should be known.

## Signal strength vs stereo reception

Unfortunately for some prospective stereo FM listeners now in fringe areas, the FCC, in choosing the approved system, was more concerned with the monophonic listeners than with the future stereo market. The system chosen has the least degradation when a mono listener tunes in a stereo broadcast monophonically. Conversely, the system chosen has the most degradation in stereo listening of all the systems evaluated. Simply stated, this means that a barely usable mono signal strength will be unsatisfactory when stereo is broadcast on the same station. In fact, the signal-to-noise reduction can be as much as 13 to 20 db compared with mono broadcasts. Thus, a given tuner in a given installation which provided a 30-db signal to noise condition (minimum acceptable for serious listening) may have only a 10- to 17-db signal-to-noise ratio (definitely unusable) when stereo is broadcast. Another way of stating the same facts is: **the range of a station is substantially reduced when it broadcasts stereo.**

## Antenna installations

Because of the stereo range problem, the antenna installation becomes extremely important. FM users have been spoiled and expect adequate reception using little more than a hank of wire hooked to one of the antenna terminals. This arrangement simply won't do for stereo. A good rule to follow is to pay as much attention to the antenna, its location, orientation and quality as you did in the early days of TV. The FCC, while acknowledging inferior reception range for stereo, has not authorized

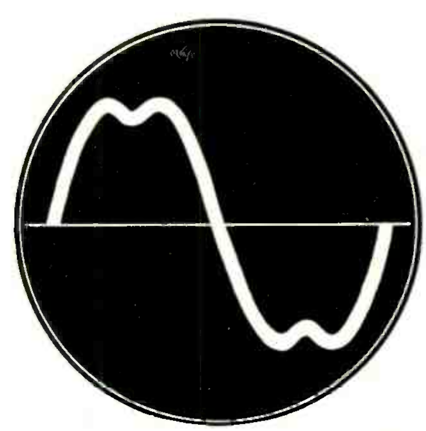


**Fig. 4—Adapter output waveform from tuner having inadequate if or discriminator bandwidth for proper conversion to stereo.**

increased transmitter power to compensate for the reduced service range. So your only solution is to increase the signal received at the tuner's antenna terminals. The mere substitution of an adequate antenna for the usual piece of wire often results in a signal improvement of 10 to 1—far more than the degradation brought about by stereo transmission.

Of course, if you already have a superior antenna installation, but the distance to the transmitter is so great as to make mono performance barely usable, don't even try a stereo conversion. The only solution in such instances is to buy a new and more sensitive tuner. Such extreme situations should

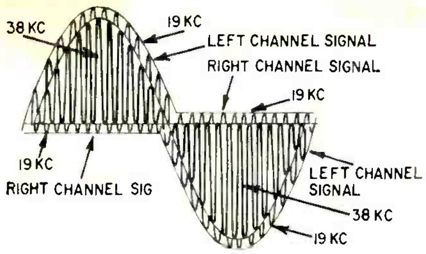



**Fig. 5—Properly recovered composite signal (only left channel has program material) suitable for multiplex adapter input.**

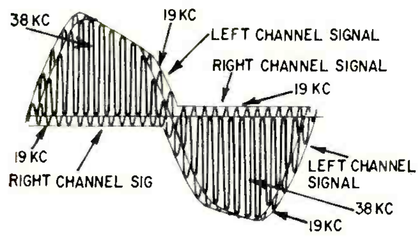



**Fig. 6—This composite waveform shows signs of diode clipping. If such a signal is applied to any multiplex adapter, the output signal will have high audio distortion.**

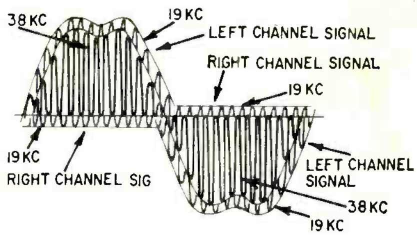



**Fig. 7—Recovered waveform from a tuner that has inadequate bandwidth.**

be few and far between, however, particularly in view of the mushrooming growth in the number of FM stations throughout the country.

## Adapter output connections

In approaching the problem of connecting the adapter outputs to amplifier inputs, we are on more familiar ground. Here, two ordinary shielded phono type cables can be used. If the adapter has cathode-follower output circuits, lead length is not critical and may be as great as 200 feet. The adapter outputs should connect to a pair of high-level high-impedance inputs on the amplifier. Many recent stereo amplifiers have an MX position on the selector switch. Use the pair of inputs corresponding to this position of the selector switch. Actually, these inputs are similar to aux or tuner positions on earlier amplifiers and those positions may be used.

Once the adapter has been connected, the MX amplifier input is used for either stereo or monophonic FM listening. Either way, signal is fed to *both* speakers when the adapter is used. If the tuner is an AM–FM unit, and AM listening is desired, the regular main output connection from tuner to amplifier must be retained, and the selector switch will have to be set to the tuner position.

## Adapter location

Some adapters have controls on their front panels, others do not. Obviously, those that feature controls such as special noise filters, separation controls and even balance controls should be installed so they are accessible during normal use. Adapters without front-panel controls can be installed inconspiculously so no front-panel cutout is required. All adapters, however, must be adjusted after being installed. This technique will be discussed shortly.

## Problem tuners

As mentioned earlier some narrow-band high-impedance discriminator type sets may cause trouble when adapters are added. Formerly, the discriminator (and, for that matter, the if circuits) handled low-frequency audio (up to 15 kc), and were called upon to detect such signals faithfully. Now, in addition to recovering audio, the discriminator must detect audio plus an assortment of frequencies ranging from 19 to 53 kc. Not only must these frequencies be recovered with low distortion, but with faithful amplitude and phase response as well. Lack of accurate phase response results in decreased stereo separation. (A left-only signal will produce some output from right channel, just like a lower-grade stereo cartridge.)

Improper amplitude response causes distortion in the output signal and usually decreases separation, particularly where high-frequency audio tones are involved. Distortion in the recovered composite waveform, however, will cause really serious distortion. Since these detectors have high output impedances, they are extremely susceptible to high-frequency rolloff because of the cable capacitance between discriminator and adapter as well as because of their own rf filter capacitor (100 $\mu\mu$f in Fig. 1). This filter capacitor has an additional detrimental effect known as diode clipping.

Fig. 5 shows the composite waveform of a left-only or right-only signal as seen at the discriminator output when a single tone is transmitted. Fig. 6 shows the same signal after having undergone severe diode clipping. Fig. 7 shows the same waveform reproduced by a set whose discriminator has insufficient bandwidth. Waveforms in Figs. 6 and 7 will result in severely distorted audio output from the adapter. There is nothing the adapter can do to correct these deficiencies—they are inherent in the tuner itself. The defect of Fig. 7 can to some extent be rectified in the tuner by rewiring the discriminator output, lowering the output impedance of the discriminator (and hence improving the frequency response of this circuit) by about 2 to 1. The changed values are shown in Fig. 8 and should be compared with the circuit of Fig. 1.

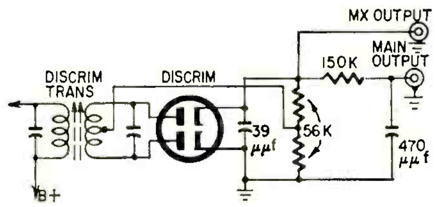



**Fig. 8—Suggested modification of Foster-Seeley discriminator reduces its output impedance and minimizes effect of diode clipping (Fig. 1).**

## Adapter problems

It is far too early to attempt to predict what service problems will arise in adapters themselves, nor is this discussion intended as a circuit troubleshooting course for adapters. Certain adjustments, however, have already been found to be critical, and these will be mentioned (Fig. 9).

## Separation

As you no doubt know by now, stereo programs are transmitted by one FM station by sending L + R (the sum of both channels) in the usual manner. L − R (the electrical difference between both channels) is transmitted via an ultrasonic subcarrier and its sidebands. Actually only the sidebands are transmitted—the subcarrier itself is suppressed. A low-amplitude 19-kc pilot signal is also transmitted so the subcarrier can be reinserted in proper phase relationship to the sidebands at the receiving end.

The separate L and R are recovered by performing the following electrical additions and subtractions: $(L + R) + (L - R) = 2L$ and $(L + R) - (L - R) = 2R$. It is obvious that exactly equal amounts of L + R and L − R must be added and subtracted to and from each other to recover a distinct L and a distinct R. If these L + R and L − R quantities are not recombined in proper proportion, the L signal will have some R mixed in and the R signal will contain some L—stereo separation will be reduced. The FCC requires that these two quantities be transmitted in correct proportion. There is no guarantee, however, that a given tuner will recover them in the same proportion. Usually, the L − R information (contained in the frequencies from 23 to 53 kc) is attenuated compared with the L + R information because of the poor high-frequency response of the detection circuit of most tuners.

This is even true to a certain degree in tuners using ratio detectors. Therefore, adapter manufacturers have incorporated a separation or L + R control which varies the amount of L + R with respect to a fixed amount of L − R as it appears at the output of the tuner in the form of ultrasonic sidebands. The manufacturer can adjust this control only on the basis of L + R being equal to L − R (the FCC standards). Nearly always, this control will have to be adjusted after the adapter is hooked up, to get best stereo separation. This should be done during a stereo broadcast during which, it is hoped, the announcer will give listeners an opportunity to make this adjustment

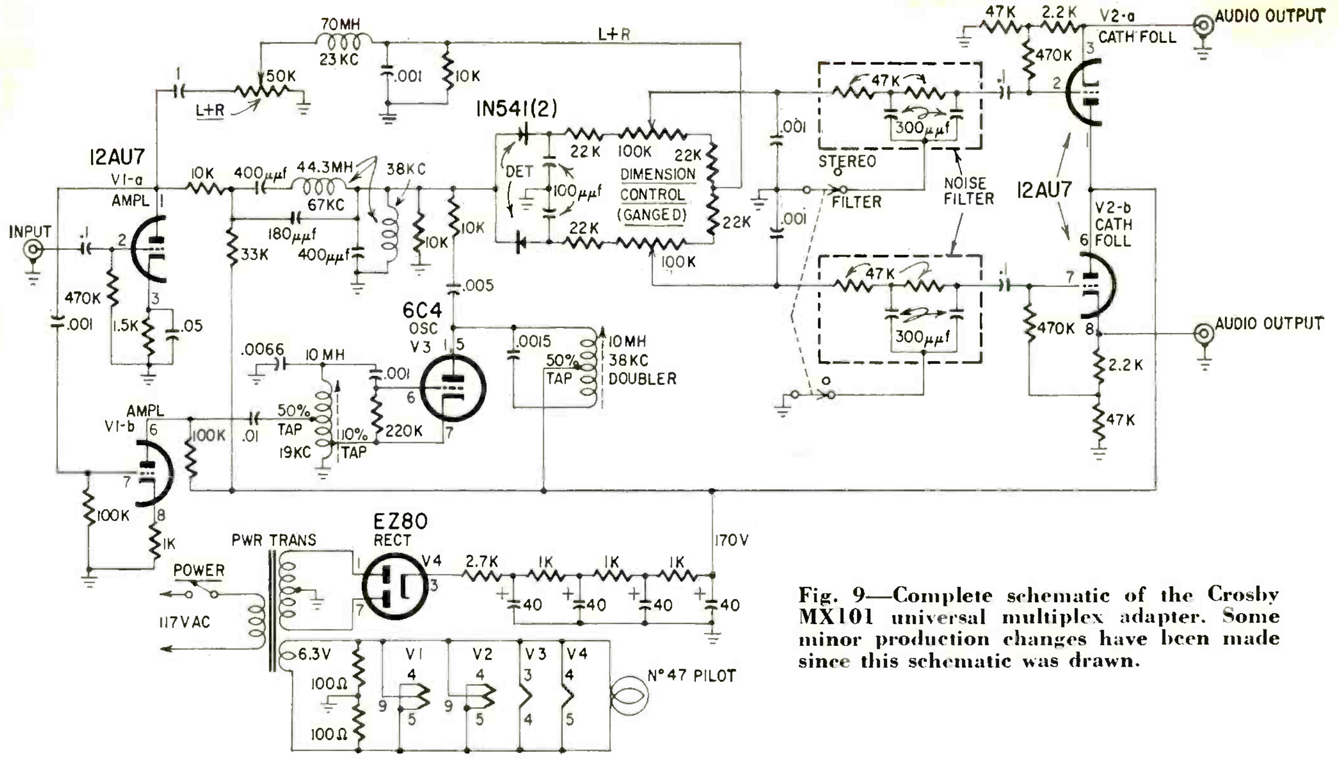



**Fig. 9—Complete schematic of the Crosby MX101 universal multiplex adapter. Some minor production changes have been made since this schematic was drawn.**

by indicating that he is speaking from the left or right microphone.

### Phasing control

In the FCC-approved stereo broadcasting system, the 38-kc subcarrier is not transmitted. Only its sidebands actually go out over the air. Therefore, the subcarrier must be restored and added to its sidebands in the adapter. For minimum distortion and maximum separation, the phase relationship of the 38-kc carrier (redeveloped by a local oscillator in the adapter) and its sidebands must be faithful to the original as transmitted. The local oscillator is locked in by a low-amplitude 19-kc signal transmitted along with the sidebands and main-channel information. This signal, of course, bears a fixed phase relationship with the 38-kc subcarrier that was suppressed at the transmitter. With any synchronized oscillator, however, the oscillator can be locked over rather a wide range, the 19-kc signal effectively pulling the oscillator into correct frequency, but not necessarily into correct phase relationship. The oscillator must, therefore, be adjusted by the manufacturer, not only for lock-in when a 19-kc synchronizing signal is applied, but also for optimum phase conditions. There is test equipment which synthesizes the composite signal, and such adjustment can be precisely made only with this type of equipment. Since this equipment is intended primarily for laboratory and production work and sells for $1,000, most service technicians will not make this investment now. In the absence of such a signal generator, proper phase can be approximated by slightly readjusting the oscillator for best separation and least distortion during a stereo transmission. This should not be attempted unless absolutely necessary (factory adjustment will hold very well, unless the tuner used exhibits severe phase distortion) and then only after the separation control has been adjusted for best separation.

Of course, if the oscillator is entirely "out of lock," you will have to retune the oscillator until it is locked in. (An out-of-lock condition is indicated by motorboating (low-frequency oscillation) heard when stereo broadcasts are transmitted. After the oscillator is set, adjust phasing as outlined above. Such severe mistuning is rare. It could only be caused by improper alignment at the factory, severe shock in shipping or unusually high operating temperature (indicating inadequate ventilation of the adapter).

As more and more adapter circuits become available, RADIO-ELECTRONICS will analyze them in detail. For the time being, we feel this article will help familiarize the service technician with some of the problems he is sure to encounter as he approaches what promises to be the next lucrative "service market" in the ever-growing consumer electronics field. END

# "Line-of-Sight" 136 Miles

The world's longest point-to-point microwave beam for TV relay service operates from a 9,000-foot peak near Salt Lake City across the length of Great Salt Lake and through a mountain pass to a receiving point on 7,000-foot-high Albion Peak in Idaho. A connecting microwave link relays it from there to KID-TV, Idaho Falls. According to C. H. College of the broadcast and television equipment division of RCA, the 136-mile link constitutes an absolute record. He pointed out that line-of-sight relay stations are normally spaced 25 or 30 miles apart, and stated that the long hop, eliminating a number of relay stations, resulted in a noticeably clearer incoming signal at the KID-TV transmitter.

# stop horizontal oscillator drift

*Get rid of that intermittent horizontal wiggle, twisting and jumping*

By WAYNE LEMONS

**Perhaps no trouble is more annoying than a TV set that seems to perform perfectly, only to become intermittently inoperative after being thoroughly "cooked" in the shop and finally delivered to the customer's home. One such trouble is horizontal oscillator drift.**

The drift (frequency change) may occur only after the set has been on for several hours. It may be slight, and resetting the horizontal hold control may correct it temporarily. Sometimes the customer may have to reset the hold control only once during an entire evening.

Other times the fault may take the form of suddenly jumping out of horizontal sync at station breaks or when changing channels. It may go out only one frame (representing a 60-cycle horizontal oscillator change) or it may "take off," going out several frames and producing numerous horizontal lines on the screen.

Just about any type of horizontal oscillator must have a stability better than 0.4% if it is to perform properly. Actually, though, by its very nature, which requires that it be controllable, a horizontal oscillator cannot be too stable! This means that, to perform acceptably, it must be neither too tight (hard to control) nor too loose. A too-tight oscillator tends to take off on its own and pay very little attention to the control voltage. On the other hand, a too-loose oscillator responds well (generally) to control voltages, but may be easily upset by noise pulses and may bend and weave if sync is unstable.

The tightness or looseness of an oscillator is determined by the overall design of the circuit. In servicing, design factors usually need not concern us. Our job is to get the darn thing working again.

On occasion, though, we may run into a set that is short in the design department. If the set has a record of horizontal oscillator problems, some technicians rebuild the entire circuit, using a layout they know is stable. If you should decide (in the heat of battle) to rebuild the horizontal oscillator, don't change oscillator types! For instance, don't replace a Synchroguide with a multivibrator unless you are prepared to modify the sync system too.

There are exceptions, of course. On an older Sylvania model, the one that used a special oscillator and sync input transformer (Fig. 1), we changed the circuit to a Synchroguide; we had to get a new transformer anyway and the Sylvania replacement was not readily available.

## What causes drift?

There are probably just as many possibilities as there are components in the oscillator and sync sections of a particular receiver. Experience, however, has taught us that some are much more frequent offenders than others.

First, let's take the familiar and most widely used circuit—the multivibrator. This is simply an amplifier with the output fed back into the input, through cathode coupling, in the correct phase to sustain oscillations. A ringing coil "tightens up" the circuit.

The size of resistor R1 in Fig. 2 plays an important role in just how "tight" the ringing coil makes the circuit. If the resistor is smaller, the ringing coil has more stabilizing effect and thus the oscillator becomes less responsive to sync control. It is our opinion that the correct size for this resistor is the one that will let the oscillator just work with the ringing coil shorted out. This is usually about 6,800 ohms.

A dc voltage developed by the phase detector controls the speed of the oscillator. The phase detector may be a dual diode tube but in recent years semiconductor diodes have been used by most manufacturers. The phase detectors measure the speed of the oscillator as compared to the sync input and develop either a positive or negative voltage, depending on this information. If something goes amiss in the phase detector circuit, such as a defective diode, the horizontal oscillator is sent an incorrect control voltage. Either a highly negative or a highly positive voltage on the oscillator control grid will stop the oscillator. Even if the voltage is not high enough to block the oscillator, it may

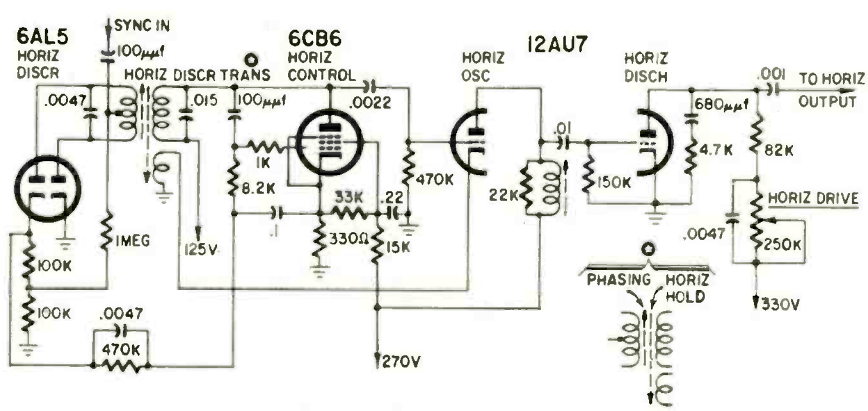



**Fig. 1—This complex horizontal oscillator and control circuit can be replaced easily with a Syncroguide circuit. Use a 10-μμf sync input capacitor.**

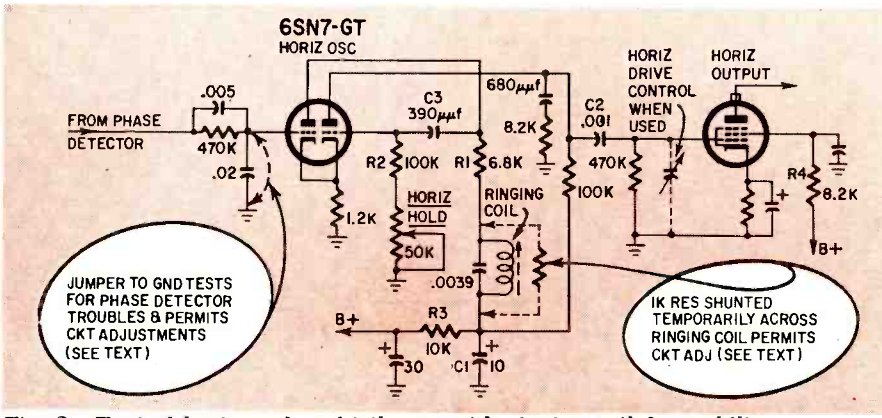



**Fig. 2—Typical horizontal multivibrator with ringing coil for stability.**

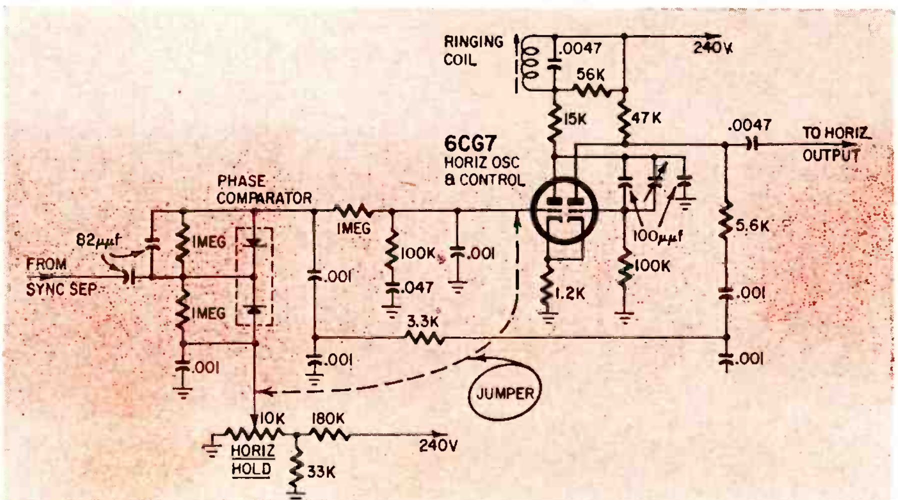



**Fig. 3—Using jumper to disable sync where grid is not normally at zero voltage.**

change the frequency so much that little or no high voltage is developed.

It follows, then, that a fault in the phase detector system can cause horizontal oscillator drift. A classic example of this occurred in G-E and Hotpoint portables a few years ago. Defective semiconductor diodes caused the raster to disappear when the set was tuned to a station, but the raster and high voltage returned when off channel.

Fortunately, it is usually simple to tell whether the trouble is in the oscillator or the phase detector stage by grounding the control grid with a jumper (Fig. 2). This completely eliminates the phase detector (and sync) as a source of trouble.

If you have severe oscillator drift, simply ground the control grid. The picture won't lock in, of course, but you'll be able to tell if there is a recurrence of oscillator drift. If, after operating the set a while, you find very little change in the "floating" speed of the picture, you can reasonably assume that the oscillator is stable. If the picture goes way out of sync or the raster disappears when you remove the jumper, you know the trouble is in the sync circuit. This method works with all horizontal multivibrators that normally have zero bias on the sync input grid. For circuits like the one in late-model Emersons (Fig. 3), connect the grid back to the center arm on the horizontal hold control, since the grid normally operates about 6 volts positive.

### Check for natural resonance

Shunt the ringing coil with a 1,000-ohm carbon resistor. High voltage should remain and the picture should stay in sync. If the oscillator changes frequency drastically, you can be almost certain of an unstable oscillator. Why? Because the natural resonant frequency of the oscillator circuit (with the ringing coil out of the circuit) is not 15,750 cycles. This means that, even though you may be able to lock the picture by (mis)adjusting the ringing coil, there is continuous "warfare" inside the oscillator circuit. A sudden noise pulse, a loss of sync or a change in line voltage may let the circuit take off, and it will be impossible for the phase detector to recapture the oscillator.

### To adjust a multivibrator

1. Remove sync by shorting the sync-controlled multivibrator grid.
2. Shunt the ringing coil temporarily with a 1,000-ohm resistor.
3. Adjust the horizontal hold control (not the ringing coil) until the picture floats by slowly.
4. Remove the 1,000-ohm shunt from the ringing coil.
5. Adjust the ringing coil until the picture floats by slowly. (Do not touch the hold control.)
6. Remove the sync short; the picture should lock in. If there is only a slight out-of-sync condition, adjust the hold control for a locked-in picture.
7. If the picture is far out when the sync short is removed, either the control grid does not normally operate at zero voltage or there is trouble in the phase detector circuit.
8. In sets without a resistance hold control, juggle values of either R2, C3 or both (Fig. 2) until the picture floats by with sync shorted and ringing coil shunted. A resistance–capacitance substitution box is ideal for this.

### Defective components

The most common cause of drift other than misadjustment is electrolytic bypasses. C1 in Fig. 2 may partially open, causing the oscillator to become erratic or slow to stabilize. Many circuits do not use the 10,000-ohm decoupling resistor (R3) and rely on the B-plus electrolytic alone to bypass horizontal currents. It is very possible for a B-plus electrolytic to cause horizontal instability without producing any other apparent symptom.

In our experience, coupling capacitors and resistors give the least trouble, at least those in the oscillator circuit proper. C2, coupling the oscillator to the output tube, is a frequent offender, however. Slight leakage here affects the oscillator plate voltage as well as the loading. C3, used in older circuits, will cause instability if it partially opens, especially if the oscillator design is critical.

An instability condition that is hard to trace sometimes occurs if the screen resistor (R4) burns and changes to a low value. This in turn causes the output tube to "gas" and load the oscillator circuit.

The ringing-coil circuit can cause trouble but the shunt method of testing makes it easy to determine. The 1,000-

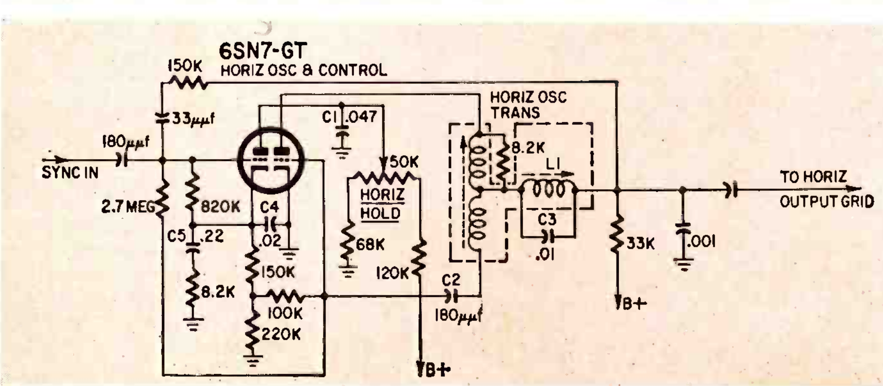



**Fig. 4—Typical Synchroguide circuit.**

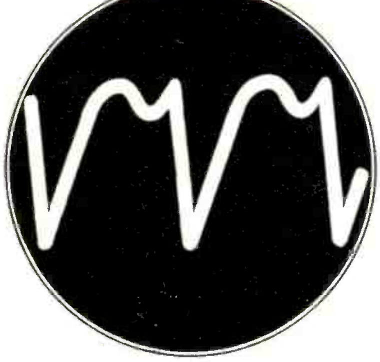


Fig. 5—Synchroguide waveform as seen on scope. Use a low-capacitance scope probe.

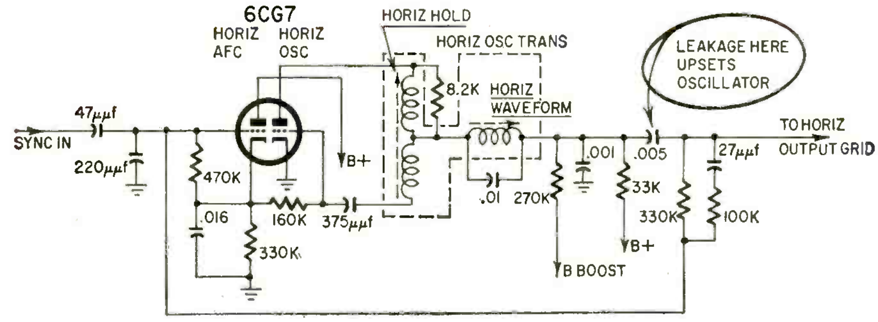



Fig. 6—Synchroguide circuit in Silvertone 528.50060. Leakage in circled capacitor can cause some unusual symptoms.

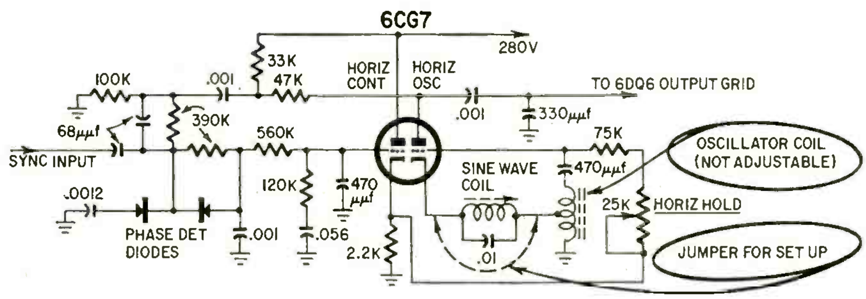



Fig. 7—Synchrophase circuit in RCA KCS-131 chassis.

ohm shunt will eliminate the ringing coil as a factor in determining the oscillator frequency.

### The Synchroguide

Drift in the Synchroguide is a little harder to isolate than in the multivibrator since the control circuit is tied with the oscillator so intimately. It is hard to separate them for testing.

Basically, the Synchroguide is a blocking oscillator with a stabilization circuit (L1–C3, Fig. 4). A second triode changes the oscillator speed in accordance with sync information.

A misadjusted stabilization circuit is the greatest cause of instability. It can be properly adjusted only with a scope and a low-capacitance probe. Fig. 5 shows the correct characteristic waveform with the picture locked in.

The Synchroguide is all high-impedance circuitry. Because of this, it is most susceptible to slight leakage in capacitors. Always check C1, C2, C3, C4 and C5 with a good leakage checker (one that puts 100 volts or more on the capacitor being tested). Any capacitor that shows even slight leakage should be replaced with exactly the same type. Do *not* replace any capacitors in this circuit with ceramic units unless you are sure of their characteristics!

The Sears Synchroguide is a little unusual (Fig. 6) in that bias for the control tube is taken from the output tube grid. The .005-μf coupling capacitor is a frequent offender in this circuit. Slight leakage here will upset the oscillator control without affecting the high voltage. A horizontal jitter or "pie-crust" effect is the usual result. This capacitor is part of a printed component pack but it may be pried loose and a paper .005-μf unit substituted.

### RCA Synchrophase

This circuit is a first cousin to the Synchroguide. This particular model (Fig. 7) uses diode phase detectors but other models use control circuits similar to the older Synchroguides.

**A scope cannot be used to adjust the** Synchrophase. Follow this procedure:

1. Turn the horizontal hold to extreme clockwise position.
2. Connect a jumper across the sine-wave coil.
3. Connect a jumper from grid to ground of the sync amplifier tube (not the control tube).
4. Adjust the horizontal hold control until a picture floats by slowly.
5. Remove the jumper across the sine-wave coil and adjust the coil until the picture again floats by slowly.
6. Remove the sync short. The picture should lock in.

Because the Synchrophase is a new circuit, not much service information has been received from the field. Probably it will be subject to essentially the same faults as the Synchroguide.

### Oscillator-drift check points

1. Check capacitors for leakage.
2. Check electrolytics for opens or partial opens.
3. Check for unsoldered terminals. These sometimes escape detection for years.
4. If the set uses semiconductor diode phase detectors, check for good front-to-back ratio with an ohmmeter. Both diodes should have about the same ratio.
5. Make sure adjustments are correct.
6. Do not use ceramic capacitors for replacements unless you are absolutely sure of their characteristics.
7. Check tubes critically for gas content and heater–cathode leakage.
8. If the customer's complaint is slow drift, enclose the set in box and let it play for 2 hours before delivery to make sure you have found the trouble. END

# Fiber Optics in New C-R Tube

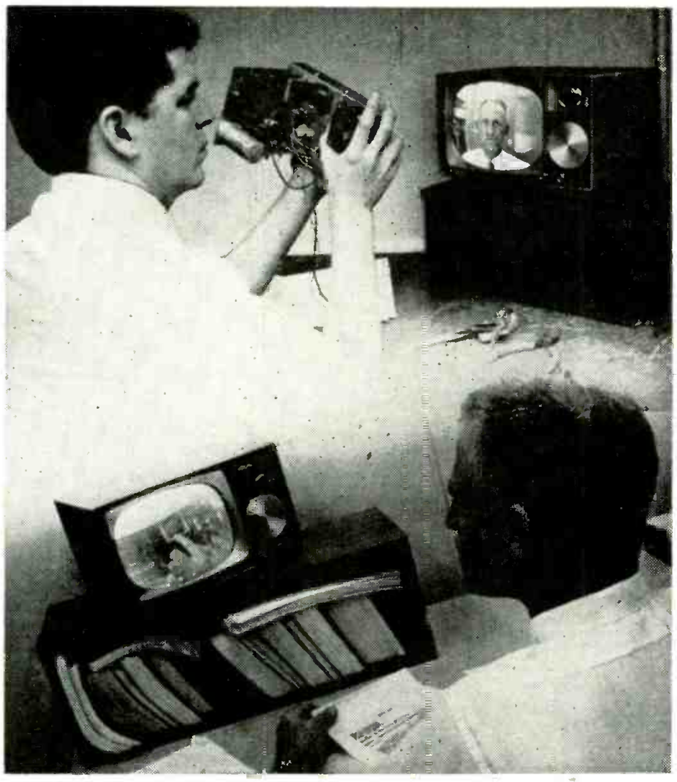
Du Mont has announced a cathode-ray tube with a glass fiber faceplate. The faceplate of the 1⅞-inch tube is made up of more than 6,000,000 glass fibers, 10 microns in diameter. Light originating from any point on the phosphor layer inside the faceplate is carried down one or more of the glass rods without spreading or halo effects. Since the image is carried direct to the outer surface, all parallax is eliminated. The tube, which costs $900, is expected to be used in such applications as flying-spot scanning, photographic printing, and coupling to fiber optical systems.

Fiber optics is also used in an image storage panel patented by Joseph T. McNaney, inventor of image display tubes. In this panel, each individual fiber is covered with a coating of selenium as a photoconductive medium. The inside surface is coated with a transparent conductive material which makes contact with the photoconductive fibers. The outer surface has a coating of electroluminescent material, over which is a transparent conductive layer. The two conductive layers are connected across an ac supply in the manner of a conventional luminescent panel. A light image projected on the back of the panel produces a luminescent image on the front. Light feedback keeps the image displayed until the power is turned off.

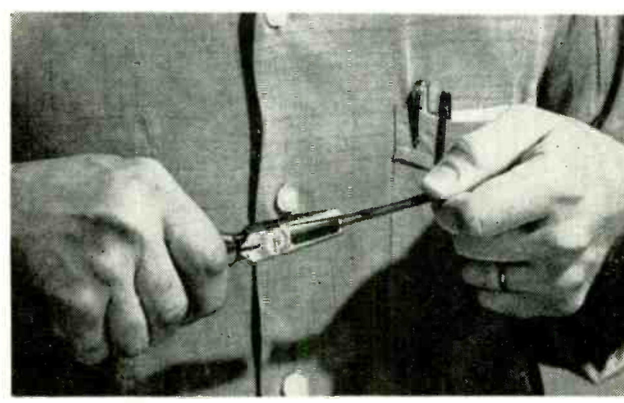
Fiber optics is based on the principle that light entering a glass or other light-conducting rod at one end may be trapped and continue to the other end, even if the rod is curved or doubles back on itself. Thus the rod becomes a waveguide for light. Possible applications of fiber optics in electronics were discussed in Hugo Gernsback's editorial in the August, 1960, issue.

# What's New

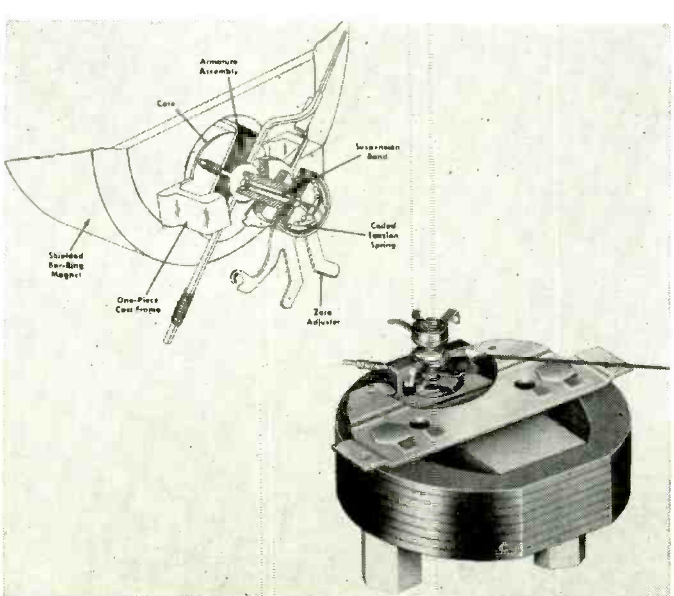
**SPACE-AGE GAUGE** directly measures atmosphere density in space. "Pressure" from $10^{-3}$ to $10^{-11}$ mm of mercury are within its range. Already tested in an Aerobee Hi rocket, these Westinghouse units are expected to be used to gather data at altitudes from 70 to 125 miles.



**EXPERIMENTAL AUDIO-VISUAL** communications system designed by Motorola may become the intercom of the future. Called ***Visicom***, it uses only simple video-frequency circuitry. Possible uses would include door answerer, baby sitter, communication between executives in separate offices, teacher–student or supervisor–workman communication and similar applications. For door answering and baby watching, the unit could be simplified, with camera in one unit and monitor in another.



**STRIPPING TWIN-LEAD**, subject of more than one how-to-do-it hint or kink in service magazines, is now reduced to a science. These special pliers, made for the job, are placed between the leads, then all insulation removed neatly with one quick jerk. The new tool, made by Kraeuter & Co., can also be used as end-cutting pliers.




**NEW IDEA IN METERS** makes instruments shock-resistant, increases accuracy and all-round ruggedness. In the new Triplett Suspension panel instruments, the moving-coil and pointer assembly is supported on a thin, narrow band kept tightly suspended between special spring terminals. No pivots, jewels or hairsprings are needed. Torsion returns the pointer to zero, and the coil-spring terminals take up the shock if the meter is jarred or dropped.

# BUILD

# A QUALITY STEREO PREAMP

*4-tube unit is easy to assemble*

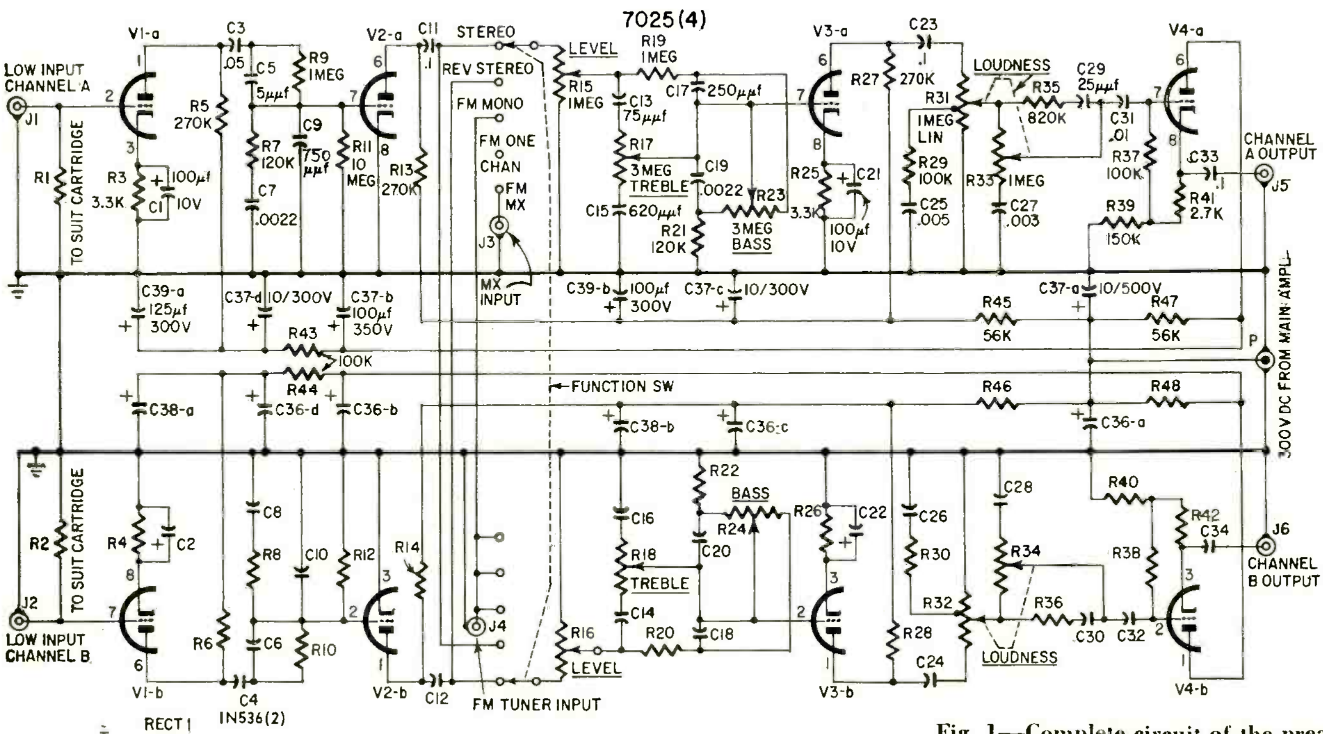
By W. R. WILLIAMS

**Here is a sweet little stereo preamp that is well worth the time it takes to put it together. It uses standard parts yet has a dual loudness control of the type normally found only in monaural preamps. Other features are maximum bass and treble boost and a dc heater supply. Four 7025 tubes assure balanced output and require only 6 to 8 ma plate current that can be drawn from the 300-volt line in the main amplifier. The unit measures only 12¼ x 7 x 4½ inches.**

The basic circuit for this preamp was found in an article on preamp design by Norman Crowhurst which appeared in the May 1960 issue. I decided it was the basis of an inexpensive stereo preamp which would have characteristics found only in more costly commercial units. Tonal quality matches anything I have ever heard and, while I haven't run any sensitivity measurements, Mr. Crowhurst's design calls for 2 volts out from a 1-millivolt input.

## Features

RIAA equalization is used on the low-level inputs as it is the standard in the recording industry. A five-position two-pole FUNCTION switch provides for stereo, stereo reverse, FM one channel, FM with multiplex, or FM with AM. This switching meets all of my require-



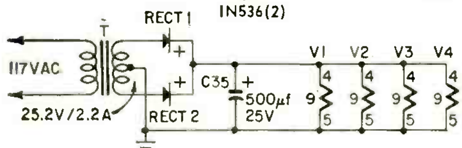
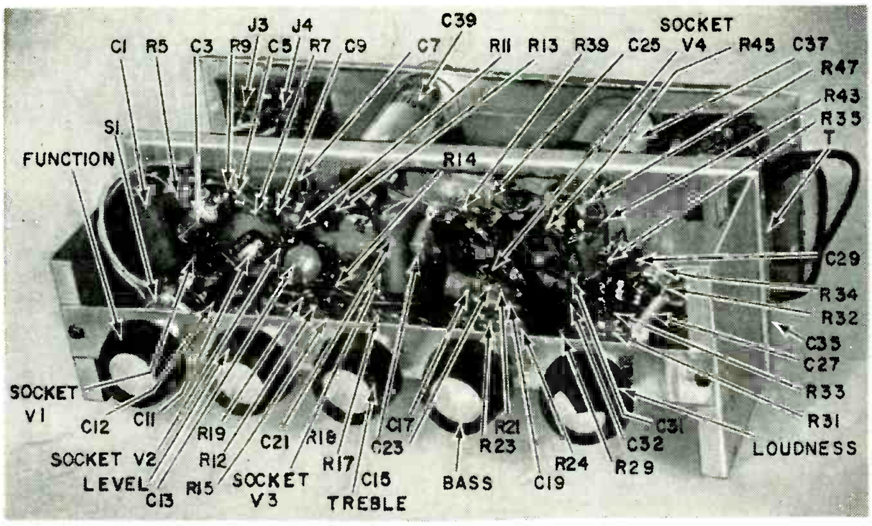




Fig. 1—Complete circuit of the preamp.

R1, R2—value to suit cartridge
R3, R4, R25, R26—3,300 ohms
R5, R6, R13, R14, R27, R28—270,000 ohms, low noise, match to 1%
R7, R8, R21, R22—120,000 ohms
R9, R10, R19, R20—1 megohm
R11, R12—10 megohms
R15, R33—pot, 1 megohm, audio taper, Centralab type F1-52 front section (see text)
R16, R34—pot, 1 megohm, audio taper, Centralab type R2-52 rear section
R17, R23—pot, 3 megohms, audio taper, front section, Centralab F1-79
R18, R24—pot, 3 megohms, audio taper, rear section, Centralab R2-79
R29, R30, R37, R38, R43, R44—100,000 ohms
R31—pot, 1 megohm, 500,000-ohm tap, linear taper, Centralab type B15/16 front control
R32—pot, 1 megohm, 500,000-ohm tap, linear taper, Centralab type B15/16 rear control
R35, R36—820,000 ohms
R39, R40—150,000 ohms
R41, R42—2,700 ohms
R45, R46, R47, R48—56,000 ohms
All resistors ½-watt 10% unless noted
C1, C2, C21, C22—100 µf, 10 volts, electrolytic
C3, C4—.05 µf, tubular paper
C5, C6—5µµf, ceramic
C7, C8, C19, C20—.0022 µf, molded paper
C9, C10—750 µµf, ceramic
C11, C12, C23, C24—0.1 µf, molded paper
C13, C14—75 µµf, disc ceramic
C15, C16—620 µµf, mica
C17, C18—250 µµf, tubular ceramic
C25, C26—.005 µf, disc ceramic
C27, C28—.003 µf, tubular ceramic
C29, C30—25 µµf, tubular ceramic
C31, C32—.01 µf, tubular ceramic
C33, C34—0.1 µf (see text)
C35—500 µf, 15 volts, electrolytic
C36, C37—10-100-10-10 µf 500-350-300-300 volts electrolytic, can type
C38, C39—125-100 µf, 300 volts, electrolytic, can type
*All capacitors 400 volts or better*
J1, J2, J3, J4, J5, J6—phono jacks
P—male connector
RECT 1, RECT 2—1N536
S1—2-pole 5-position rotary switch
T—filament transformer: primary, 117 volts; secondary, 25.2 volts, ct. 2.2 amperes (Triad F41X)
V1, V2, V3, V4—7025
Chassis, 12 x 4 x ⅜ inch, aluminum
Side pieces, 2 — 4 x 4¾ inches, aluminum
Sockets, 9-pin miniature (4)
Miscellaneous hardware




**Parts arrangement inside the chassis.**

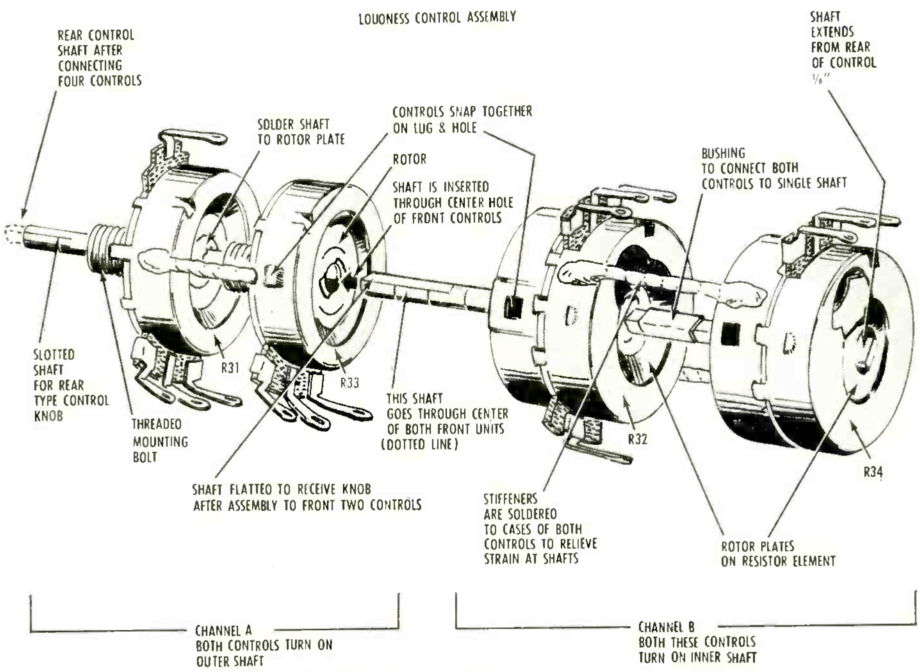



**Fig. 2—Details of the loudness control assembly.**

ments but could be changed if desired (Fig. 1).

Dc heater voltage was desired to reduce hum and, for this reason, heater voltage could not be taken from the power amplifier. A separate dc heater supply is therefore included. The BASS, TREBLE and LEVEL controls for each channel are independent and concentric, and give a wide variation in tonal response. The loudness control is a worth-while feature that eliminates the need for readjusting bass and treble controls whenever volume is adjusted.

## Construction

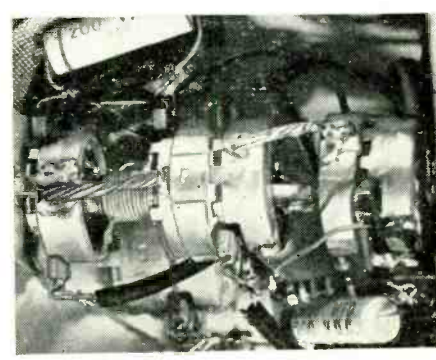
The main wiring is done on a 12 x 4 x 3/8-inch chassis. Terminal strips make for neat component placement. The tube sockets are in the center of the chassis. Channel A is wired on one side of them and channel B on the other. This arrangement makes wiring simple and assures maximum channel separation. When chassis wiring is completed, add the side pieces that support the control mounting strip. Dual concentric controls are used throughout. Position the terminals on the controls so they face in opposite directions (see loudness-control detail, Fig. 2) for maximum channel separation.

The loudness control cannot be purchased as a complete unit but is made from two sets of standard controls. (Fig. 2 shows complete construction details for assembling it.) The channel-A control is made by joining two front units together, soldering the shaft of one to the wiper disc of the second. Do not apply too much heat when doing this; you may damage the resistive element and make it noisy. Solder two pieces of copper wire (approximately No. 9) from the case of the first control to the case of the second. This makes the unit rigid and takes all strain from the shaft connection.

The channel-B control is made from two rear controls. Since they have aluminum shafts, they are joined by filing one shaft flat on each side, then bending a piece of brass strip to form a bushing. The bushing is pushed over the shaft projection on the wiper disc of the other control. I used Centralab type B controls for these units because they have features that make joining possible. To complete the channel-B control, two more wire stiffeners are used. One word of caution: Make sure that you have full rotation of the front and rear controls before soldering. When the control for each channel is complete, snap the two together in the normal way, lugs in opposite directions.

In the preamp output circuit, capacitors C33 and C34 are suitable for amplifier input resistance of 250,000 ohms; 0.25-μf capacitors should be used for input resistances of 100,000 ohms.

The preamp is extremely sensitive to hum, therefore follow all standard precautions to guard against it. Ground returns should be made to the same point for each stage. Connect the ground bus from stage to stage (a separate bus for each channel) continuously from input to output, and ground to the chassis at the input end. Notice that a large amount of filtering is used; this is necessary as there is little filtering in the power supply. Should a regulated well filtered supply be used, filtering could be reduced. Plate loading resistors are low-noise types, matched to within 1%. Elsewhere, standard carbon units are used.



**The loudness control mounted and wired.**

The dc heater supply is built on the tube side of the chassis, using a 25-volt center-tapped transformer rated at 600 ma or more, and two silicon rectifiers. These rectifiers are small, inexpensive and preferable to selenium units because of their negligible voltage drop. Heaters are wired separately, connected to ground at the output end of the bus with the transformer center tap.

An aluminum cover completes the preamp and shields the unit from possible outside hum sources. END

**By DAVE STONE**


**Portable Trans-Marine uses three transistors to cover a frequency range of 225 kc to 4.5 mc**

# RF SIGNAL GENERATOR COVERS MARINE BANDS

THE Trans-Marine transistorized rf signal generator produces tone-modulated or CW signals from 225 kc to 4.5 mc and is particularly useful for aligning and testing the rf and if stages of marine, auto, long-wave, broadcast and some short-wave receivers. The lightweight, compact, battery-powered set can be slipped into the service technician's toolbox and carried afloat for on-the-spot marine receiver repairs.

A modest battery drain of 2.5-ma provides a 2-volt output on the low ranges, dropping to a 0.1-volt level on the highest range, enough for the normal run of alignment problems in most receivers. The Trans-Marine is made with easily obtained parts and does not require any complicated or difficult construction techniques, but the end result is a useful test set that is ready for operation anytime, anywhere.

## Circuit action

Rf transistor V1, a 2N1086, operates as a grounded-base, collector-to-emitter feedback oscillator. Capacitors C1, C2, C3 and C4 form the variable elements of the feedback path between the collector and emitter. Oscillator frequency is controlled by variable capacitor C6 and coils L1 through L5.

The oscillator's output is taken across R1 and applied to V2's base. This transistor operates as a straight voltage amplifier. The amplified signal is then fed through C11, output LEVEL control R6, and C12 to the output jack.

The audio modulation is supplied by V3, a 2N35 transistor in a transformer-coupled feedback audio-oscillator circuit. The transformer provides a feedback path between collector and base, causing the circuit to oscillate at a frequency determined by the inductance of the collector winding and the stray capacitance of the transistor and transformer.

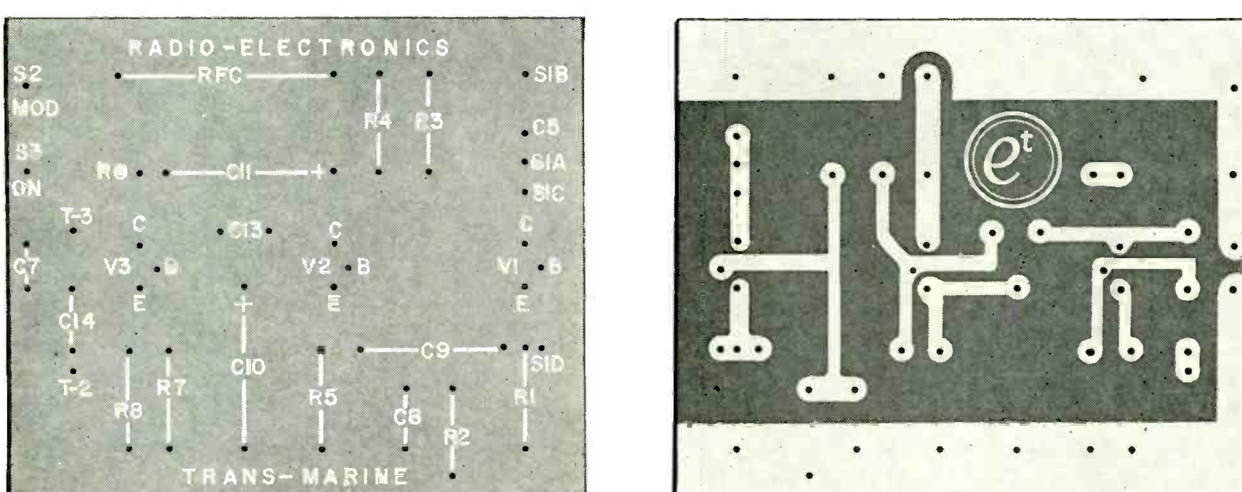
The resulting tone (approximately 1,000 cycles) is coupled through C13 to V2's base to modulate the signal produced by V1. S2 switches the audio oscillator on or off.

## Construction hints

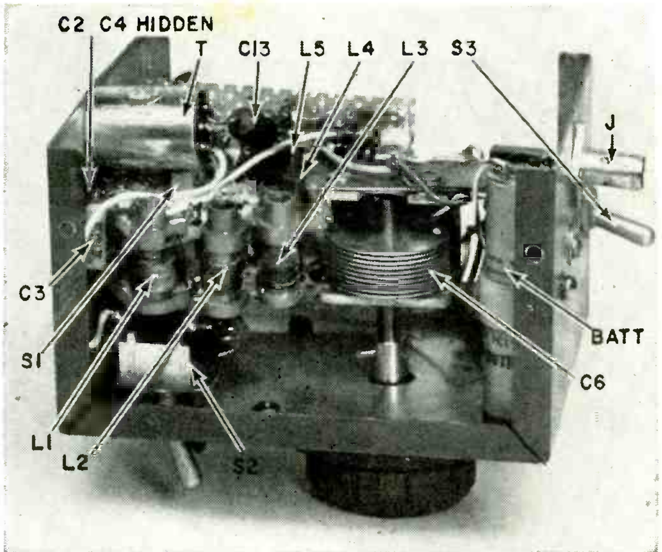
Inductances L1 through L5 and feedback capacitors C1 through C4 are all mounted on RANGE switch S1. The coil lugs are straightened and fastened across the upper-and lower-deck switch terminals, one terminal to each deck. The feedback capacitors are mounted between the deck terminals in the same manner.

T, S2, S3, R6, C6, J and the battery are mounted to the sides of the case. The remaining circuitry is fastened to

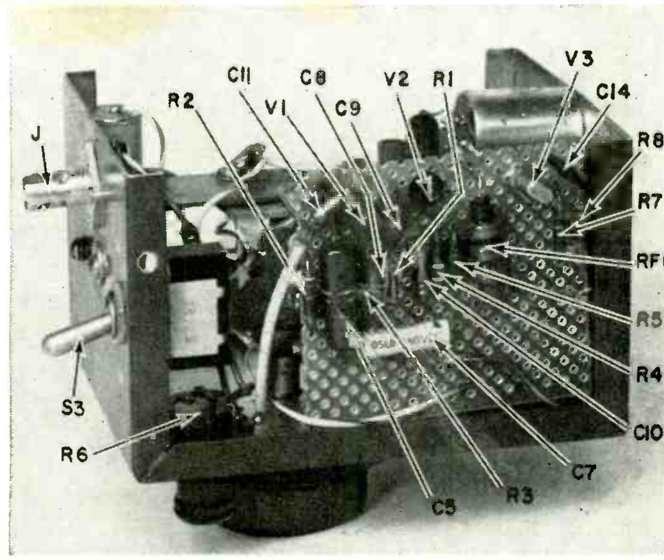
**Speed construction time. Use a RADIO-ELECTRONICS printed-circuit board. Available for $1.25 each, postpaid, from Detroit Electronic Corp., 13000 Capital Ave., Oak Park, Mich.**




**Details of the printed-circuit board for this unit. These figures are actual size.**




This view gives a detailed look at how the coils are mounted across the range switch.




Parts layout on the perforated plastic chassis.

a 2½ x 3-inch perforated board and installed close to S1 and the tuning capacitor. Straightforward layout is used, and all leads are kept as short as possible. The 5 x 4 x 3-inch case doesn't allow much free space so careful layout is necessary if you want to keep the unit small.

Miniature parts are used wherever possible to keep the test set compact, but standard-size components can be used without ill effect. A mercury battery is used because of its relatively constant output during its life, but standard dry cells and a larger enclosure can be used if desired.

To help speed construction, RADIO-ELECTRONICS is making available a printed-circuit board for this signal generator. Of necessity, the coils are still mounted right on the switch—it's the most convenient method. But all other components mount on the board. If you use the printed-circuit board, mount it in the same manner as the perforated board shown in the photos. Of course, don't forget to ground the ground foil to the cabinet. If you don't, the unit won't work and your output jack will be floating.

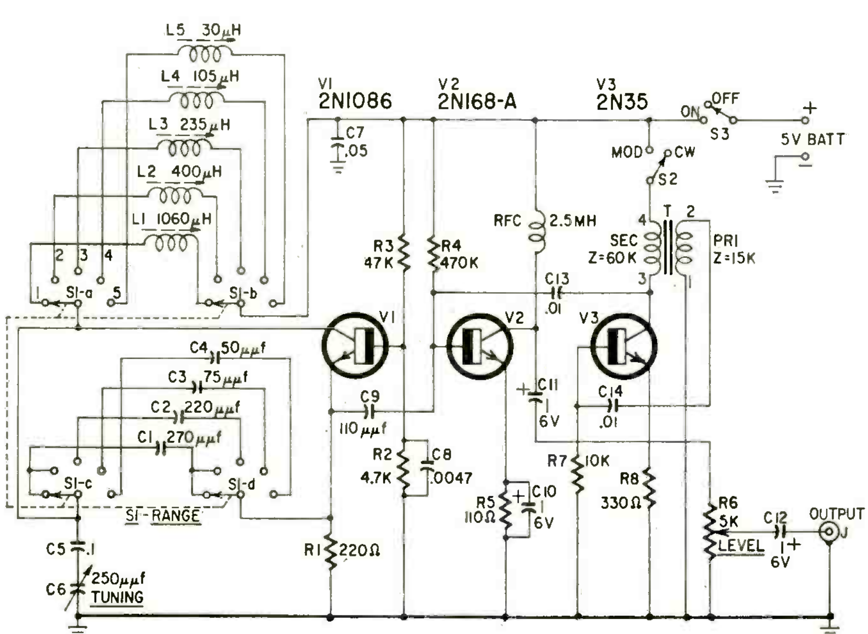
Calibration techniques remain the same. A smaller case was suggested but, unless you need a really tiny instrument, there is no advantage to this. In fact, many technicians prefer larger instruments for their shop. When it doesn't have to be portable, they like an instrument that won't get lost.

## Calibration

After construction is complete, insert a milliameter in series with the positive battery lead and S3. Turn S2 to CW, throw S3 to ON and note the current reading. If it is appreciably higher than 2.5 ma, remove the power immediately and inspect the wiring for a wrong connection or defective transistor. When the correct reading is obtained, turn S2 to MOD and again note the reading. If the audio oscillator circuit is correctly wired, the meter reading will increase only 0.5 ma.

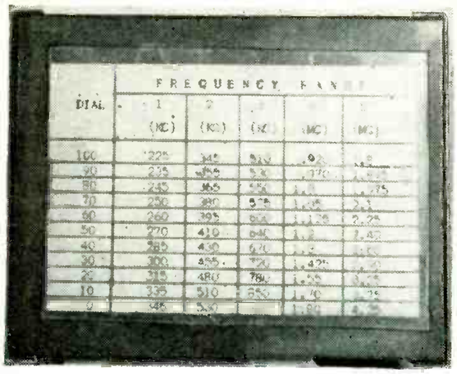
It is easy to calibrate the generator's upper ranges with a good communications receiver. For the lower ranges you'll need a stable signal generator and oscilloscope since most communications receivers do not go below the broadcast band. If a low-frequency receiver can be borrowed, it will be a lot easier to use for calibration than a generator and scope.

Connect the Trans-Marine output to the receiver's antenna terminals and set the receiver's dial to about 4.5 mc. Place a numbered dial on C6's shaft and rotate C6 to its full-open minimum-capacitance position. Turn the RANGE switch to position 5, S2 to MOD and S3 to ON. Adjust L5's slug for a tone-modulated signal at the 4.5-mc setting of




The generator circuit is simple, but effective.

R1—220 ohms
R2—4,700 ohms
R3—47,000 ohms
R4—470,000 ohms
R5—110 ohms, 5%
R6—pot, 5,000 ohms, linear
R7—10,000 ohms
R8—330 ohms
*All resistors ½-watt 10% unless noted*
C1—270 µµf, mica
C2—220 µµf, mica
C3—75 µµf, mica
C4—50 µµf, mica
C5—0.1 µf, paper
C6—250 µµf, variable (capacitor used was cut down from a midget 2-gang unit to 9 stator and 11 rotor plates. However, you can use a Hammarlund MC-250-M or equivalent if you get a deeper case)
C7—.05 µf, paper
C8—.0047 µf, paper
C9—110 µµf, mica
C10, C11, C12—1 µf, paper or 6-volt electrolytic
C13, C14—.01 µf, paper or ceramic
BATT—5 volts (2 Mallory TR-134R or equivalent in series)
J—coaxial connector
*L1—1060 µh (North Hills 1000-N or equivalent)
*L2—400 µh (North Hills 1000-L or equivalent)
*L3—235 µh (North Hills 1000-K or equivalent)
*L4—105 µh (North Hills 1000-J or equivalent)
*L5—30 µh (North Hills 1000-H or equivalent)
RFC—2.5 mh
S1—2 decks, 4 poles, 5 positions, rotary
S2, S3—spst toggle
T—audio transformer: primary, 15,000 ohms; secondary, 60,000 ohms (UTC O-4 or equivalent)
V1—2N1086 (G-E)
V2—2N168-A (G-E)
V3—2N35 (Sylvania)
Case, 3 x 4 x 5 inches
Miscellaneous hardware
*Available from Harrison Radio, 225 Greenwich St., New York, N.Y., and Hudson-Terminal Radio, 212 Fulton St., New York, N.Y.



**The author ended up with this scale of frequencies covered by his instrument.**

the receiver. Rotate C6 toward the low-frequency or maximum-capacitance end and tabulate C6's dial markings with the frequencies indicated on the receiver.

When C6's fully closed position is reached, leave the receiver at this frequency, rotate S1 to position 4, turn C6 back to its full-open position and adjust L4's slug for a signal at the previous setting of the receiver dial. Continue the calibration toward the low-frequency end.

Follow this simple procedure until all ranges are calibrated. If the receiver you have doesn't go down far enough, calibrate with the receiver until you run out of the receiver's lowest frequency range, then use a stable signal generator and oscilloscope to finish the job with Lissajous figures.

Connect the calibrating signal generator's output to the scope's horizontal input and the test set's output to the vertical input, with S2 set to the CW position. When the two generator frequencies are equal, an ellipse will ap- calibration by noting C6's dial marking pear on the scope face. Continue the with the calibrating generator's frequency when an ellipse is obtained.

The Trans-Marine generator can be used in the same manner as any other standard signal generator. Connect it to the rf, mixer or if stage of any receiver for alignment or signal substituting. If it is to be connected to a test point which contains dc, like the plate of a mixer tube, insert a 0.1-μf 400-volt capacitor between the output jack and test point. The modest investment in the construction of this handy unit will repay itself many times over with ease of aligning and testing marine, auto, portable and fixed receivers. END

**PRINTED-CIRCUIT BUILDERS**

The photos of the original instrument were shown, since assembly on the board is semi-automatic. R-E had a board made and tested the unit with it wired in place. There was no change in performance. All parts not mounted on the printed board are fastened to the case or mounted on the switches. Connect the arms of S1-a,-b,-c,-d to S1A, B, C, D on the board with ordinary hookup wire. S3's ON terminal and S2's MOD terminal to go to S3 ON and S2 MOD on the board.

# DX SHORT-WAVE FORECAST

**Sept. 15–Oct. 15**

**By STANLEY LEINWOLL†**

THE TREND TOWARD WINTER PROPAGATION CONDITIONS, CHARACTERIZED BY HIGHER usable frequencies during the daylight hours and lower usable nighttime frequencies, will continue.

During the latter part of September, a noticeable decrease in static levels and ionospheric absorption will result in a significant improvement in the 4-, 6-, and 7-mc broadcast bands during the evening hours. Conditions in these bands should be better for the next several months than they have been in 5 years.

Propagation conditions between the United States and Australia, Africa and South Asia improve considerably during equinox periods. This improvement will be general and should be noticeable in all bands.

The tables show the optimum broadcast band, in megacycles, for propagation of programs between the locations shown during the time periods indicated.

To use the tables, the listener selects the one most suitable for his location, reads down the left side to the region he wishes to hear, then follows the line to the right until he is under the appropriate time. (Time is given at the top of each table in 2-hour intervals from midnight to 10 pm, *in your local standard time.)* The figure thus obtained is the short-wave band (in megacycles) nearest to the optimum working frequency.

For example, a listener in the Central USA would be most likely to receive broadcasts in the 17-mc broadcast band from Western Europe at noon.

The tables are designed to serve primarily as a general guide, since day-to-day variations in receiving conditions can be large.

At certain hours, propagation over some of the paths given in the tables may be extremely difficult, or impossible. These are shown with an asterisk (*).

†Radio Frequency and Propagation Manager, RADIO FREE EUROPE

**EASTERN US to:**

| | Mid | 2 | 4 | 6 | 8 | 10 | Noon | 2 | 4 | 6 | 8 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| West Europe | 7 | 7 | 7 | 15 | 17 | 17 | 17 | 17 | 17 | 11 | 9 | 9 |
| East Europe | 7* | 7* | 7* | 11 | 15 | 15 | 17 | 15 | 11 | 9 | 7* | 7* |
| Northern Latin America | 11 | 11 | 9 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 11 |
| Southern Latin America | 15 | 11 | 11 | 11 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 |
| Near East | 7 | 7* | 7* | 11 | 15 | 17 | 17 | 17 | 15 | 11 | 9 | 9 |
| North Africa | 9 | 7 | 7 | 15 | 17 | 17 | 17 | 17 | 17 | 15 | 11 | 9 |
| South & Central Africa | 9 | 9 | 9* | 17 | 21 | 21 | 21 | 21 | 17 | 15 | 11 | 9 |
| Far East | 9 | 7 | 7* | 7* | 11 | 11 | 9* | 9* | 11 | 15 | 11 | 9 |
| Australia & New Zealand | 11 | 11 | 9 | 9 | 9 | 7* | 9* | 21* | 21 | 21 | 17 | 15 |

**CENTRAL US to:**

| | Mid | 2 | 4 | 6 | 8 | 10 | Noon | 2 | 4 | 6 | 8 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| West Europe | 7* | 7* | 7 | 11 | 15 | 17 | 17 | 17 | 11 | 9 | 7 | 7* |
| East Europe | 7 | 7* | 7* | 11 | 15 | 15 | 11 | 11* | 9* | 9* | 7 | 7 |
| Northern Latin America | 11 | 9 | 9 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 11 | 11 |
| Southern Latin America | 11 | 11 | 9 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 11 |
| Near East | 7* | 7* | 7* | 11 | 15 | 15 | 15 | 11 | 11* | 9* | 9 | 9 |
| North Africa | 9 | 7 | 7* | 15 | 17 | 17 | 17 | 17 | 11 | 11 | 9 | 9 |
| South & Central Africa | 9 | 7 | 9* | 15 | 17 | 17 | 17 | 17 | 17 | 15 | 11 | 9 |
| Far East | 9 | 7 | 7* | 6* | 11 | 9* | 9* | 17 | 17 | 17 | 17 | 11 |
| Australia & New Zealand | 11 | 11 | 11 | 9 | 9 | 9* | 21* | 21 | 21 | 21 | 17 | 15 |

**WESTERN US to:**

| | Mid | 2 | 4 | 6 | 8 | 10 | Noon | 2 | 4 | 6 | 8 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| West Europe | 7 | 7* | 7* | 11 | 15 | 15 | 17 | 11 | 9* | 9* | 7 | 7 |
| East Europe | 9 | 7* | 7* | 11 | 15 | 11 | 11 | 9* | 9* | 7* | 9 | 9 |
| Northern Latin America | 11 | 9 | 9 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 11 | 11 |
| Southern Latin America | 11 | 11 | 9 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 11 | 11 |
| North Africa | 7 | 7* | 7* | 11 | 15 | 15 | 17 | 11 | 11 | 9 | 9 | 9 |
| South & Central Africa | 9 | 7* | 7* | 17 | 17 | 17 | 21 | 17 | 15 | 9 | 7 | 9 |
| Far East | 9 | 7 | 7 | 7 | 11 | 9 | 11 | 17 | 17 | 17 | 17 | 11 |
| South Asia | 9 | 7 | 7* | 7 | 11 | 15 | 15 | 11* | 15 | 17 | 15 | 11 |
| Australia & New Zealand | 15 | 11 | 9 | 9 | 9 | 15* | 21 | 21 | 21 | 21 | 21 | 17 |

# DOES FM STEREO FOLLOW ITS OWN THEORY?

*Some of the explanations are more complex than the circuit workings*

**By NORMAN H. CROWHURST***

EVER SINCE THE ARTICLE IN THE JULY issue of RADIO-ELECTRONICS, we have been trying to get information about adapter circuits. Many manufacturers had released information on an adapter, with model number and photograph, with the usual claims of tested performance superior to anything else available. But when it came to giving technical information about how their circuit was different from the others, or supplying a schematic so we could see for ourselves what they had done, nothing was forthcoming. Several did invite us to go see.

These visits have been informative. The questions we asked uncovered so much that engineers did *not* know about the new system and how to work with it, that we started to find at least some of the answers. A week's intensive work, followed by further visits to other companies working on the problems, shows that our long background in audio design has paid off, when it comes to stereo multiplex: we suspect that we now know more about the theory and practice of stereo multiplex than anyone else in the industry.

Of course, a lot of people are making rapid progress. Many ideas for new circuits are in the works. Some of these will fulfill the dreams of their originators and some of them won't. But the biggest thing we found from this lightning investigation is a general misunderstanding about how the system works—or should work. This incorrect understanding of some aspects is hindering progress in solving the problems.

## Basic concept

It's commonly known, from the very fact that the system was developed independently in two different ways by Zenith and G-E, that the same system can be analyzed from two different viewpoints. And it will work with correspondingly different circuitry. But there are points about each that have led many "up the garden path" unnecessarily.

We have had several arguments about the mathematics presented with the Zenith approach. The Zenith method works, there is no argument about that, but the math used to explain *how* it works can mislead the student.

The approach uses a switching concept: an electronic switch flips between left and right channels at a frequency of 38 kc. The mathematical analysis assumes this switching is instantaneous, like a square wave (Fig. 1). The circuit may in fact use this technique. But if it does, the modulation frequencies will include sidebands of 38 kc, sidebands of 114 kc, sidebands of 190 kc, and so on, just like any other 38-kc square wave.

The highest frequency that should be used to modulate the transmitter is 75 kc. So, regardless of the switching method used, all those sidebands of 114 kc, 190 kc and higher frequencies just have to be cleaned off with a low-pass filter.

If we show the sidebands corresponding to 38-kc modulation, square wave, of the transmitter, they look like Fig. 2. Compared with the FCC requirements, every harmonic up to the 29th is at too high a level, after the first. Then an SCA subcarrier of 67 kc may have to be squeezed in too. In point of fact, the composite stereo, L + R with L − R suppressed-carrier modulated on 38 kc, is passed through a very-sharp-cutoff 54-kc low-pass filter, so everything but the simple 38-kc sidebands is cleaned off, for all intents and purposes.

If you have a 38-kc square wave, it isn't a very good square wave if you only have 38, 114 and 190 kc (Fig. 3). But if you take away the 114 and 190 kc, it doesn't even begin to look like a square wave. It's just a sine wave, pure and simple. To try and analyze it as an approximation to a square wave would be ridiculous. The approximation isn't rough—it's nonexistent. Yet that, in effect, is what the use of Fourier analysis in the Zenith math is trying to do.

Then you do the same on reception, with a similar "approximation". If that

*Audio Design Service.

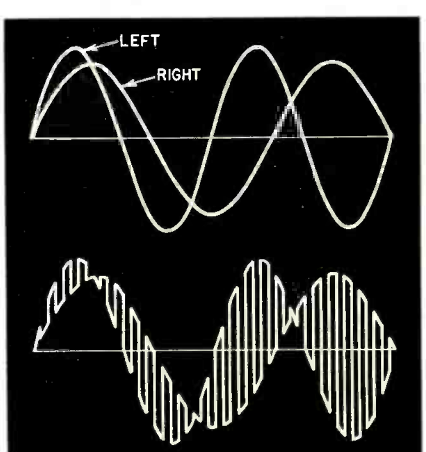



**Fig. 1—How mathematical approach to time-division multiplex assumes the waveform is made: top shows the left and right waveforms superimposed; at bottom is theoretical composite stereo waveform (without pilot).**

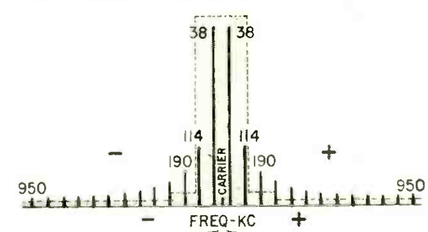



**Fig. 2—Sidebands corresponding to 38-kc modulating *square* wave. Shaded area is permitted boundary level of the FCC; note how many sidebands exceed this level seriously.**

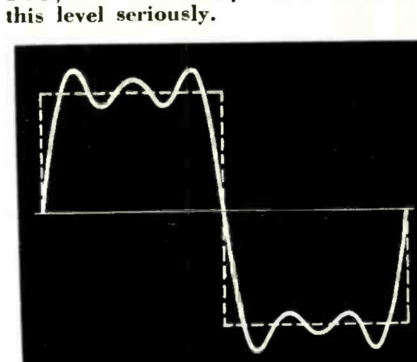
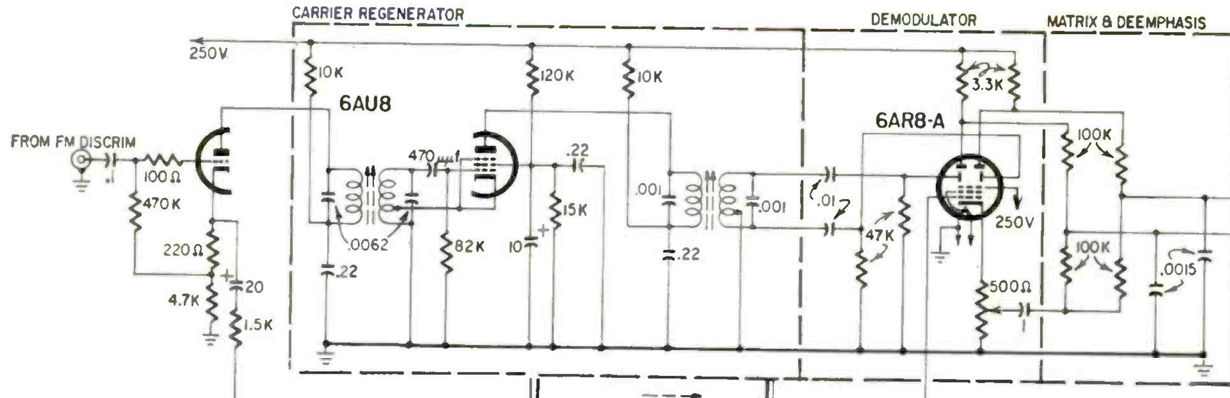
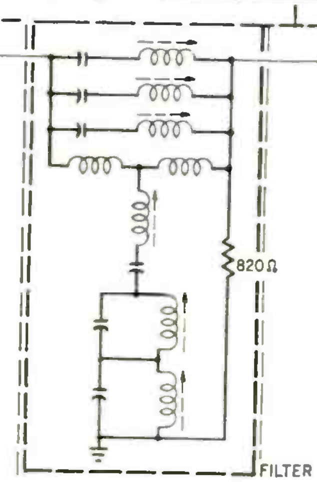


**Fig. 3—Nearest approximation to a square wave possible with fundamental, third and fifth harmonics (38, 114 and 190 kc) is shown here; it is not a particularly close approximation.**






**One of the schematics shown in the Zenith documentation. Filter shown here is a phase-linear low-pass (not bandpass, as some have thought) with 67-kc rejection beyond the cutoff.**

approximation even resembled the true explanation, the error in approximation, twice over, would mean there should be about 90% distortion. The very fact that the system works shows there must be a direct explanation that does not involve such radical approximations.

Whether a circuit uses sudden switching twice during every 38-kc cycle and filters off the harmonics, or whether a more direct arrangement samples left and right by a sinusoidal fluctuation at 38 kc from one to the other (Fig. 4), the latter is the kind of signal actually used to modulate the transmitter. We don't find that waveform at all hard to visualize. In fact it's easier to imagine and draw than trying to figure out what happens to the suddenly switched signal when all its harmonics are cleaned off.

Incidentally, this correction gets rid of the $2/\pi$ factor in the math that has been mentioned as having to be built into the reception circuit. If you have to build it into the adapter at all, it's only because you make it necessary by introducing the particular approximation that causes it—at the receiver—using a sudden switching circuit with low-pass filtering for demodulation, which some are doing.

Oddly enough, the math involving Fourier series is so complicated only an engineer pretends to understand it, while this more correct explanation is simple enough for a technician to understand from the waveform drawing of it. We would also emphasize that this criticism applies only to the Zenith *theorization* — their *system* definitely works.

## Bandpass filters

That criticism concerned the Zenith approach. To keep things fair, this one concerns the G-E approach! Their original design uses a bandpass filter to separate subcarrier modulation from L + R. They prescribe "phase-linear" filters for this and the associated low-pass filter.

It was only when we tried to design a phase-linear bandpass filter to the required specification that we found out there is no such animal—in this *bandwidth*. To "prove" that such a filter is possible, some have quoted the complicated Bode filter shown in the Zenith schematic (top of page). That is not a bandpass filter, but a low-pass type.

A phase-linear low-pass filter is no great problem. But a phase-linear high-pass cannot possibly exist, and a bandpass of this bandwidth is essentially a synthesis of the two. In a correctly designed low-pass filter, the phase delay, up to cutoff, is proportional to frequency (Fig. 5). If it's 30° at 5,000 cycles (5 kc), 60° at 10 kc, and 90° at 15 kc (all practical figures), it is phase-linear. The delay is ¼ of a 15-kc cycle, 1/6 of a 10-kc cycle, or 1/12 of a 5-kc cycle, each of which means 16⅔ microseconds, the same constant delay *time*.

But in a complementary high-pass filter, 90° phase *advance* (not delay in high pass) at 15 kc would correspond with 60° advance at 22.5 kc and 30° advance at 45 kc. These figures convert to time advances of 16.7, 7.4 and 3.3 microseconds, respectively. Nothing can be done, over a band this wide, to make the time-delay/advance characteristic anywhere near linear.

In relatively narrow bandwidth filters, where the response is due to the relative Q and coupling factor of tuned circuits, the overall response can be analyzed, *to a close approximation*, as analogous to a low-pass filter, where the cutoff frequency is equal to the deviation of either cutoff in the bandpass from mid-frequency (Fig. 6).

This close approximation depends on the upper cutoff being at an equal frequency fraction from mid-band with the lower cutoff. In an FM if coil, the mid-frequency is around 10 mc, and the cutoffs are a small fraction of 1 mc on either side. In a receiver for the Subsidiary Communications Authorization subcarrier multiplex, the mid-frequency is 67 kc, and the cutoffs are at 60 and 75 kc, only 6 or 7 kc above and below 67 kc—still a 10-to-1 ratio. But in the stereo subcarrier, the mid-frequency is 38 kc and the cutoffs are 23 and 53 kc, which is a very different kettle of fish.

The G-E alignment instructions are a little bit of a giveaway to this fact. They say the subcarrier reinsertion phase should be adjusted for maximum stereo separation at the higher audio frequencies, and the matrix (dimension) adjustment should be used for separation at the lower stereo frequencies. Put in simple terms, what this means is this:

Having two variables, the subcarrier reinsertion phase and the dimension

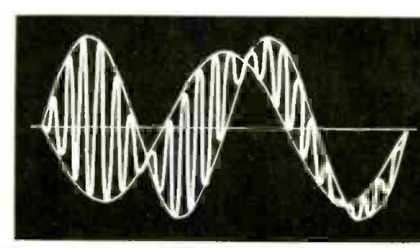


**Fig. 4—Actual kind of waveform the system does use, based on left and right waveforms used in Fig. 1. Each time left and right waveforms cross, the 38-kc component goes through zero and reverses phase.**

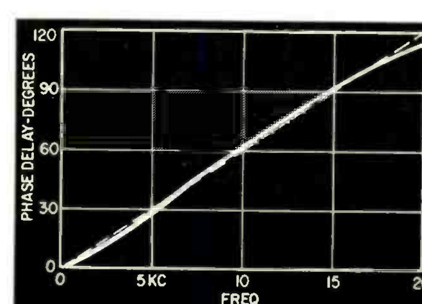



**Fig. 5—Phase response of 15-kc low-pass filter to illustrate phase linearity. Dashed line represents theoretical ideal. Solid line is for a relatively simple practical circuit.**

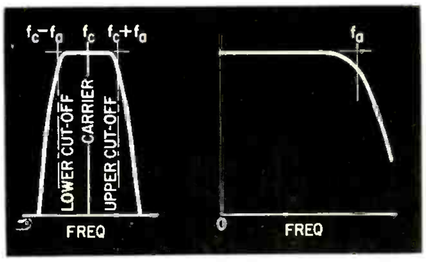



**Fig. 6—Where band of bandpass filter is narrow, in terms of mid- or carrier frequency, it can be analyzed approximately in terms of an equivalent low-pass response (right).**

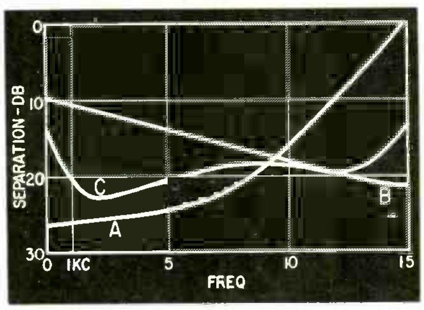



**Fig. 7—Separation when a bandpass filter is used in L − R circuit. Curve A, with subcarrier phase and matrix adjusted for maximum separation at low audio frequencies; curve B, with both adjusted for maximum separation at highest audio frequencies; curve C, practical setting, with phase adjusted to get maximum separation at high frequencies and matrix adjustment for maximum separation at low frequencies.**

control, means that separation can be made high at two frequencies by what is really a "crooked" adjustment. Suitable choice of these frequencies means the separation does not get too high in between or beyond them (Fig. 7). But the very method means separation cannot be very high anywhere.

Fortunately there is a fairly simple remedy. A phase-linear low-pass filter is no problem, so we can use this to separate the L + R component. It is easy to null out the L + R component from the subcarrier detection, merely by returning the detector load circuit to the output point of the low-pass filter (Fig. 8). In this way, the whole L − R demodulation circuit "floats" at L + R audio, and a bandpass filter is not needed. Time delay can be equalized between L + R and L − R very completely by matching the delay caused by the detector load to that caused by the low-pass filter (Fig. 9).

These are some of the things engineers have been finding out the hard way. What has hindered them, of course, has been the absence of any generator or test equipment to work with. The more successful manufacturers made their own rather than wait for a model to be made available by somebody else.

## Other details

One misunderstanding encountered was that the G-E system provides

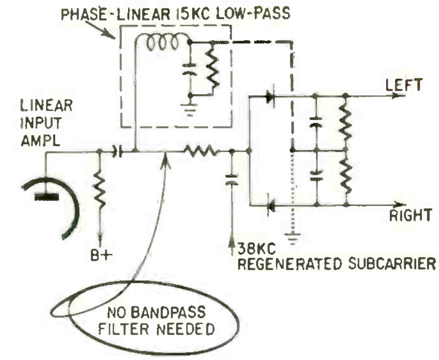



**Fig. 8—Change in filter-circuit connection with matrix arrangement obviates need for bandpass filter. Instead of returning diode load circuits to ground (dotted line), the return is made to the low-pass filter output (dashed line).**

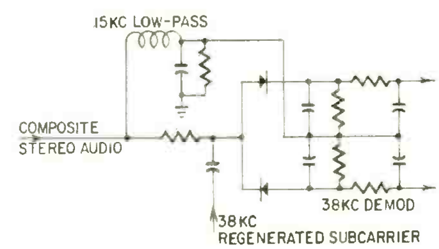



**Fig. 9—Equalizing delay times is easy with this arrangement. The 15-kc low-pass and the 38-kc demodulator circuit loading are adjusted to have the same time delay.**

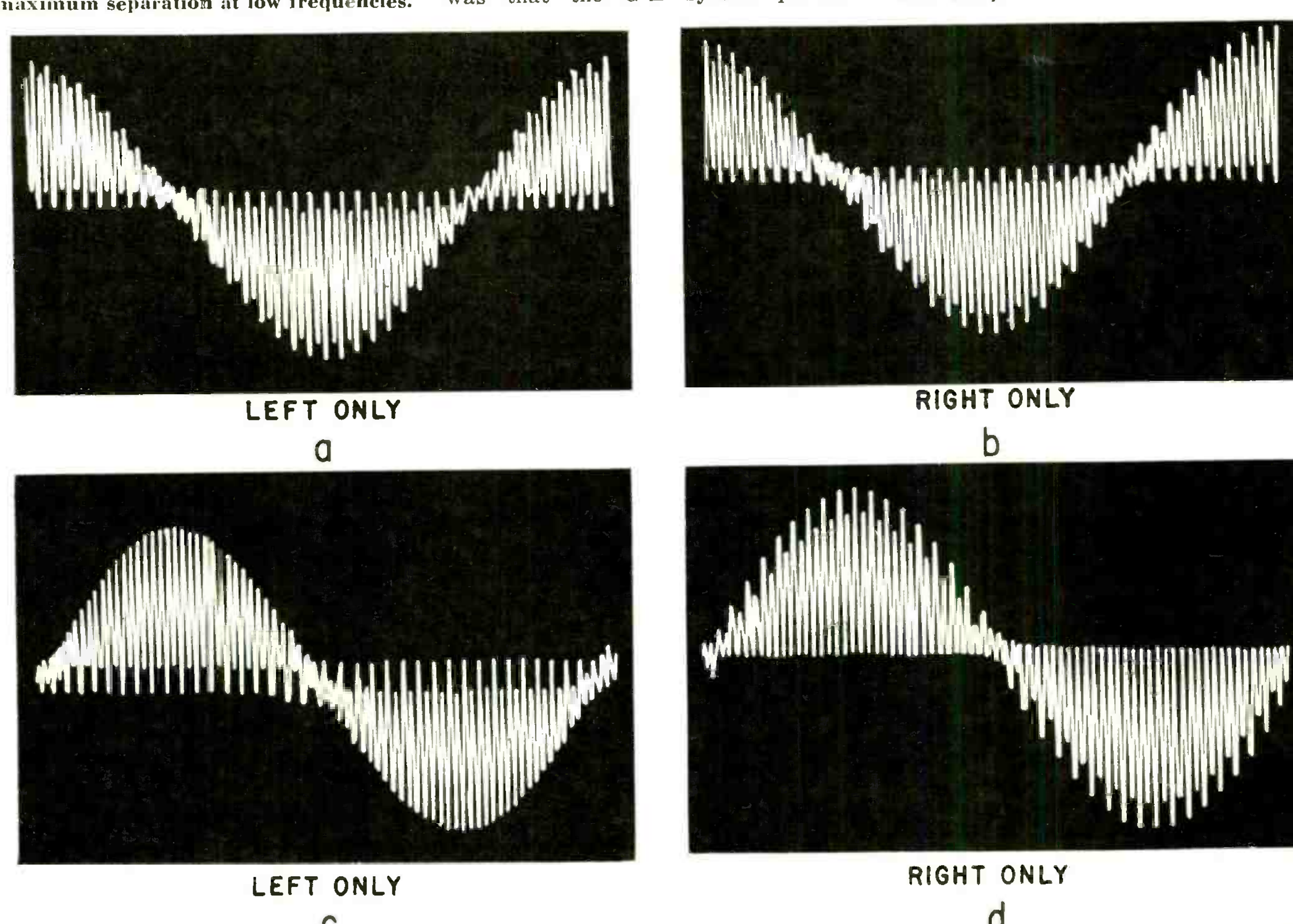



**Fig. 10—Patterns published by Zenith for FCC issued standard can be used to phase pilot frequency. In *a* and in *b*, the double pilot frequency crosses 0 axis with modulated subcarrier. In *c* and in *d*, it is 90° out of phase with the subcarriers.**

means for adjusting relative magnitudes of L + R and L − R, thereby controlling separation, while the Zenith method of reception does not. When the foregoing misunderstandings are corrected, the picture changes.

Either circuit is capable of adjustment to secure maximum separation of left and right after either switching (Zenith) or dematrixing (G-E). The exact method will vary from circuit to circuit. To give anything like a complete rundown on this aspect, we'll have to wait until we have a more complete picture of the various circuits available. At this writing, few have been released for publication.

Another important feature about alignment, which depends on having a good generator of some sort, is being sure that the phase of the pilot carrier is right, relative to the suppressed-carrier modulated subcarrier. Stated like that it sounds like looking for the phase of something that isn't there, which would be a problem. It's only there when there is L − R modulation.

If you check the phasing, by Lissajou pattern or any other method, at the output from the respective generator circuits, before mixing, there may be some error. This is due to differential phase shifts before you reach the output, which is the input to your adapter. The best place to check phase is where it matters, at the input to the adapter under test.

In their document of Oct. 28, 1960, Zenith showed different phasings of pilot frequency, with audio on only one channel (Fig. 10). The patterns for

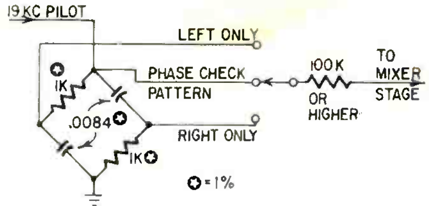



**Fig. 11—Simple circuit that can be included in a service type generator to check pilot frequency phasing.**

signal as prescribed by the FCC are those at *a* and *b*. The easiest to check phase is *d*. If the pilot signal circuit has a phase adjustment, followed by a low-impedance twin phase-shifting network to give 45° advance or delay from the center position (Fig. 11), the center position can be used to get an output pattern like Fig. 10-d by careful adjustment. The other two positions provide an input signal equivalent to left only and right only, for phase-alignment and separation checks on the receiver.

One adapter with a nice feature has already appeared, from Fisher. It has a "stereo beacon" which, as well as indicating when stereo is being transmitted by FM from the station to which the tuner is set, switches off the subcarrier demodulator when no pilot is present, and thus avoids unnecessary noise when receiving mono on the same system. It just parallels left and right when the transmission is monophonic.

A number of other interesting developments are going on, about which we have unofficial news but not permission to say anything at this juncture. In fact, this whole project looks like about just the most flexible system ever to tickle an audio man's fancy.

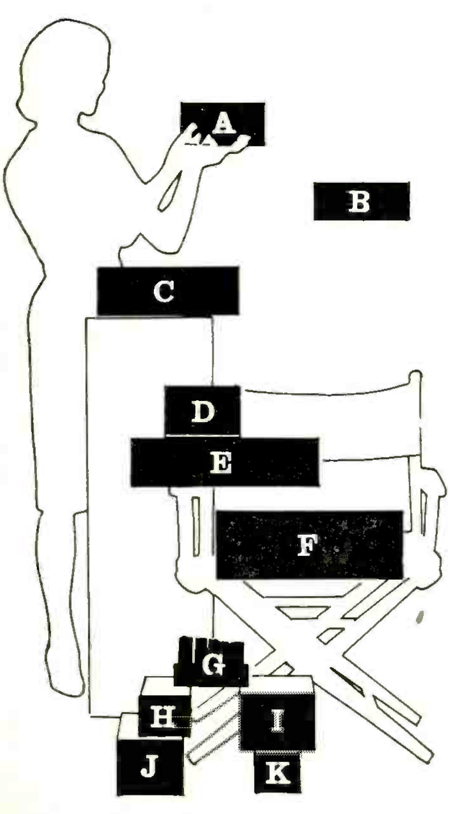
Installing the new system will bring a few problems. Not all tuners will work well with an adapter, although they might be quite good monophonic tuners. The main difference (but this statement may oversimplify matters a little) is that for stereo the tuner must provide distortion-free reception of "audio" up to 75 kc, instead of just 15 kc, as previously.

Antenna installation becomes more important than before. Reflections that could cause ghosts on a TV screen may not be audible on monophonic FM reception in any way—distortion or frequency response. But on stereo multiplex, these ghosts can cause distortion, change in frequency response and interference with separation at different frequencies. So you need a good antenna installation that will virtually eliminate reflections, due either to excessive mismatch or multi-path reception.

Testing the same antenna for TV reception is not the answer, of course, because the TV program does not use either the same frequency or the same transmitting antenna location as the FM stereo. It's a job that has to be done with patient observation on actual FM stereo multiplex reception when transmissions are available.

The new system will undoubtedly have its "teething" problems all around. But "stay tuned"—we'll keep you posted on new developments. END

# KEY TO THE COVER




A lot of FM stereo gear is keeping the young lady on our cover rather busy. As she can't tell you which unit is which, we've prepared this little guide. Just pick out any item on the cover, match it to the diagram here and check the letter to identify it.

| | |
|---|---|
| **A—Paco** | **MA-100** |
| **B—Eico** | **MX99** |
| **C—Pilot** | **200** |
| **D—H. H. Scott** | **335** |
| **E—Sherwood** | **S-8000** |
| **F—Bogen** | **RP40A** |
| **G—Harman-Kardon** | **MX600** |
| **H—Bogen** | **PX60** |
| **I—Lafayette** | **LA-215** |
| **J—Crosby** | **MX-101** |
| **K—Heath** | **AC-11** |

Want to know more about these units? Check the directory starting on page 38.

# REASSEMBLING SPRING-LOADED GEARS

**By CHARLES E. COHN**

Many dial mechanisms use spring-loaded gears to eliminate backlash. When reassembling such a mechanism after working on it, gear adjustment must be right. Note the relationship of the two spring-connected gears with no force on the springs. Then move the gears relative to each other, in the direction that compresses the springs, until the teeth of the two first coincide with the springs under force. Then mesh them with the other gear of the train. Moving the gears to compress the springs further than this increases the friction of the system and makes it harder to operate. This can be done, however, if the load carried by the gear train is high enough so that the light spring loading recommended here is not enough to take up the backlash. The lightest spring loading that will keep the two loaded gears from moving relative to each other under reversal of motion is the loading that should be used.

# INDUSTRIAL TEST EQUIPMENT IS IT DIFFERENT?

*Operation is basically the same, but precision is better than that of TV test instruments*

**By MATTHEW MANDL**

THE differences between industrial test equipment and TV service gear are those of refinements and modifications of basic voltmeters, ohmmeters, oscilloscopes and related units to adapt them to the more demanding requirements of industrial electronic gear and circuitry. Service technicians who know how to use their own equipment will have no difficulty using similar higher-level industrial equipment once the ranges, applications and variations are understood.

On occasion, a piece of equipment unrelated to the test equipment found in TV servicing will be encountered, such as the strip-chart recorder discussed later. When its basic principles are understood, however, the technician will have no trouble using it, particularly if he is proficient in handling ordinary meters, scopes and checking devices.

## Vtvm's and vom's

The ordinary vtvm and vom are extensively employed in testing, servicing and maintaining industrial electronic equipment. There are, however, numerous occasions when more specialized types are used for tasks normally beyond the capabilities of the basic units. One such might be a miniature unit to meet a certain set of requirements, or it may have a greater input impedance and higher scale ranges. Others may interpret the signal voltage output from transducers and give a direct reading of the information sensed by them.

An example of an industrial meter is the Metronix model 311, a panel-mounted ac unit. Its usefulness in industrial electronics, is due to its high input impedance and broad frequency range. These desirable factors were obtained by using a vtvm.

The input impedance of the model 311 is 5 megohms, paralleled by 25-$\mu\mu f$ capacitance. The high input impedance is particularly useful when it is necessary to make voltage measurements without loading the circuit under test with the voltmeter circuit.

Ordinary voltmeters for industrial work are calibrated at 60 cycles, and their accuracy varies when signal voltages above or below the calibrated frequency are measured. But this meter's frequency range is from 20 cycles to 250 kilocycles. Accuracy is ±2% of full-scale deflection over the entire frequency range. Also, the instrument is comparatively unaffected by any line-voltage variations. A 10% change in line voltage will cause an error of no more than 1% of full-scale deflection. The full-scale sensitivity of the unit begins at 10 mv and goes up to 300 volts rms.

A volt-ohmmeter with a special speed-reading (tachometer) probe is the Servo-Tek Speedvolter. It is designed to meet industrial requirements for a quick and accurate means of measuring speed. Because of its voltage and resistance checking capabilities, it can also be used as a testing and servicing device.

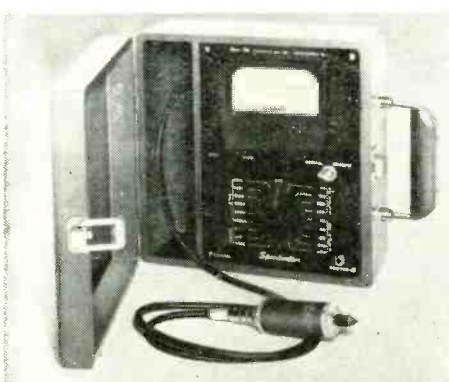
The Speedvolter has an external tachometer transducer which is attached to probe leads as shown. It is used to measure the speed of motors, rotating machinery, conveyor belts and other motions. The speed is directly indicated on the specially calibrated meter dial.

The tachometer transducer is based on the dc generator principle. When an armature rotates in a magnetic field, the magnetic lines of force are cut and a voltage is induced in the output leads. In a tachometer, the generator assembly is very small so the unit is not excessively bulky.

When the shaft which protrudes from the tachometer housing is held on a motor shaft or other rotating device, the spinning armature in the tachometer generates a voltage output proportional to the speed of the device being measured. The tachometer output voltage is calibrated on the meter dial in terms of revolutions per minute (rpm). Adapters are available to accommodate shafts of various sizes.

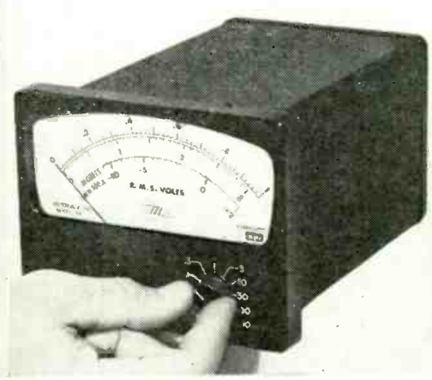
The tester, as mentioned earlier, is a voltmeter and ohmmeter as well as a tachometer. The selector switch chooses any of six speed ranges, from 0 to 300 rpm up to 0 to 12,000 rpm. For measuring linear speeds, the ranges are from 0 to 30 feet up to 0 to 12,000 feet per minute. The dc ranges are from 0 to 30 up to 0 to 600 volts. The basic meter movement is a 5,000-ohm-per-volt unit. The ac ranges are from the low scale of 0 to 30, up to 0 to 600 volts. The ohmmeter scale measures 1 to 200,000 ohms.

(*Continued on page 66*)



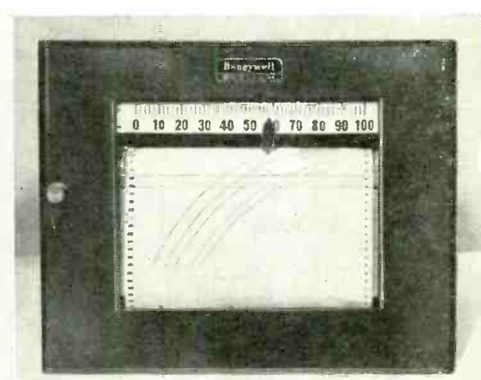
*Servo-Tek Products Co Inc.*

**The Speedvolter with its tachometer probe measures rpm.**




*Metronix Inc.*

**Metronix model 311 is miniature industrial vtvm.**




*Minneapolis-Honeywell Regulator Co.*

**Typical strip recorder.**

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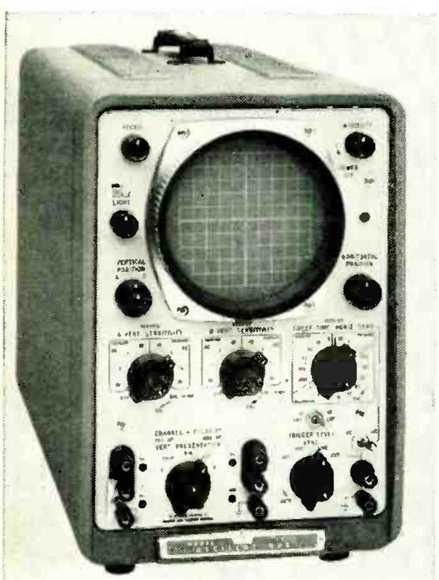
(*Continued from page 63*)

### Oscilloscopes

As in radio and television servicing, the industrial oscilloscope is useful for visual observation of the signals in oscillators, amplifiers and other such circuits. It is also used for signal tracing in conjunction with a signal generator, and for measuring peak-to-peak voltages. Many industrial scopes are similar to the types used by the TV technician. In research and design laboratories, however, more complex ones are used. They have a greater degree of input voltage sensitivity and a much higher sweep range. The more expensive scopes also have signal amplifiers which reproduce faithfully the sharp rise and fall of square waves and pulses. (See "About These Superscopes," RADIO-ELECTRONICS, March, 1961.)

A scope which is useful in industrial electronic applications is one which can display two input signals simultaneously. A typical instrument is the Hewlett-Packard model 122A. It has a 200-kc bandwidth which permits observation and measurement of the performance of electrical as well as mechanical equipment. It can be used as an ordinary scope with just a single trace, or, where two signal waveforms are to be compared, can provide two separate traces just as though two scopes were used.



**Hewlett Packard model 122A is a dual-trace scope.**

This unit has twin vertical sweep amplifiers which have direct-coupled circuitry so that very-low-frequency square waves may be used for test purposes. Ac coupling may also be used, to eliminate unwanted dc signals. The device is useful, for instance, in vibration studies in industrial electronic applications. In this application more rapid analysis is possible because both the driving source waveform for the vibration test as well as the actual vibration pattern can be seen at the same time and in relation to each other.

When two signals are viewed, they may be of different amplitudes because there are separate attenuators for each of the two signals. Direct-reading calibrated sweeps are available. One knob selects any of 15 calibrated sweep ranges from 5 μsec to 200 msec. The same concentric knob also selects the calibrated horizontal sensitivity. A feature of this scope is the sweep expander which aids observation and also speeds the analysis of transient signals by magnifying any 2-centimeter portions of the trace to 10 centimeters for easy viewing of the sectional details. This expander device may be used on any sweep range and increases the 5-μsec sweep to 1 μsec per centimeter.

### Strip-chart recorder

Strip-chart recorders contain a roll of paper marked with graph lines. The roll is driven by a motor and glides under a recording pen or a recording stylus for graphing information. This type of recorder is useful because it will show variations in signals over extended time periods and can be used for keeping a permanent record of the variations of temperature, voltage, current, motor speed, and other such data.

Of particular interest is the Brown Instrument Co.'s ElectroniK Function Plotter. It is especially useful where it is necessary to indicate graphically one variable function with respect to another. Thus this strip-chart plotter is of value in industrial electronic applications such as the recording, plotting and graphing of variables in fabrication processes, construction applications, power distribution systems and chemical plants. Specifically, the device plots curves capable of indicating such information as relationship of speed vs torque, stress vs strain, temperature vs pressure, amplifier output vs amplifier input, fluid volume vs pressure and magnetizing force vs flux density. In the latter application, it is of significant usefulness in the plotting of hysteresis curves of magnetic materials.

The ElectroniK Function Plotter uses two measuring circuits, two balancing circuits and two amplifiers which regulate drive motors. The pen which traces the graph lines moves horizontally under control of one of the variables sensed by any one of various devices such as thermocouples, tachometer generators or other dc sources. As the recording pen travels horizontally across the calibrated scale chart, it indicates continuously magnitude of the variable and hence represents the X-axis on a rectangular coordinate plot. The second variable, representing the Y-axis on a graph, is mechanically linked to the chart drive mechanism to regulate the vertical movement of the chart. The result of these simultaneous operations is a continuous plot of Y as a function of X.

So far we have examined three categories of industrial test equipment. Next month we will continue by showing how hysteresis curves of magnetic materials are plotted with strip recorders and why we bother to do so. Also, typical industrial test procedures will be presented. END

# Add a pilot light to variable autotransformers

By RONALD L. IVES

VARIABLE autotransformers such as the Variac, Varitran and Powerstat are widely used in electronic work to adjust and control line voltage. At many installations, a pilot lamp is used to indicate when the device is operating.

Conventional methods of connecting a pilot lamp to a variable autotransformer are shown in Fig. 1. Here (Fig. 1-a) a neon lamp with a series current-limiting resistor is connected across the primary. This is inexpensive and produces little heat but does not produce very much light. In Fig. 1-b, a filament pilot (such as a No. 44 lamp) is connected across the line with a suitable series dropping resistor. This produces adequate light for most purposes but emits considerable heat, 25 watts being dissipated in the dropping resistor and only 1.5 watts in the lamp. In Fig. 1-c, a similar lamp is connected across the input in series with a large capacitor which limits the current to that required for the lamp filament. This method, although bulky and initially costly, operates stone cold. In Fig. 1-d, the pilot lamp is powered by a midget stepdown transformer. This is relatively inexpensive and compact.

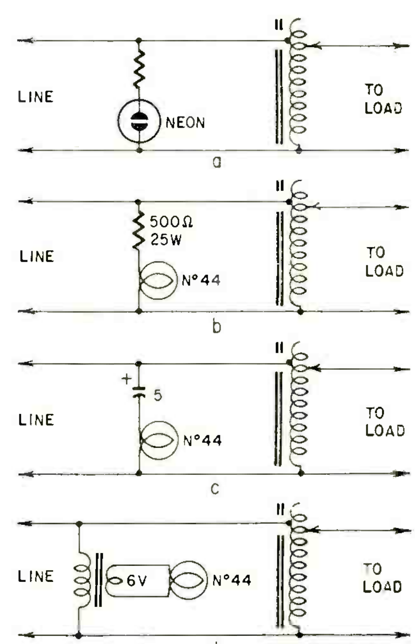



**Fig. 1—Four standard methods of connecting a pilot lamp across a variable autotransformer.**

By taking advantage of the properties of any standard variable autotransformer, most of the voltage reduction necessary for ordinary pilot-lamp operation can be handled by the transformer itself. Usually, the voltage across the two outer taps of a conventional variable autotransformer is about 20, with a 117-volt input (Fig. 2).

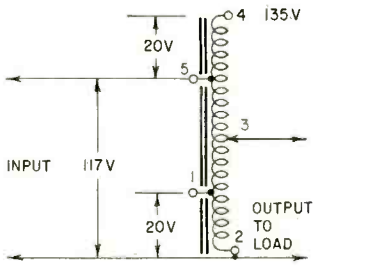



Fig. 2—There is about 20 volts across the top two taps of the transformer.

By using these taps, a low voltage for the pilot lamp is available, and most conventional lamps can be operated in series with a small resistor, to drop the voltage. Connections and constants for No. 44 lamp are shown in Fig. 3. The value of a dropping resistor for other lamps is easily computed by using Ohm's law.

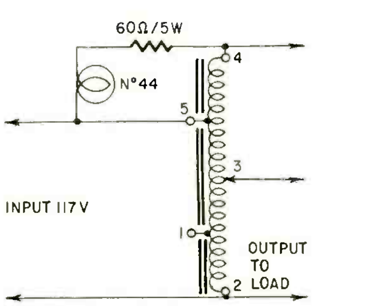



Fig. 3—Pilot lamp (No. 44) hooked up across the 20-volt taps.

Obviously, the same general principles can be applied to devices other than lamps. In some industrial installations, relays, tube filaments and crystal oven heaters could be so operated. However, don't forget that anything connected to the supply line and may be hot in rela- an autotransformer is also connected to tion to ground. END

## CORRECTIONS

In the transceiver chart on page 53 of the September issue, the location of Karr Engineering Corp. was inadvertently listed as Englewood, Calif. The correct location is Palo Alto, Calif.

The electrocardiogram (EKG recording) in the article "Electronics in the Psychology Laboratory" (page 82, July issue) is upside down.

We thank Dr. Evan H. Ashby, Jr., of Remington, Va., for calling this to our attention.

# TV Service Clinic

conducted by

**JACK DARR, SERVICE EDITOR**

**This is your column in the magazine: the service is absolutely free; there is no charge for answering your questions, and your name and address will be kept confidential if you so wish. The main purpose is to help everyone working in electronics with their unusual problems. Send in your questions; each one gets an immediate personal answer. Later, the more interesting cases are published in the Clinic columns.**

**Due to the many peculiarities found in commercial TV circuits, you might find a different answer to a question than the one we give, even though the "conductor" of this column is himself a full-time professional TV technician. We would be interested to hear of such cases, as we feel that the more widespread the knowledge of such peculiarities, the better off we'll all be! So, if you have an unusual service job, or one which is giving you trouble from an obscure cause, send in a question on it; we'll answer it promptly and to the best of our ability.**

THERE ARE TIMES WHEN THE MAIL IN THIS department runs pretty heavy on width troubles. In our day-to-day servicing activities, we've found that the percentage of width troubles to other defects runs fairly high at times. So we thought that we'd run over some of the more common (and a few uncommon) causes of this defect. Let's take them one at a time.

## Tubes

As with all other TV troubles, weak tubes cause most of the complaints. They get the most wear. So the first step in troubleshooting width complaints is to **replace all tubes in the horizontal sweep circuits—oscillator, output, damper and high-voltage rectifier.** Unless this is done, there's always the chance that an unsuspected bad tube is still in the set. (Might throw in the low-voltage rectifier while you're at it, just for luck.)

Frankly, the horizontal sweep and high-voltage sections of a TV set are pretty rough to test, unless you have one of the specialized in-circuit testers, such as the unit designed by Wayne Lemons and described in the February 1961 issue of RADIO-ELECTRONICS. These make the task a lot easier, for you're able to read actual operating values of voltage and current. There are several professional test instruments built for the purpose: the Doss 250, B&K 1070 and Sencore SS105. I can't recommend them too highly.

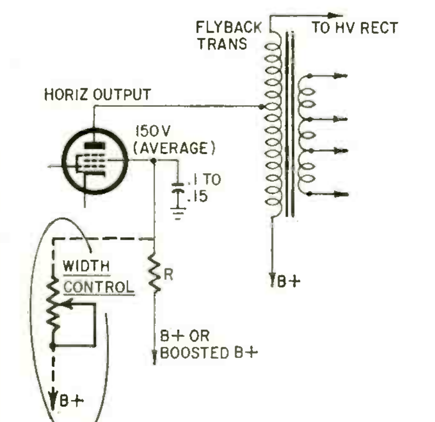



**Fig. 1—Screen supply circuit in average TV set. Dashed lines show alternate circuit where a variable dropping resistor is used as the width control.**

You've changed the tubes, and the picture is still narrow. We're going to have to pull the chassis and take some measurements. While there are wide variations in voltages in other stages of a TV set, you'll find a lot of uniformity in horizontal output stages.

For example, the voltage on a 6BQ6 plate will be about the same in all sets (but don't measure it), and the screen voltage should be about 150. This is usually obtained through a dropping resistor to B-plus or boost. Check this resistor carefully. A previous tube may have shorted and burned the resistor, causing it to go off value. A change in screen voltage alters the operating constants of the tube severely. Some sets vary the screen voltage to adjust width. Check this variable resistor. It may be burned or dirty (Fig. 1).

Low screen voltage causes insufficient width. High screen voltage causes excessive plate current in the output stage and shortens the life of the output tube. As a quick average, almost all common horizontal output tubes in use today have screen voltages ranging from 100 to 157 (average, 150) except the 'BG6 series, which use from 250 to 300 volts on their screens.

The screen bypass capacitor can be the source of some obscure troubles. If it is open, the usual result is a loss of width or sometimes parasitic oscillations of various kinds. If it is leaky, we get low screen voltage and loss of width. Average value of this capacitor is about 0.1 to 0.15 µf, and it must never be rated at less than 600 volts.

While we're working around the screen circuit, let's take in a very obscure complaint that has caused lots of headaches among technicians. This is screen emission, or grid emission, in the horizontal output tube. When the tube develops this defect, the screen actually emits electrons. This, of course, plays hob with the normal sequence of events in the electron stream within the tube. The usual symptom is a gradual loss of width and brightness after the set has been on for a while. Sometimes it takes as long as 2 hours for the trouble to show up. We get pull-in from the sides, and in some cases, even a slight horizontal instability.

There is a good test for this (Fig. 2). Connect a vtvm to the grid of the output tube, set to a medium range (0–30 volts negative) and open the cathode of the tube while the set is running and thoroughly warmed up. If there is any reading at all after the initial reading has "soaked off" (the normal grid-bias reading from the grid current developed by the horizontal drive), either the tube has screen or grid emission or the coupling capacitor is leaky.

A sure test for coupling capacitors is easy. Just pull the tube out of the socket. If there is any reading, the capacitor must be leaking. Now you'll have a reading to begin with, as we said, but this should drop to zero in 5 seconds or so. If it doesn't, substitute a new tube, heat the set for an hour or so and repeat the test.

This width situation covers more ground than we expected. We'll stop here for now and continue next issue.

## Tuner replacement

*In the December 1959 issue of* RADIO-ELECTRONICS *you had an article on replacing a tuner. I have a similar problem and would like your help on it. I want to change a variable-capacitance tuner in a Philco 53-T-1883, replacing it with a turret tuner from a 51-T-1602 Philco. Is this possible without too much revamping? I am sure the original tuner is beyond repair.—C. R. D., Ashtabula, Ohio.*

I think this will be possible without

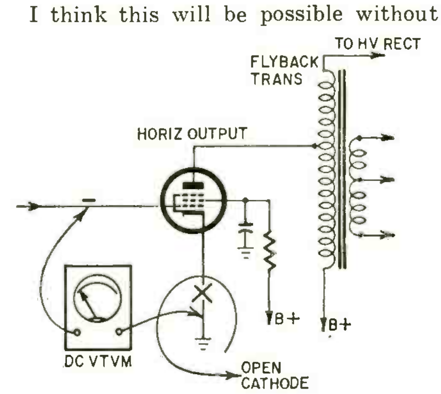



**Fig. 2—To check for grid emission, open the cathode of the tube while the set is operating and measure voltage between grid and ground.**

too much trouble. The 53-T-1883 uses the 44 rf chassis and the tuner mounts on the side. This should leave you plenty of room. Physical dimensions and mounting will be your worst problems.

Both tuners have the first video if transformer in the tuner chassis, so this should simplify your connections. This transformer is tuned to 23.6 mc on both tuners unless the alignment has been changed or tampered with.

There were several versions of the turret tuner in that series of Philco chassis. Some were built by Philco, others by Standard Coil. Some had only 8 channels, some 12. Electrically they are all close enough so that it will make no difference which one you have. After making all connections as per the schematic—B-plus, filament, agc, etc.—it would be a good idea to run a video if alignment curve on the whole set. If you don't have the necessary FM sweep-alignment equipment, wait until you can get a good clear test pattern, with sound, and very lightly touch up the alignment of the 23.6-mc adjustment on the tuner for best definition of the vertical wedge and best sound at the same time.

### Retrace eliminator

*Can you tell me how to hook up a vertical retrace eliminator in a Philco 52-T2140?—J. L., Wayne, W. Va.*

This is fairly simple. To eliminate vertical retrace lines, we simply apply a pulse of voltage to either the cathode or grid of the crt to cut off the electron beam during vertical retrace time. To apply blanking to the cathode, we need positive-going pulses. To the grid negative-going pulses are used.

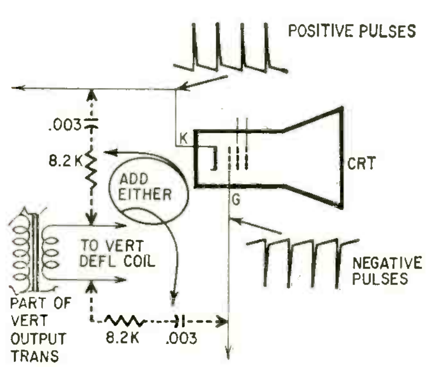



**Fig. 3—A simple vertical retrace eliminator circuit.**

Fig. 3 shows some typical circuits you can use. Incidentally, you can do a lot of cut-and-try here without hurting anything. You don't even have to check polarity on your pulses. Just hook up the R-C network to wherever you want it. If the retrace lines get worse, you've got the wrong polarity. You can pick up pulses almost anywhere in the vertical circuit except at the plate of the output tube.

### Poor height

*A Crosley 11-461WU has insufficient height. I checked voltages, and found only 25 volts on the plate of the vertical oscillator. All the resistances be-*

*tween the plate and B-plus were normal. If I remove the tube from the socket, the voltage comes up. If I put a 100,000-ohm resistor between cathode and ground the plate voltage comes up to normal, but the oscillator doesn't work. The vertical amplifier in the same envelope is OK.—P. H., McKees Rocks, Pa.*

Your loss of plate voltage is obviously caused by the tube drawing too much current. This accounts for the rise in voltage when the tube is removed. When you inserted the high resistance in the cathode circuit, you overrode the defective bias circuit, blocking the tube, and the plate current stopped flowing.

Check the grid voltage on the defective section. You will undoubtedly find it positive. Check two components: the coupling capacitor between the vertical oscillator grid and the integrator, and the vertical blocking transformer (for leakage between the windings). If the positive plate voltage is leaking between windings, it would drive the grid heavily positive. The tube would draw a very high plate current, giving you the symptoms you describe. To check it, disconnect the grid end of the transformer at the grid connection, and remeasure your grid voltage. It should drop to zero. If the transformer is leaking, the open end of the grid winding will show a high positive voltage.

## No raster on strong stations

*I am working on a Westinghouse V-2192. The complaint is no raster on strong stations and very dark raster on weaker channels. If I substitute an agc bias, I can get a picture. The voltages around the agc keyer tube are as shown in the sketch (Fig. 4). If I touch the grid of the first video if, the picture comes back.—J. H., Hudson, N. Y.*

This is an agc blackout caused by overloading on the strong signal. This sounds awfully simple, but I've been caught on it myself at times. Check the shields on the video if stages. If one of them is missing, you may be getting regeneration or oscillation strong enough to cause this.

The voltages you show on the keyer tube are almost all wrong (Fig. 4). Notice that the plate and screen voltages are high. This indicates a lack of the proper grid bias. You show 80 volts here and it ought to be 60. The cathode reads 120 volts, leaving you with an actual grid–cathode voltage of −40. You're just not drawing the right amount of plate current in this stage.

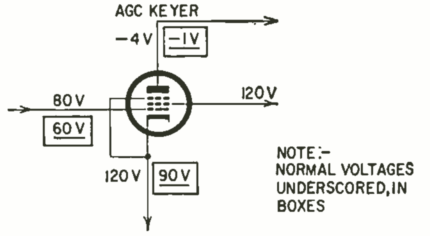



**Fig. 4—Measured and correct voltages on 6AU6 agc keyer. Correct voltages are underscored, in boxes.**

The most likely cause of this trouble is either incorrect resistors in the supply circuit, or insufficient video signal applied to the control grid. Check this with a calibrated scope. There could be an open coupling capacitor or leakage in the supply circuit between grid and the signal takeoff point at the video amplifier. Also, don't overlook the possibility of open peaking chokes, etc., in the video amplifier stage or even a weak tube.

## Chronic tube burnout

*I am having trouble keeping tubes in the high-voltage section of a Sylvania chassis 1-512-1-2. It is a 27-inch set and uses two 6BQ6's and two 1B3's. It has a voltage-doubler circuit and the tubes seem to get too much current, making them go bad every 3 or 4 months.—Q. E. C., Port Arthur, Tex.*

Your difficulty is caused by just slightly low drive voltage on the 6BQ6's—this has occurred before in several sets. The cure is to raise the drive to normal. Check the horizontal oscillator tube and circuit and be sure that there is at least 18–20 volts dc, as measured on a vtvm, or about 150 volts peak-to-peak, as read on a scope. The short life of the 1B3's could also be traced back to the same fault. Excessive currents through the horizontal output tubes could raise the pulse voltage, overloading their filaments. Check the plate current of each of the 'BQ6's, after repairs have been completed. It should not be over 100 ma per tube.

One other possibility would be to replace the 6BQ6's with 6DQ6's. However, before doing anything drastic to the set, make a very careful check of the ac *line voltage* at the customer's home! It could be slightly high and would cause all of the symptoms described!

## Hot linearity coil

*I'm having trouble with a Hoffman 21 M115, chassis 196. The 6BQ6 screen grid resistor gets very hot. The linearity coil is dripping wax. The waveform at the 6BQ6 grid is 100 volts p-p, but it doesn't look right to me (Fig. 5). Voltages seem close to normal and the 6BQ6 is drawing 95 ma.—R. H., Collins, Miss.*

There are two possibilities here. One, of course, is improper adjustment of the horizontal linearity coil. However, since you read 6BQ6 plate current as only 95 ma, you probably have the other one.

This is parasitic oscillation in the horizontal output stage, mostly in the screen circuit. It is the most likely cause of the ringing seen in the horizontal oscillator grid waveform. Put a resistor of about 100–150 ohms in series with the screen of the 6BQ6 and adjust the horizontal linearity coil for minimum plate current. Check the screen bypass capacitor (Fig. 6). Also, take a low-capacitance probe and check all of the B-plus supply circuits for traces of horizontal hash. If you find any, it is caused by insufficient filtering or bypassing. Bridge the electrolytics in and around that circuit and check up on your lead dress around the 6BQ6.

**Fig. 5—This waveform was on the grid of the horizontal output tube of a Hoffman 196. Note the excessive ringing.**

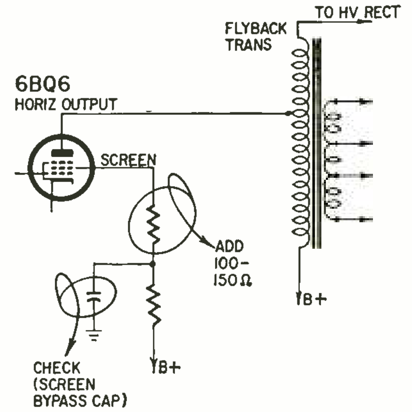



**Fig. 6—Add a 100- to 150-ohm resistor in series with the screen grid to damp out parasitic oscillations. Also check screen bypass capacitor for leakage.**

## 19- to 21-inch conversion

*I have the problem of converting a Zenith 24H21 from a 19AP4-A to a 21-inch picture tube. Please tell me if this change can be made, and how.—S. T., Johnstown, Pa.*

This will be a fairly simple conversion, with only mechanical changes required. The best choice of picture tube would be a 21EP4. If the present tube is being fully swept, you will have ample width. The 21EP4 is also economically priced. Don't forget to ground the outer coating when you install this tube.

## Poor pix detail

*The picture detail is poor in a Raytheon 17AY21. I've changed all the tubes in the video section without helping it. The scanning lines are sharp. —J. S., Rockford, S.D.*

Sounds like your video if is badly out of alignment. This is the most common cause of loss of fine detail if the picture is focused properly.

Run a complete realignment of these stages. You might also check the series and shunt peaking chokes in the video and detector output circuits. If one of these is defective, it could cause the same trouble. END

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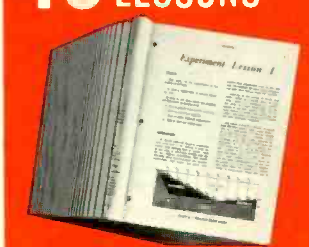

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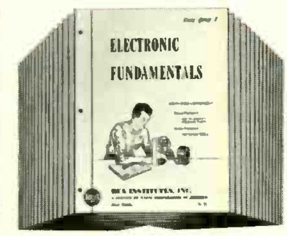


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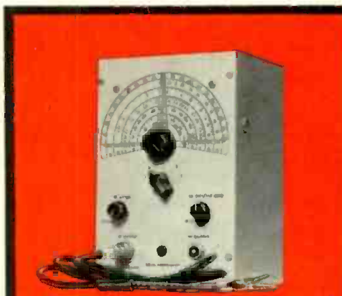

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Accurate alignment of

# Hi-Fi FM TUNERS

By JOSEPH MARSHALL

*This time we use an FM generator and a distortion analyzer to do the job*

LAST MONTH WE SAW HOW TO ALIGN FM tuners without using either a scope or a sweep generator. This month we will discuss another FM alignment procedure that uses instruments.

There is a method of alignment, not nearly as well known as the visual and vtvm methods, which is both simpler and more effective. It calls for an FM generator covering the FM band and a distortion meter (or a 400-cycle null network and any ac meter capable of reading 400-cycle ac). It works equally well with any kind of detector, requires a minimum setup time, and the setup remains the same throughout the alignment process. Since its criterion of measurement is the lowest distortion, it also results in the highest fidelity.

Quite a few shops specializing in hi-fi servicing own distortion meters, either IM or harmonic. Few shops own a good FM signal generator. The Measurements Corp. and Boonton Radio generators, which are ideal, unfortunately leave very little change out of a thousand-dollar bill. An occasional Measurements 78FM can be found on the surplus market for as little as $100 and, if in good condition, is a real bargain. The procedure is very simple.

▶ Connect the harmonic-distortion meter to the tuner output and adjust the tuner volume control and the sensitivity of the distortion meter so that tuner noise produces a 0-db reading on the meter scale. Connect the FM generator to the tuner input and feed an unmodulated signal at either 90 or 106 mc into the tuner and adjust the generator output to produce a 20-db reduction in the reading on the distortion meter. Note, for reference, the input in microvolts. Retune the generator and tuner to 106 (or 90) mc and repeat. Compare the input with that at 90 mc. Note which position yields the highest sensitivity, and tune the generator and tuner carefully to this weak signal at either 90 or 106 mc, whichever is the more sensitive point.

▶ Modulate the generator with internal 400-cycle tone and adjust for 75-kc deviation. Adjust tuner volume control and meter sensitivity so audio output gives about a half-scale reading.

▶ Now adjust the primary slug of the detector transformer and the slugs of all if and limiter transformers for maximum output as read on the meter —this will coincide with maximum swing on tuner's tuning meter or indicator.

▶ Increase the generator output until tuner tuning indicator is saturated. Null the distortion meter for the 400-cycle tone and take a distortion reading. Now adjust the detector transformer secondary for lowest distortion. You can safely sweep the entire range of the slug through the two or three peaks. One of them will have considerably lower distortion.

▶ Reduce generator output to the low input used in the first step and carefully adjust the tuner for minimum distortion on the distortion meter. Raise generator output again till the tuning indicator is saturated and readjust the detector secondary again for minimum distortion.

▶ Reduce generator output to the previous low value, reset the distortion meter to read the total audio output of tuner. Now adjust the tracking and peak the front-end trimmers.

You can check sensitivity at 90 and 106 mc by repeating the first step. You should have an improvement. If you find that the difference in sensitivity at 90 and 106 mc is greater than 6 db, try to equalize the sensitivity by adjusting capacitative trimmers at the high end and coil inductances at the low end. Or, in a fringe area, adjust the sensitivity to favor desired weak stations.

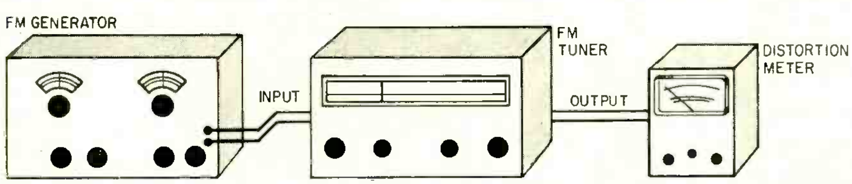


**Fig. 1—A typical setup using sweep generator and distortion meter for FM tuner alignment.**

You can also use an IM analyzer. Feed the tuner output to the analyzer input. Feed the composite signal from analyzer into the external modulation jack of the FM generator. You can meter this input to the voltage suggested in the generator manual. Or, more simply, you can set the deviation at 75 kc and then increase IM analyzer output until you hear or read appreciable distortion.

This method is so simple, foolproof and effective that it is to be hoped that someone will soon provide a reasonably priced FM generator—or better yet—a generator with a built-in nulling network and meter.

The outlined procedures will apply equally well to the mass-produced FM tuners and receivers that are found in hi-fi packages, table model receivers, etc. However, you are likely to run into gated-beam detectors. No component tuner I can recall uses a gated-beam detector though several use gated-beam limiters. The gated-beam detector combines the functions of limiting and detection and can be aligned as follows:

▶ Feed the tuner with a signal from an AM generator anywhere in the FM band or, if you want to go to the trouble, at the intermediate frequency.

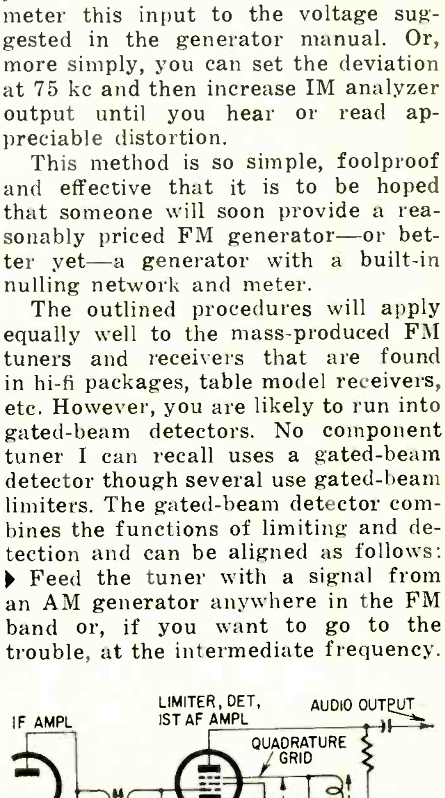


**Fig. 2—The gated-beam detector. Alignment details are in the text.**

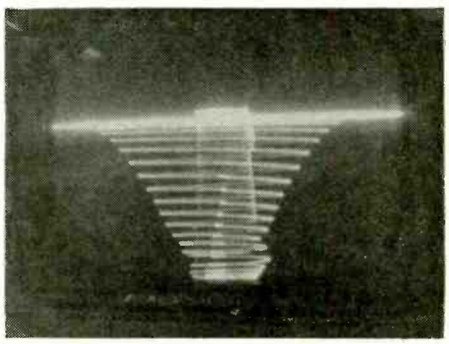
# WHAT'S YOUR EQ?

The EQ's are now the most popular department in the magazine. Our mail is reaching an all-time high! We just can't answer individual letters, but will continue to print the more interesting solutions (the ones the original authors never thought of!).

Here are a few more we hope our readers will find challenging. And if you can develop an original EQ that will stump our readers, send it to us. We pay $10 and up for each one accepted. Write to EQ editor, RADIO-ELECTRONICS 154 West 14th St., New York 11, N.Y. Answers to September puzzles are on the opposite page.

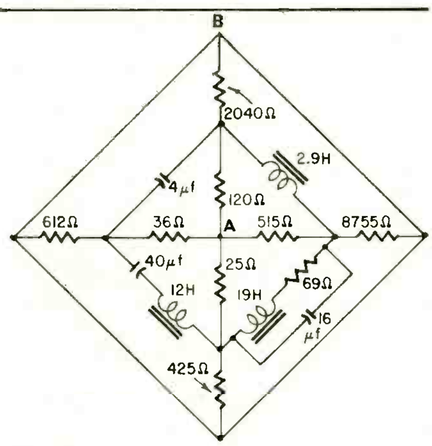
## An Electronic Ground?

This Zenith chassis 15Z31 came into the shop with what appeared to be a folded-over ground symbol. The shop technician took one look and pointed out the trouble, not by deduction, but because he had had the same trouble before. Could you have done as well? —*Wayne Lemons*



## Simple Impedance Problem

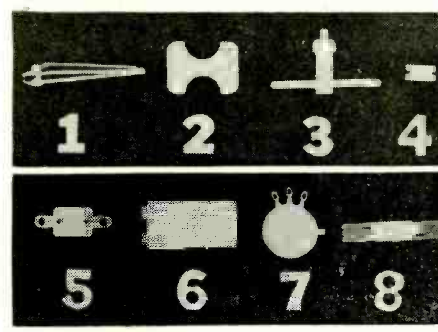
At 1,000 cycles, what is the impedance of this circuit (to the nearest ohm) between points A and B, and what is its phase angle (to the nearest degree)? —*Charles Erwin Cohn*




## Electronic Photogram Puzzle

This novel, puzzle can provide many minutes of fun for the electronic technician and hobbyist. The object is to see how many of the radio-electronic components you can identify correctly in the photo-diagram. Watch out—a couple foreign (nonelectronic) parts are thrown in just to mislead you!

List your answers in the blank spaces and then check your answers next month.—*John A. Comstock*




1. ________
2. ________
3. ________
4. ________
5. ________
6. ________
7. ________
8. ________

## Accurate Alignment of Hi-Fi FM Tuners *(continued)*

Carefully peak the signal and modulate at around 30%. Connect an audio output meter or the ac section of your vtvm to audio output of tuner.

▸ Ground the quadrature grid (see diagram). Turn up the volume control on the tuner and adjust generator output to produce a moderate reading on the meter. Check to see that the limiter is not limiting. If limiting shows up, reduce output.

▸ Tune the primary and secondary slugs of the detector transformer for maximum swing.

▸ Increase generator output until the limiter is saturated (meter reading does not increase with increased input). Adjust the variable cathode resistor for minimum reading on the meter.

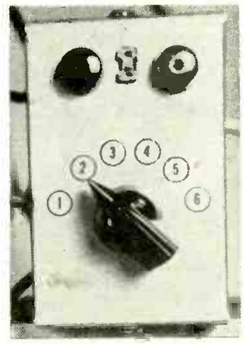
▸ Disconnect the generator and tune in an FM station of moderate strength. Unground the quadrature grid and tune quadrature coil for maximum audio output.

### Peaking double-humped if

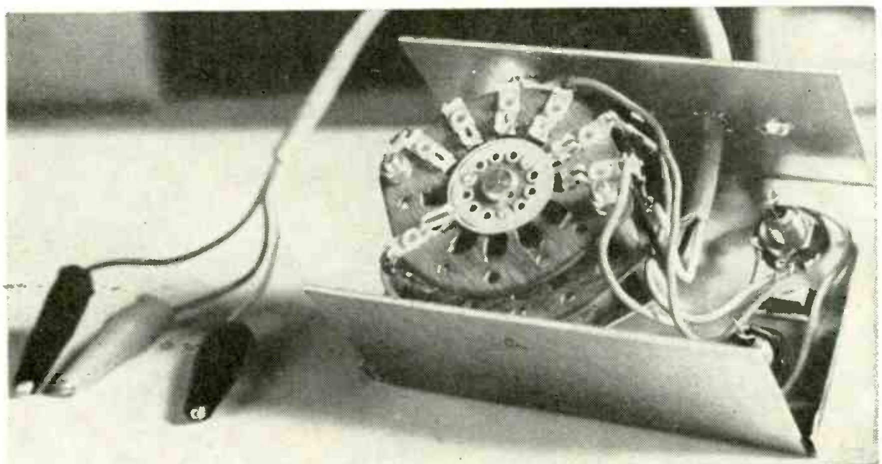
If you run into an older tuner with the double-humped response curve, you can still peak it easily by the method below. The double-humped response may show up when you check the shape and symmetry of the if as detailed earlier. Or it may show up when you try to peak the if. Get a 1,000-ohm resistor and attach two small alligator clips to its leads. Keep the leads as short as possible but with enough flexibility to be conveniently used. Clip this loading resistor across the secondary of the if transformer when you are peaking the primary, and across the primary when peaking the secondary. You will find that you get a broad single peak and the idea is to adjust the trimmer or slug for the middle of this broad peak. END

# SPEEDY TRANSISTOR TESTER

*With this switchbox and an ohmmeter you can spot defective transistors and separate the p-n-p's from the n-p-n's*




**Front panel of the switchbox sports a selector switch, transistor socket and jacks for your ohmmeter probes.**



**Inside the switchbox.**

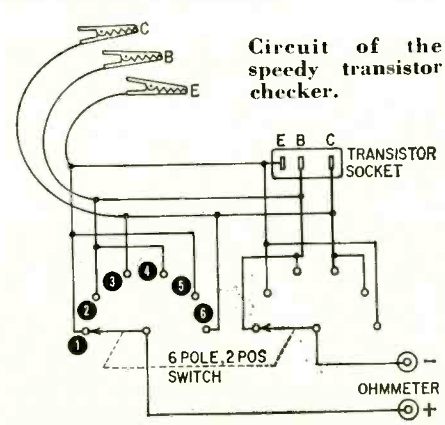
**By WAYNE LEMONS**

NEARLY ALL MANUFACTURERS RECOMmend an ohmmeter test for transistors, especially for power types. It consists of placing test leads between the base and emitter, base and collector, collector and emitter, and then reversing the leads to check diode action. If you get a high-resistance reading in one direction and a low-resistance reading in the other between the base and emitter and the base and collector, and a high-resistance reading in both directions from collector to emitter, the transistor is considered good.

This does not check gain but, since transistor gain seldom changes, a gain test is virtually unnecessary for service work. Unfortunately, holding two test leads while fumbling with three transistor leads and trying to remember which is which and why, is no job for a man with only two hands and a one-track mind.

The little box shown here, used with your ohmmeter, decomplicates and defrustrates the process marvelously. A transistor socket is used for plug-in transistors, and the three clips for other types. It makes no difference whether the transistor tested is an n-p-n or p-n-p. Simply plug your ohmmeter into the jacks provided and rotate the tester switch from 1 to 6. You should get alternate low- and high-resistance (or high and low) readings in positions 1 to 4 and high-resistance readings on both 5 and 6. In other words, there will be two low-resistance and four high-resistance readings if the transistor is good. You can identify transistors as n-p-n or p-n-p by noting if the low-resistance reading occurs on position 1 or 2. This unit and the meter used with it gives a low-resistance reading on position 1 for n-p-n types and position 2 for p-n-p's. Other wiring arrangements or a different meter could reverse this. It's easy to find out—check a good transistor with known characteristics.

The R × 10 scale is used for most transistors but you may want to use the R × 1 scale for power types. The R × 10 scale is probably about right for most of the resistances encountered. Transistors will vary but you usually get 100 ohms or less in the forward direction to over 50,000 ohms in the reverse direction for small-signal types. Power types usually have less resistance in both forward and reverse directions. Different meter scales will alter the readings—for instance, you may get 20 ohms forward resistance on the R × 10 scale and only 10 ohms on the R × 1 scale. Ratio of front to back is more important than actual values. Ratios of 100 to 1 are desirable though sometimes not necessary. END

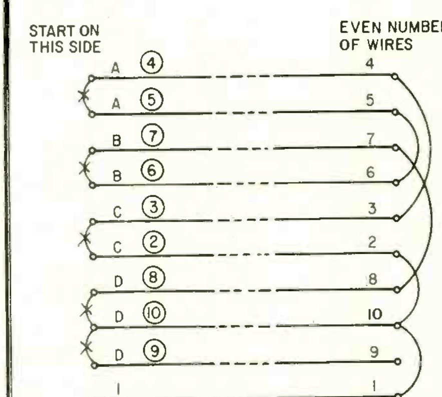



**Circuit of the speedy transistor checker.**

# What's Your EQ *September Solutions*

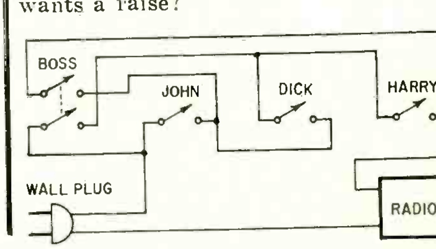
## *Over the River*

The solution shown is for 10 wires but it applies to any even number of wires greater than 4.—Start by tying wires into pairs except for four wires. Tie three of these together and leave one free. Label the pairs A–A, B–B, C–C; then label the set of three D–D–D. The remaining wire is then labeled 1. Move over to the other side. Find the free wire and label it 1. Find the pairs and label them 2–3, 4–5, 6–7; then label the set of three 8–9–10. Tie 1–2–10 together. Then tie the following wires into pairs 3–4, 5–6, 7–8; leave 9 free. Move back to the first side. Open all the wires that are tied together. Find the free wire and label it 9. Find the wires that are connected to No. 1. Label the D-wire 10 and the C-wire 2, then the other C-wire must be 3. Label it. Find the wire connected to No. 3 and label it 4. Since it is an A-wire, label the other A-wire 5. Find the wire connected to No. 5 and label it 6. Since it is a B-wire, label the other B-wire 7. Find the wire connected to No. 7 and label it 8. This completes wire identification.




## *Automated Voting*

Now everyone gets to vote. Three employees can outvote the boss—when they want to listen to the radio, that is. Wonder how this system works when Dick wants a raise?

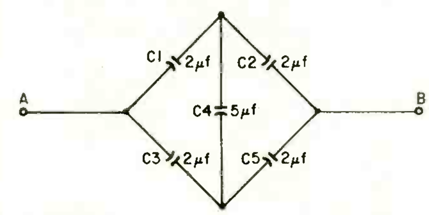


## Black Box Mixup

Almost too simple. The black box merely contains a nice, neat short circuit. The cells, of course, both have equal internal resistances through which the current, I, flows. When two cells are in series, the resistance as well as the voltage doubles, leaving current I essentially constant.

## Series-Parallel Capacitors

This is a typical sample of the present-day right-angled drawing. (It can make any problem unnecessarily complicated.) Drawn in bridge form as shown here, it is easy to see that the 5-μf capacitor has no effect on the circuit,




and that we have two parallel branches of two 2-μf capacitors in series with each other. Capacitance of each branch: 1-μf; total capacitance: 2-μf.

END

## Relay Service Note

A relay that intermittently fails to operate when the proper signal is applied is exasperating. We ran into this twice—the escapement relay in two signal-seeking automobile radios failed to operate. In each instance the proper current was applied to the relay winding, mechanical action was free and the escapement released smoothly when operated manually.

We noted that when operated manually with current applied, an unusual amount of force was required to actuate the mechanism. Close inspection disclosed a small sliver of iron filing held in a horizontal position between the armature and the pole piece of the relay. Residual magnetism prevented its being moved in normal handling. When current was applied, the filing bridged the gap between the armature and the pole piece, preventing normal operation of the relay. We removed the filing with a piece of gummed tape to effect a permanent cure.—*Roy E. Pafenberg*

# Electronic Repeating Switch

This simple repeating switch is useful for life testing, ornamental lighting, cycling display motors, cycling soldering irons to prevent overheating and numerous other applications. It acts as a spdt switch whose contact arm can be moved downward and held for 10 to 28 seconds and upward and held for 20 to 40 seconds.

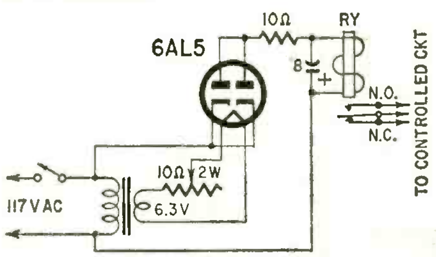



Fig.1

The basic circuit is shown in Fig. 1. When the potentiometer is set for zero resistance, it takes about 5 seconds for the tube to warm up and conduct enough to pull in the relay. The time delay can be increased by increasing the resistance in series with the heater.

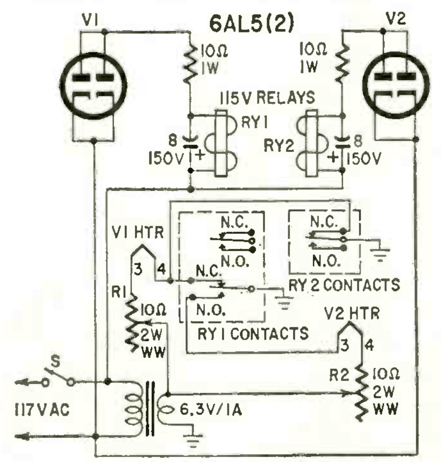
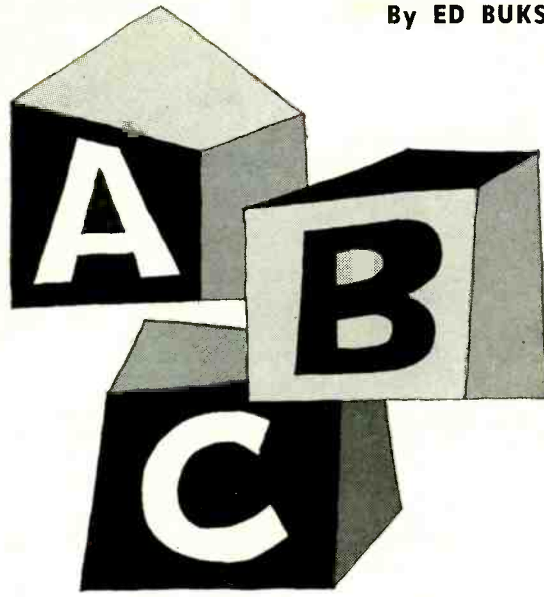



Fig.2

With two of these delay circuits interconnected as in Fig. 2, we can vary the on and off times of the device being controlled or tested. When S is closed, heater voltage is applied to V1. After a warmup period (determined by the setting of R1) V1 conducts and RY1's normally closed contacts open up. V1 continues to receive heater voltage through RY2's normally closed contact.

When RY1 pulls in, it applies heater voltage to V2 through R2. When V2 reaches operating temperature, RY2 pulls in and opens V1's heater circuit, thus releasing RY1. This breaks V2's heater circuit and the cycle repeats.

Assuming that a lamp is connected to power through RY1's normally closed contacts, it goes off as soon as V1 warms up and comes on again when V2 reaches operating temperature. Off time is controlled by R2; on time by R1. R1's and R2's functions are reversed when the lamp or load is connected across RY1's normally open contacts.—*Ronald Wilensky*




By **ED BUKSTEIN**

# INDUSTRIAL ELECTRONIC DICTIONARY

*From electron microscope to hard X-rays.*

**Electron microscope:** Magnifying device using an electron beam instead of light as in a conventional microscope. The electron stream diverges and casts a shadow of the specimen on a fluorescent screen or a photographic plate. The electron microscope is capable of greater magnification and resolution than its optical counterpart.

**Electrostatic precipitation:** Method of controlling small particles of paint, dust, smoke, abrasives and other materials with electrical charges. The particles are charged by passing them through a set of wires or plates connected to a high-voltage power supply. The charged particles are then attracted to any object given an opposite charge. In electrostatic paint spraying, for example, the particles of paint are charged oppositely as compared to the object to be painted. In the manufacture of sandpaper, the abrasive particles are charged so that they fall with sharp points upward on the paper backing. Smoke and dust particles are attracted to a metal plate to remove them from chimney gases in industrial plants. This not only cuts down on fumes and smoke, but the recovered particles may be very valuable (in refining operations, for example).

**Electrostatic storage welding:** Same as capacitive storage welding. A bank of previously charged capacitors is allowed to discharge through the primary of a welding transformer. The resulting current flow in the secondary produces enough heat to weld the metals.

**Error detector:** That portion of an automatic control system that determines when the regulated quantity has deviated beyond the limits of the dead zone. The error-detector circuit generally consists of a transducer for measuring the value of the quantity to be regulated, and a comparator circuit for comparing the measured value against a reference quantity. The difference (error) is then amplified and used to restore the regulated quantity to the desired value. The transducers used in error-detector circuits are variously referred to as sensing elements, pickup elements and data pickoffs. Typical examples are thermocouples (for temperature control), bellows-actuated potentiometer (for pressure control), moisture detectors (for humidity control), etc.

**Feedback:** Process of returning a portion of the output (or a signal proportional to output) to the input. In automatic control systems, the feedback is compared against a reference quantity and the difference (error signal) is applied as input. As a result of this input, the output changes in a direction that reduces the error to zero.

**Firing angle:** The electrical angle (of plate supply voltage) at which a gaseous tube ionizes. Thyratrons, ignitrons and other gas- or vapor-filled tubes are often operated with ac plate supplies. The tube may be made to fire (ionize) at a selected time during the positive half-cycle of plate supply voltage by adjusting the bias voltage (Fig. 12). If the bias of a thyratron is increased, for example, the plate voltage must reach a higher value before the gas can ionize. The tube, therefore, fires later in the positive half-cycle of plate supply voltage and the average current through the load is decreased. (See Amplitude-controlled rectifier.)

**Flame-failure control:** A circuit that automatically shuts off the fuel supply to a furnace if the pilot burner should accidentally go out. This keeps unignited fuel from accumulating in the furnace, avoiding its attendent hazards. Blue-sensitive phototubes are often used to sense the characteristic blue flame of the pilot burner.

**Flip-flop circuit:** Same as binary circuit. A distinction is sometimes made between the binary circuit and the flip-flop on the basis that the binary circuit has only one input terminal (feeding to both grids) and the flip-flop may have separate input terminals for the two grids. The simplest flip-flops use neon lamps.

**Fluoroscope:** An X-ray instrument in which the object to be examined is positioned between an X-ray tube and a fluorescent screen. The X-rays penetrate the object according to its density and then excite the fluorescent screen to produce a visible image. A system of mirrors and lead-glass shields permits the operator to view the image without exposing himself to direct radiation. Fluoroscopic examination is used industrially to inspect packaged foods for proper filling and to spot foreign particles, citrus fruits for internal texture and quality, and rubber tires for internal defects, etc.

**Fluoroscopy:** X-ray examination by viewing the image produced on a fluorescent screen (see Fluoroscope). This feature distinguishes fluoroscopy from *radiography*, a process of producing an X-ray image on a photographic film.

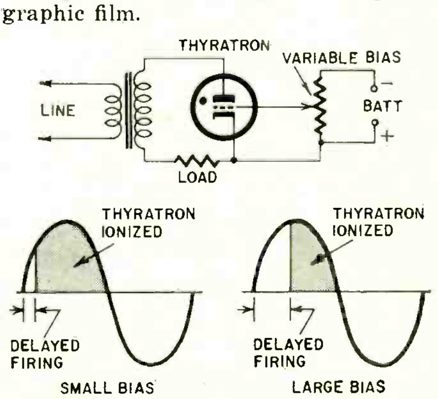



**Fig. 12—Thyratron has this typical firing-angle diagram.**

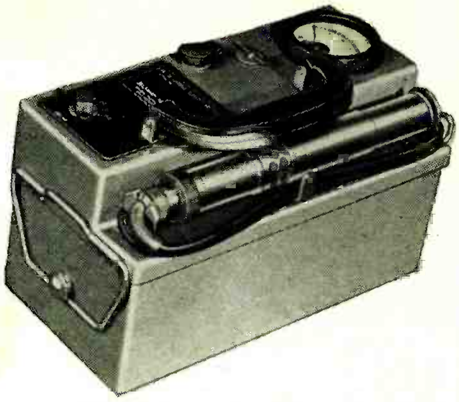


Fig. 13—A portable Geiger counter.

**Gas amplification:** A numerical rating indicating the greater sensitivity of a gas-filled phototube as compared to a vacuum phototube. A phototube having a gas amplification of 5, for example, will draw 5 times as much current as an otherwise equivalent vacuum phototube under equal conditions of illumination. Gas amplification is generally in the range of 3 to 10.

**Gas detector:** Photoelectric instrument used to monitor the concentration of harmful gases in the air. Many noxious gases absorb ultraviolet radiation. Therefore, the presence of these gases decreases the illumination received by a phototube from an ultraviolet source. The phototube controls a relay to sound an alarm when the gas concentration approaches a dangerous level.

**Geiger counter:** Instrument used for detecting and monitoring radioactivity. The Geiger tube is a cold-cathode, gas-filled diode operated with a plate supply voltage slightly less than that required to ionize the gas. Particles and radiation emitted from radioactive substances enter the tube and ionize the gas. The resulting pulses of plate current—one for each particle detected—are amplified and applied to a headset, neon lamp, counting rate meter or other indicating device.

**Grid-controlled rectifier:** Rectifier circuit employing thyratrons. Load current is varied by adjusting the bias of the thyratrons. Grid-controlled rectifiers are of two general types: amplitude-controlled and phase-controlled. The former uses a variable dc bias, and the latter a variable-phase ac bias (see Amplitude-controlled rectifier).

**Hard X-rays:** Highly penetrating X-rays as distinguished from soft X-rays, which are less penetrating. The degree of hardness (penetrating power) is determined by the amount of voltage applied to the X-ray tube: the greater the voltage, the harder the X-rays. Hard X-rays are used to inspect metal castings for internal cracks and air bubbles, for examining welded joints and for inspecting complex mechanical assemblies for proper location and positioning of internal components. Soft X-rays are used for inspecting low-density materials such as plastics, packaged foods, etc. TO BE CONTINUED

# NEXT MONTH

## NOVEMBER—RADIO-ELECTRONICS

Joe Marshall's back with—

### WHAT'S WITH HI-FI PICKUP ARMS?

The provocative Joe Marshall writes again in our November issue. This time he takes critical aim at some pickup problems and tells how the 1961 arms are trying to meet them. He's compiled a useful tabulation of pickup arms, features, characteristics and prices that makes an invaluable buying guide. Don't miss it in next month's issue.

Super R/C—

### PRINTED CIRCUIT RADIO CONTROL SYSTEM

Here's a powerful and reliable radio control unit with muscles. It will control not only model boats and such—but even your lawnmower. Printed circuit boards are available to make construction even easier. See it in the November issue.

### CRYSTAL CONTROLLED FREQUENCY DIVIDER

Looking for low frequencies? Insert this divider after the output of a 100-kc oscillator and get down as low as 2 kc. This neat and simple job uses three transistors. Read about it in the November issue.

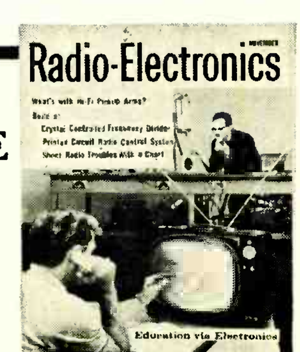
New Way to Shoot Trouble—

### SHOOT RADIO TROUBLES WITH A CHART

November *Radio-Electronics* gives you an effective, systematic graphic way to radio troubleshooting. It leads you through circuitry the quickest and surest way. This one is high priority for service technicians.

**NOVEMBER ISSUE ON SALE**

**OCTOBER 17th**



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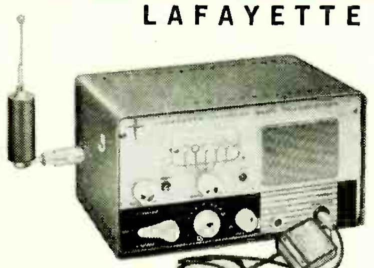

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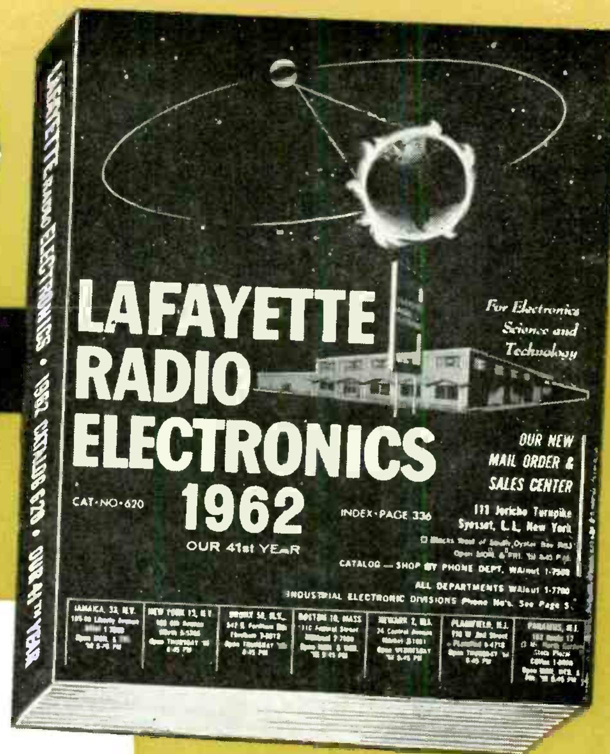


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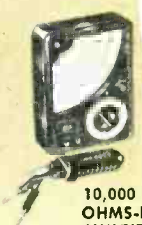

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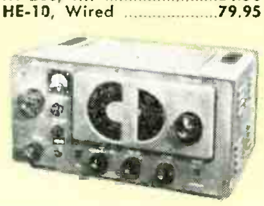

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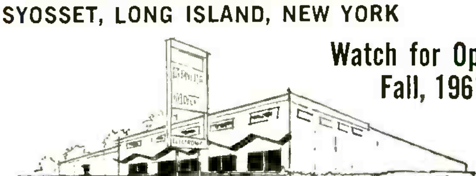

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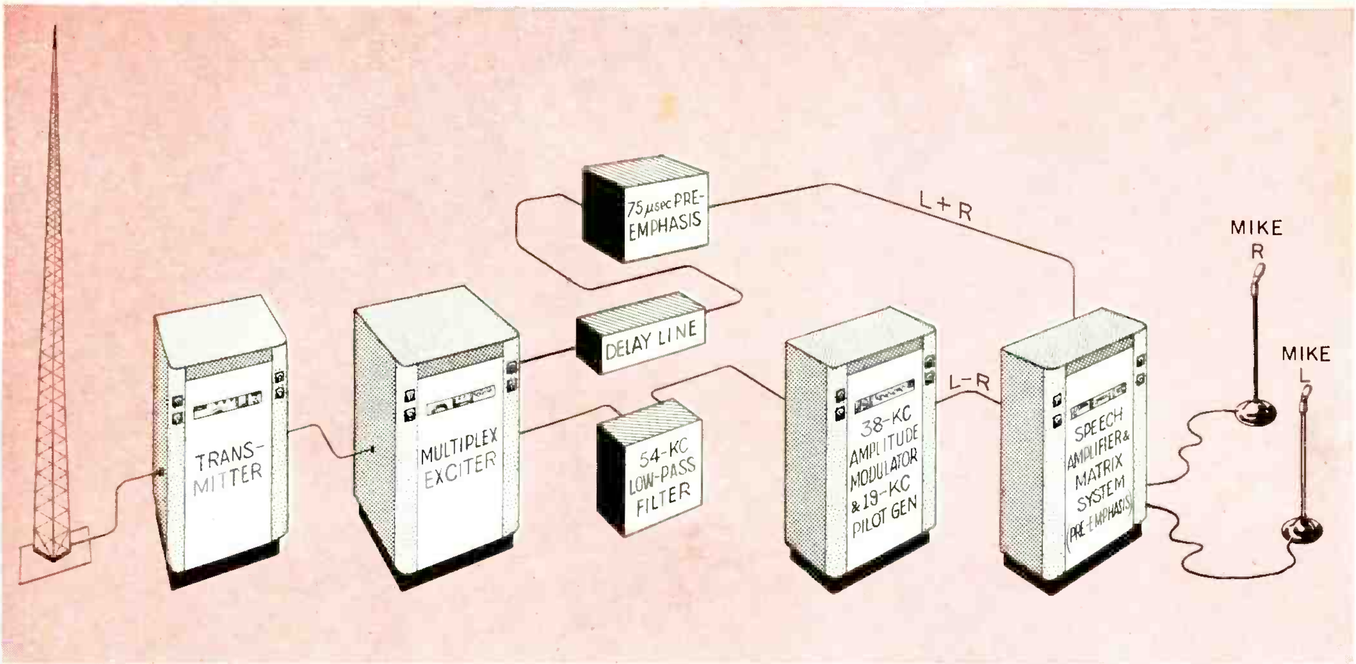



# FM STEREO IS NOT SO TOUGH

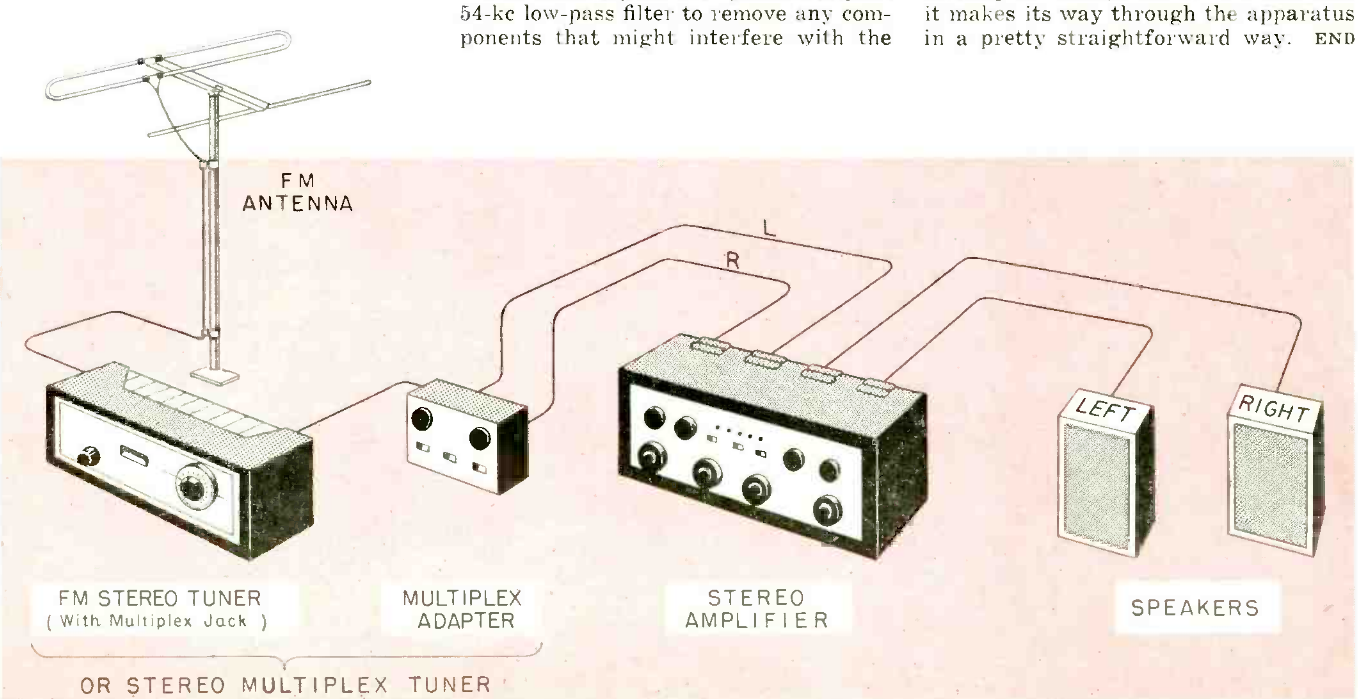
STEREO FM TRANSMISSION AND RECEPTION is not as complex as some of the descriptions have made it look. The illustrations above shows what happens in stereo broadcasting.

The signal from the two microphones at the far right is amplified and then mixed by a pair of transformers to produce an in-phase (L + R) and an out-of-phase (L − R) component. Pre-emphasis is applied (shown for the L − R in the first rack—for the L + R in a separate unit) and the L + R signal delayed roughly 48 μsec to keep it in phase. The L − R signal then is used to modulate a 38-kc carrier (afterward suppressed). The equipment that produces the 38-kc carrier also originates the 19-kc signal that acts as a pilot in the receiver.

The 38-kc signal now goes through a 54-kc low-pass filter to remove any components that might interfere with the 67-kc SCA signal that will also be transmitted by many stations. Then it and the L + R signal modulate the rf in the multiplex exciter. The rf signal from the exciter is amplified in the FM transmitter.

Reception (lower illustration) is simpler. If the listener has a good FM tuner, he uses it with a multiplex adapter as shown. Or he may buy a new stereo FM tuner which has left- and right-channel outputs instead of a multiplex jack. In either case, the right and left outputs go to a two-channel stereo amplifier and to speakers as would the output from a stereo pickup or stereo tape.

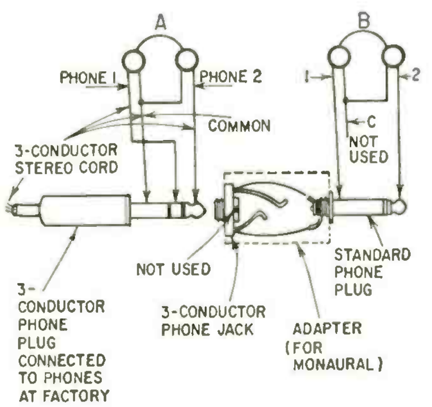
There may be many complicated formulas and confusing distinctions to trouble the engineer in designing this equipment. The stereo signal knows nothing of these, and we can see that it makes its way through the apparatus in a pretty straightforward way. END

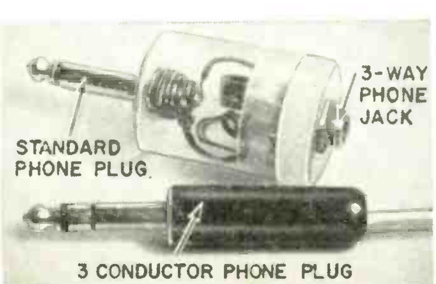


# Stereo Phones to Mono Phones

JUDGING BY THE INCREASING NUMBER OF quality stereo phones around, the pleasure of listening to stereo with earphones is gaining in popularity. Some of these stereo phones are equipped with a three-conductor phone plug which is wired as in A in the diagram. When you want to plug the phones into a monaural jack for monaural listening, the hookup is wrong and you hear the signal in one phone only. The simple adapter described here converts the phones from stereo to monaural wiring without changes in the plug that comes with the phones. The adapter converts the stereo phones to monaural as in B in the diagram.

As shown in the illustrations, the adapter consists of a three-conductor phone jack and a standard phone plug mounted in a plastic pill container, wired as shown. I used a 1-inch-diameter plastic container cut to a length of 1½ inches. A plastic container is used to avoid shorts—if you use a metal container, mount either the jack or the plug with fiber shoulder washers to insulate either from the metal can. The phone plug is securely cemented into a hole in one end of the plastic case.
—*Art Trauffer*



# Double CB receiver sensitivity

*Add a 1-tube rf stage to your Heathkit*

By **HAROLD DAVIS**

**Performance of the already good Heathkit Citizens-band GW-10A and GW-10D transceivers can be greatly improved by adding an rf stage to the receiving end.**

**The modification described here was designed by my good friend D. C. Nix. It can be made before or after completing the kit, but is probably easiest to handle during construction.**

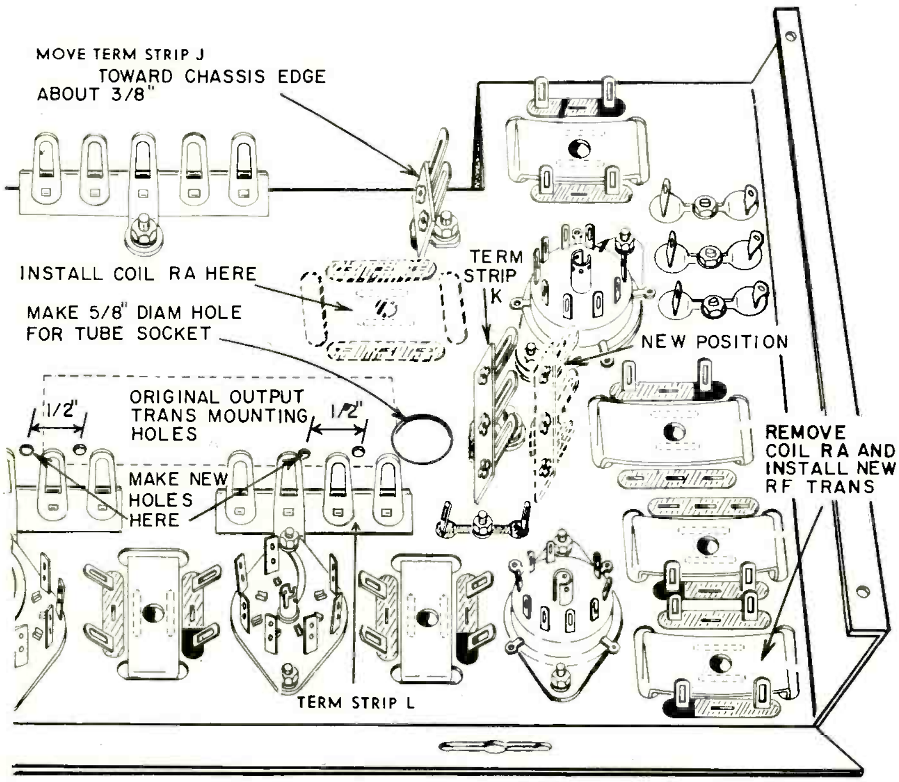



**Fig. 1—Pictorial diagram shows necessary modifications.**

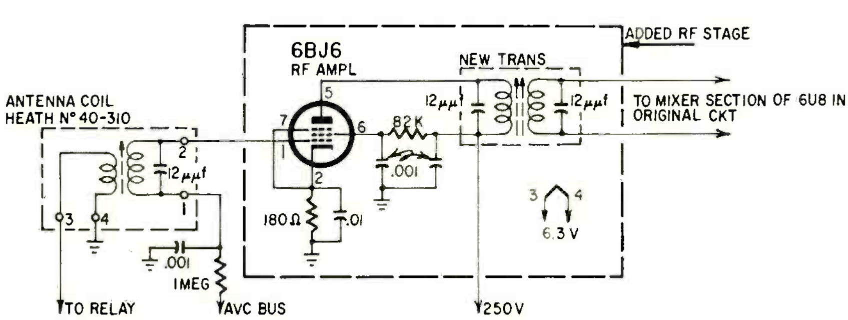



**Fig. 2—Circuit of the rf stage inserted in the transceiver.**

Adding an rf stage is not simple, but is well worth the effort. Looking at pictorial 6 in the construction manual (the necessary portion is duplicated in Fig. 1), swing terminal strip K around 180°. Then move the output transformer ½ inch to the left. You will have to drill new mounting holes ½ inch to the left of those now on the chassis.

Punch a ⅝-inch hole in the chassis between terminal strips K and L. Place a seven-pin miniature tube socket in this hole. Fasten one ear of the socket with the screw that holds terminal strip K. Use another screw and nut to fasten the other ear through the hole that originally held one side of the output transformer.

Now break off the right side of the bracket installed on the speaker. It was originally intended to hold the output transformer but is not used in this kit, and it interferes with the added rf stage.

The next step is the rf transformer. You'll have to wind it yourself. Several TV if transformers were tried but none were entirely satisfactory. Having access to a frequency meter and a GDO, it was no job at all to design one. I stripped the windings of a Meissner No. 163487 transformer, and in their place wound 15-turn coils of No. 26 enameled wire for both primary and secondary. Install a 12-μμf NPO disc capacitor across each winding.

Once the rf transformer is finished, remove antenna coil RA, cut a new hole for it just forward of terminal strip J, and mount it there. You'll have to move terminal strip J about ⅜ inch closer to the edge of the chassis. Install the rf coil where the antenna coil was originally located. Now you are ready to wire in the rf stage. Complete all wiring following the schematic in Fig. 2. You shouldn't have any trouble.

Once the circuit is wired you only have to tune the rf transformer and you're ready to go once again. Use the original slugs and peak the stage for greatest output. This can be done even without a signal generator. Just tune in a station on the desired band and peak the transformer.

This rf stage is fixed-tuned, and one might wonder about its efficiency. However, when we consider that all 23 CB channels are packed into an area only 0.715 mc wide, the stage won't be far off at either end. In addition, if it is peaked on the channel that is used most, efficiency is optimum.

If you want figures to back up the facts, here they are. On a direct side-by-side comparison with another make set that includes an rf stage, the modified Heathkit performed equally well. The specifications for the reference set stated that it had a sensitivity of 0.5 μv for a 10-db signal-to-noise ratio. Since the Heathkit specs read 1 μv, we can assume that receiver sensitivity has been doubled. Additional proof of improved performance came in a side-by-side test with an unmodified receiver. Signals that could not be read previously, were easily understood with the modified unit. END



*Don and Larry Taylor, with twin backgrounds and skills, have competitively built kit after kit, Paco vs. other makes. In one test Don built the Paco, in the next Larry did. Net results: Paco kits proved faster, easier, and better in performance.* **For a typical Twin-Test report turn the page.**

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**G-15 Kit:** Complete with 8 plug-in coils, "Twin-Tested" manual ......$31.95 net

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# *"I built the Paco SA-40 Stereo Preamp Amplifier."*

Larry Taylor, 8 Stevens Place, Huntington Station, N. Y. "It took me one-third less time to build the Paco kit than it took Don to make the almost identical preamp-amplifier by another kit maker. But it wasn't just the time; it was knowing you're using the right part, and that you understand the instructions completely. Paco parts are all pictured and labelled, the resistors are neatly mounted on cards for easy identification. And Paco's instruction book doesn't leave you guessing. The fold-out diagrams and drawings are always right beside the instructions, so you're not reading one part of the book and following a diagram in another part. Photographs in Paco's book show how each assembly should actually look. I enjoyed building Paco kits, because I wasn't wasting time or worrying."

(Continued on next page)

# An Integrated Antenna

### Field-Test Report by our Service Editor, Jack Darr

I HAVE ALWAYS FAVORED ANTENNA BOOSTers (mounted on the antenna itself). Now the Winegard Co. has come up with what looks to me like a logical step. The antenna booster is *designed as part of the antenna!* This new antenna is called the Powertron, and comes in several models. The P-44, which is the one we tested, is a 14-element all-channel Yagi, similar in design to the company's CL-4. The antenna booster uses a single ECC88/6DJ8 tube, and a gain of 14 db is claimed for the amplifier. (This seems a reasonable figure, to us. We were making some tests on signal propagation at the time, using another older antenna and a 4-tube antenna booster. Pictures received with the P-44 were equal to those from the more elaborate rig, and the signal strength on the field-strength meter showed only a very slight loss!)

Two other models add more directors to the basic P-44. The P-44X has 21 elements and the SP-44X no less than 30 elements.

More recently, the company has put out a trio of transistorized Powertrons: the P-55, a 14-element antenna; the P-55X with 21 elements, and the SP (Super-Power) 55X, a 30-element antenna. The transistor types were not available when I ran my test on the P-44.

Mechanical construction of this antenna is very sturdy, and, while this type is not *quite* as convenient as the "snapout" ones, there is very little real assembly work to do. We put it together at the top of a 40-foot tower without any trouble at all. Lead-in terminals on both booster and power supply are of the "no-strip" type.

The booster is designed as an integral part of the antenna: the tapered-T dipole is fed directly to the booster input! Circuitry used is standard broadband amplifier type. Power supply is 24 volts ac, from a stepdown transformer located at the set. The lead-in is also taken off there to the TV receiver, with the customary rf chokes and capacitors to separate the rf and 60-cycle currents.

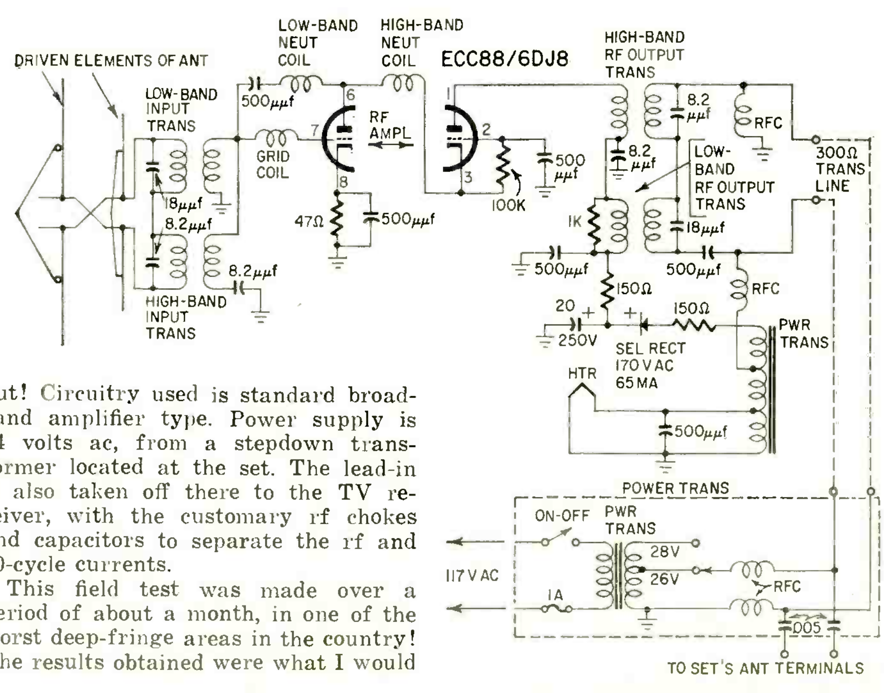
This field test was made over a period of about a month, in one of the worst deep-fringe areas in the country! The results obtained were what I would call very good, and equaled any type of antenna so far tested here. This model shows the usual slightly wide frontal lobe common to all-channel Yagi configurations with only three directors—about 60–70°. The larger models will probably bring this down to a very narrow lobe, suitable for use under any condition of co-channel interference. At one time, we picked up three stations on channel 4, simply by rotating the antenna 360°! Each one was quite clear, and there was a minimum of venetian-blind interference.

In a deep-fringe location, front-to-back ratio is often more important than absolute gain. This antenna showed a very good FTB ratio. In fact, the first time we read it, we waited until we could check it for another 2 or 3 days so that we could be sure.

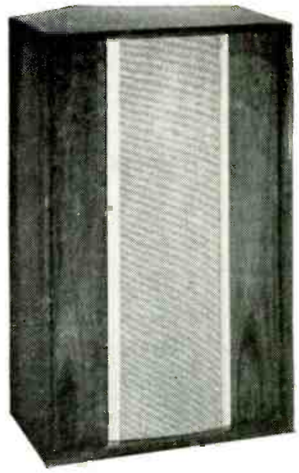
Incidentally, the P-44 does not show any signs of my pet hate in all-channel antennas: *pattern breakup* on the high bands! (An antenna develops three, four or even seven or eight individual lobes, none too usable.) On both high and low bands, the P-44 shows only a single lobe.

Color reception on this antenna was very good. One of the big headaches in color has been standing waves on the lead-in, especially with high-gain boosters. This one showed no trace of ringing or ghosts on any channel.

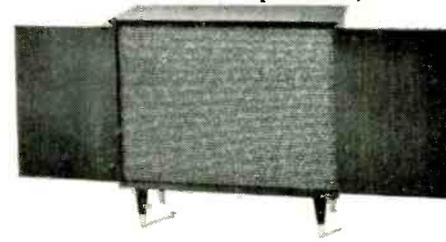
We used our regular stations for the test: channel 5, 85 miles away; channel 6, 95 miles; channels 4 and 11, 20 miles (all distances airline, of course), and even our favorite freak, channel 8 from 206 miles away! This last comes in regularly, and even snowfree once in a while! Reception was very good on all, despite some highly disturbed weather during most of the test. END



# HOW TO PLACE YOUR STEREO SPEAKERS



The Patrician by Electro-Voice.



University's TMS-2 speaker system.

*The inside story on how to select and use stereo speakers to get the most in listening pleasure*

**By GEORGE L. AUGSPURGER**

THE ANNOUNCEMENT OF AN APPROVED system for broadcasting stereo sound on a single FM channel is already stimulating new interest in stereo reproduction. All the questions asked when disc stereo was first introduced commercially will be asked again. Those who were bored by discussions of stereo speaker placement 2 years ago are trying to find the answers to such questions now.

Fortunately, a lot of the initial confusion that surrounded the mysterious process of stereophonic reproduction has been cleared away. Notions about stereo loudspeakers, for example. Do you remember the profusion of systems, gadgets, formulas and recommendations into which the innocent audiophile was plunged when he investigated the possibility of converting his installation to stereo? There were 101 different methods of hooking up assorted speakers, networks, pads and transformers. And each manufacturer had his own pet loudspeaker arrangement.

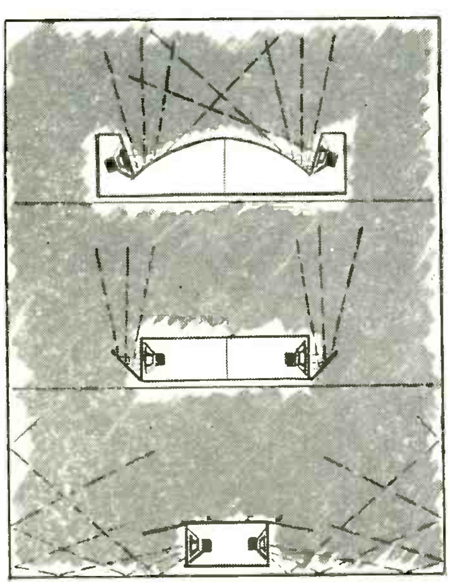


Fig. 1—Three types of integrated speaker systems and their sound radiation patterns. (Top) JBL Metregon, (center) Bozak Stereo Fantasy, (bottom) University TMS-2.

Today, while the choice of excellent speakers has never been greater, their selection is far easier. The majority of speaker manufacturers suggest a pair of identical speaker systems as the basic stereo ensemble. This is logical, since the two-channel stereo system we're using is exactly that—two separate but identical channels over which sound can be reproduced.

### Basic stereo speaker rules

This brings us to a fundamental axiom: **stereo requires two matched speaker systems properly oriented with respect to the listener.** This is not quite as inflexible as it sounds, but it is the cornerstone, so to speak. All the fancy patented systems with their reflectors and mixers and directors are variations on this primary axiom. The two speaker systems required for stereo listening don't have to be any special type. They can be single speakers, multiple speakers, small speakers or big speakers.

As an interesting sidelight, a lot of people thought that the trend toward small "bookshelf" speaker systems resulted from the space requirements of stereo installations. But now, with a new wave of interest in stereo, just the opposite seems to be happening. Speaker manufacturers who had practically given up trying to promote their larger models find that audiophiles are once again choosing big boxes and corner horns. A number of outstanding new big speaker systems have been introduced in the last year, and the critical listener with an appetite for the best in sound has a variety of products from which to choose.

But whether they be small or large, modest or expensive, two matched speaker systems are a necessity for your stereo installation. However, there is a difference between *matched* speakers and *identical* speakers. Also, the reference to proper orientation needs further explanation.

The basic axiom for stereo speakers can be expanded to include two subrules. These are based on an accumulation of experience and represent pretty general agreement among speaker manufacturers, engineers and audio specialists.

- Use speakers that sound alike.
- Place the two speakers so the listener sees an angle of about 40° between them.

### Use speakers that sound alike

You will get best possible stereo sound if you use identical speaker systems. The two systems can be installed in separate enclosures, or you may prefer one of the single-cabinet, or "integrated," stereo speaker systems.

Which is better? Answer: It depends.

Single-cabinet stereo speaker systems have a number of advantages. It is often easier to find a place for a single new piece of furniture than a pair of speaker enclosures. The integrated system may offer engineering features that cannot be duplicated with separate enclosures.

For example, University makes a deceptively small cabinet which incorporates deflector panels to bounce the sound off room walls and thus achieve a wide, somewhat diffuse sound source. Bozak made a system using similar deflector panels, but in reverse. Here the panels reflect the sound directly to the listening area. They can be adjusted to focus the sound toward the listener and give the desired amount of diffusion.

The JBL "gon" series (Paragon, Metregon, Minigon) turn the Bozak arrangement inside out and direct the sound from the two speakers inward, reflecting it from a curved panel which is the distinguishing feature of these models. The idea is to control the directional characteristics of the two sound sources so that properly balanced stereo can be appreciated over a larger listening area. The operation of these three types of integrated systems is shown in Fig. 1.

(*Continued on page* 94)

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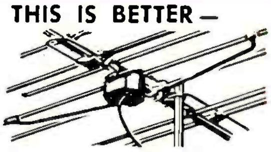

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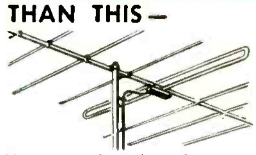

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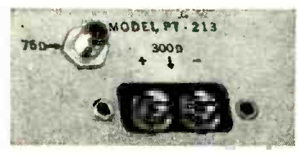


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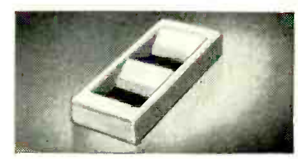

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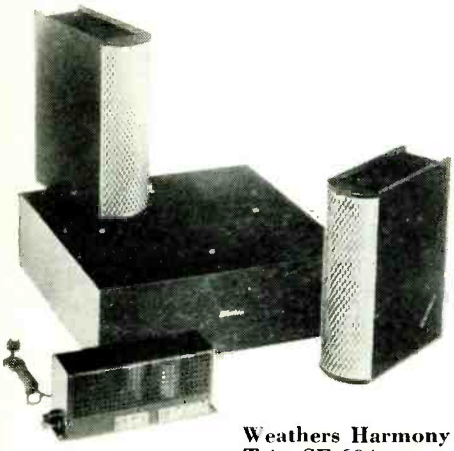


**Weathers Harmony Trio SE-60A.**

(*Continued from page* 91)

But an integrated system has its limitations. The University design, for example, can't operate sandwiched between two pieces of heavy overstuffed furniture. The Bozak and JBL models provide a stereo sound source whose width is limited by the size of the cabinet. This in turn establishes how far away you can sit and still enjoy the stereo effect.

A third factor is that most single-cabinet systems try to achieve a diffuse sound source. This satisfies the listener who is annoyed by the effect of two distinct sound sources, but those who like ping-pong stereo are disappointed. (One of the first multiplex demonstrations was a flop because the sound didn't jump back and forth between speakers—it wasn't "stereo".)

Two separate enclosures may not be able to match some of the features of the integrated systems, but they have the advantage that spacing can be adjusted to give best possible results in specific surroundings. Also, if you move or if the furniture is rearranged, the speakers can be relocated too.

If you can't use identical speakers, the next best thing is to use systems which have identical sound characteristics *except* in the low bass region. The sense of directionality is largely lost below 150 cycles or so, and this very low bass content is usually present on both channels of normal stereo material. True enough, some stereo recordings are made with most of the bass funneled through one channel, but you can use the "channel-reverse" switch on your stereo amplifier to feed the deepest bass to the speaker best able to reproduce it, no matter how the material was originally recorded.

Why would anyone want a combination like that? Because it may be the only practical way of utilizing a very large and expensive monophonic speaker system which you already own. An alternate solution is to use the same mid- and high-frequency transducers, together with a smaller woofer, all installed in a smaller enclosure. In either case, the speaker manufacturer will be happy to give you more explicit advice about the combination which will work best in the space you have available.

What about using speakers of different types or different brands? This is skating on thin ice, and I would want to hear the combination or else be awfully sure of results before much money was invested.

This is not to say it can't be done. Remember, the rule is that the speakers should *sound* alike, and surprising combinations sometimes yield acceptable stereo quality. Offhand, I know of a high-quality 8-inch speaker which has a characteristic sound very similar to that of one of the big corner-horn systems. It isn't identical to the big system of course, and it can't begin to duplicate its dynamic range, but so long as the volume control is kept to a reasonable setting the two together make a most pleasing stereo sound.

## Two-speaker variations

Since symmetry is desirable, some people want to know if they can keep their present speaker system and flank it with two smaller units. This can be made to work, but it is usually not recommended. Since the side speakers carry most of the sound (and all of the stereo information) their limitations determine the quality of the whole system.

Another variation uses a single woofer in combination with two sets of mid- and high-frequency speakers. The University system already described uses a single woofer. The Weathers Harmony Trio system consists of two small speakers disguised to look a little like books, and a single unusual woofer hidden somewhere in the room.

However, most of the common-bass systems have been supplanted by pairs of compact speakers. Placement, wiring and balancing of the extra low-frequency reproducer are usually more trouble than the novelty is worth.

## Speaker placement

Although important, the recommended 40° angle needn't be taken literally. There is nothing critical about it. It is easier to remember that the speakers should be separated about half to three-quarters the distance from them to the listener (Fig. 2). The farther the listening area, the farther apart the speakers should be. If the listening area is about 12 feet from the wall where the speakers are to be set, they should be 6 to 9 feet apart. It is as simple as that.

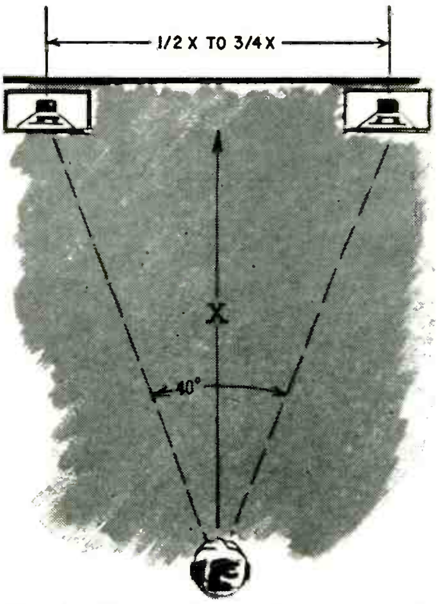



**Fig. 2—The optimum listening angle puts the speakers 40° apart.**

But sometimes the arrangement of a particular room makes it impossible to locate two speakers for best results. Look at Fig. 3. A second speaker can be placed only at A or B. If it is set at A, the speakers are too close together. At B, they are too far apart.

The solution is to use position B for the second stereo speaker, and then set a third speaker at A. This "center-fill" speaker handles a mixture of both

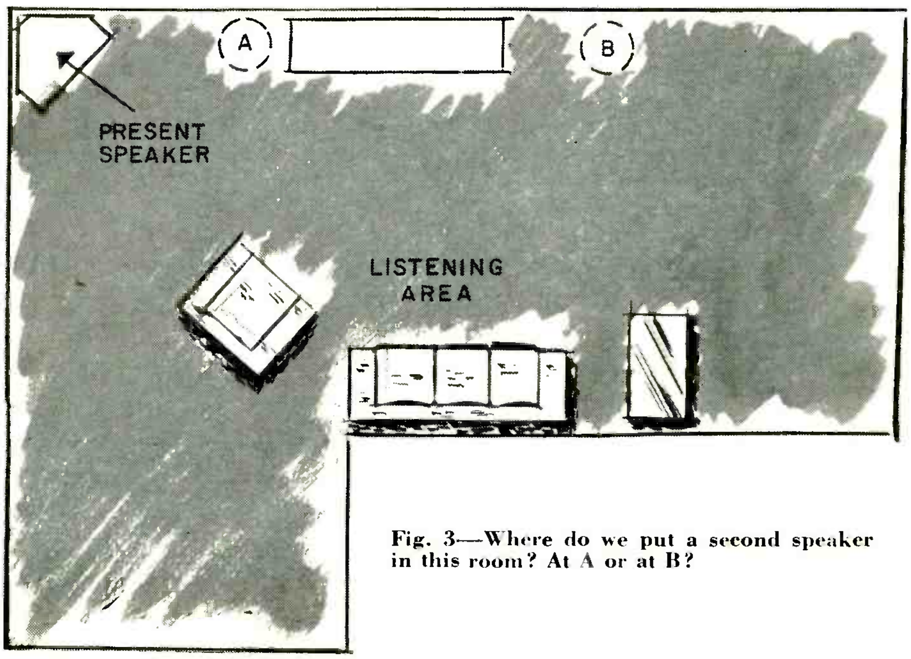



**Fig. 3—Where do we put a second speaker in this room? At A or at B?**

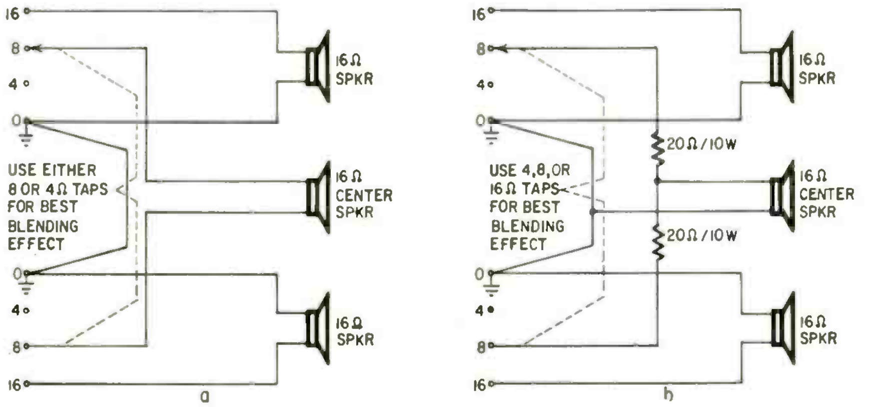



**Fig. 4-a—Use this arrangement to feed the center speaker a difference signal. b—This arrangement feeds a sum signal to the center speaker.**

stereo channels and effectively fills the "hole in the middle" which would otherwise result from wide speaker spacing.

Some people have the idea that such a three-speaker arrangement is three-channel stereo. This is not so. All commercial stereo program material is recorded on two channels, and no matter how many amplifiers and speakers you add, you still have two-channel stereo. A third speaker merely augments the sound from the basic pair of matched speaker systems.

The easiest way to hook up a third speaker is that suggested by Paul Klipsch and shown in Fig. 4-a. This circuit won't pump much bass through the center speaker since it feeds a signal consisting of the difference between the two channels, but there is no reason why the two main speakers can't handle all the bass anyway.

If you are a stickler for engineering niceties, you may prefer to feed the sum of the two channels to the center speaker. You can use the circuit in Fig. 4-b, or you can provide a separate amplifier to drive the third speaker. Some stereo amplifiers have a jack for this purpose. The separate amplifier is the best method to use if you want to drive additional monophonic speakers at remote locations.

In working out speaker placement, whether you use two or three, try to keep the listening area located symmetrically with respect to the speakers. One disadvantage of having only two channels of stereo information is that the effective listening area is fairly restricted. In general, the more directional the speakers used, the smaller the stereo listening area. The integrated stereo speaker systems which use reflecting surfaces to disperse the sound are generally better in this respect than two individual speaker systems.

It is a good idea to keep the speakers near ear level if possible. Stereo is more impressive than monophonic reproduction primarily because of the heightened sense of a live performance. Hearing a jazz combo crammed against the ceiling, or a coloratura soprano trilling from the bottom shelf in a bookcase tends to be unnerving.

And one last thing about placement. Only the very low audio frequencies flow around objects. The most important part of the sound spectrum tends to travel like light, in a direct path. Like light, it will be blocked by a solid object between the source and the listener. Again and again lengthy correspondence about a speaker system which was "obviously defective because it doesn't sound at all like it did in the dealer's showroom" finally turned up the fact that it was neatly hidden behind an overstuffed sofa! END

By TOM JASKI

# Unusual Relay Circuits

**Fourth of a series, this article discusses sophisticated circuits—alternators, pulse generators, counters and flip-flops**

**Besides their more familiar functions relays are used in many industrial applications calling for more sophisticated circuits. Among them are the special sequence circuits, selection and counting circuits, alternators, pulse generation and stretching, and special functions that are not in these categories.**

One special circuit is the wavefront relay shown in Fig. 1. It energizes when ac is applied and the capacitor demands a heavy charging current. This current keeps the relay energized. But as the capacitor charges, the current drops and the relay opens. Now it cannot be energized again until the ac is removed and the charge on capacitor C leaks off through the resistor. Actual component values depend on the relay and how long it must be energized, but can easily be determined. The value of the capacitor, in excess of the minimum required to energize the relay, determines how long the relay remains energized.

Another interesting circuit is shown in Fig. 2. This is a time proportional relay. It is arranged so that the time the relay remains energized after the control voltage is removed depends on how long the voltage was on in the first place. The capacitor cannot charge rapidly because of the reversed diode. Only backward leakage in the diode charges the capacitor. If the control voltage remains on a long time, the capacitor can gain enough charge to hold the relay closed for a considerable time after the control voltage is removed. Again the actual values needed depend on the relay.

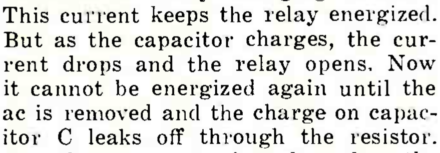



**Fig. 1—Wavefront relay energized once each time ac is applied.**

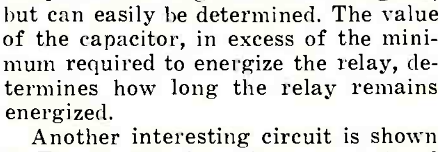



**Fig. 2—Time-proportional relay holds in after control voltage is removed. Holding time is proportional to time voltage was applied.**

Fig. 3 is a useful circuit. It prevents accidental reversal of a dc supply. This is needed where devices would be damaged by such a reversal. In Fig. 3 the sensitive relay is not normally energized, since the voltage is blocked by the diode. But if the input polarity is reversed, the sensitive relay energizes rapidly and activates the heavy-duty relay which immediately opens the dc supply circuit. The contacts of the heavy-duty relay must carry the current normally drawn through them.

Many special circuits can be designed. But most industrial applications call for fairly well established functions that can be handled by the relays. For example, alternate circuits are frequently used in industry. Often several devices that can do the same job equally well are available, but one is kept on standby. However, a completely idle unit might deteriorate and provide no safety margin. To prevent this, an alternator circuit is used to operate both devices equally.

A typical example is a pumping station with two identical pumps. One is needed for intermittent pumping jobs, and the other is a standby. Or one is needed most of the time, the other only once in a while when the load is heavy. An alternator circuit can be used to assure even wear of the pumps. In the first case (Fig. 4), the pumps are started alternately and only one pump runs. In the second case pump 1 is started and both pumps run when demand is heavy (Fig. 5). Pump 2 will be started on the next run. Each time the float demands pumping a ratchet relay is activated. As shown, the ratchet relay remains on as long as the float contacts are closed.

Though shown for two pumps only, the circuits of Figs. 4 and 5 could be readily extended for three, four or more pumps. They could be arranged, not only to alternate which pump will be used, but also to provide a sequence of which pump will be used first, second, third etc.

The same kind of alternator or commutator function can be used with counting circuits, but these are more complicated than the cam or ratchet type relay circuits.

The next useful function performed by relays is selection. Fig. 6 shows a simple system which can select one of 16 points with only four signals. However, as you can see, this circuit has the disadvantage that the first relay needs only one set of contacts and the last eight sets. Fig. 7 shows how this circuit can be rearranged to equalize the number of contacts. With an equal number of contacts, the relays will all operate at the same speed and with the same holding margin.

Selection often calls for pulse operation. We can operate a relay with one pulse and release it with the next, provided the pulses are matched to the operating speed of the relay. Fig. 8 shows how this can be done. In Fig. 8-a, the first positive pulse locks the relay, the second releases it. This circuit is sensitive to pulse length. In Fig. 8-b, a positive pulse locks the relay, a negative pulse unlocks it. The flip-flop in Fig. 13 (it is discussed later) is one means of producing alternate positive and negative pulses.

Another way to do the job is with two coils on the relay. One coil is used for energizing, the second for holding. Shorting the first coil will reduce holding power enough to let the relay drop out. Two winding coils are generally found only in telephone type relays.

Another item ostensibly available only in telephone relays but used extensively in circuits shown here is the make-before-break contact. To get this in an industrial type relay we adjust a normally closed and normally open contact to overlap.

Counting circuits can also handle selection, so let's look at some counting circuits and see how they operate. Out

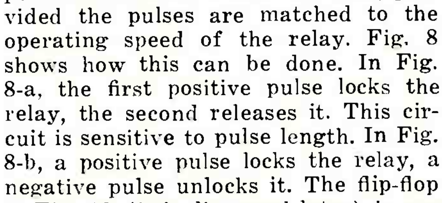
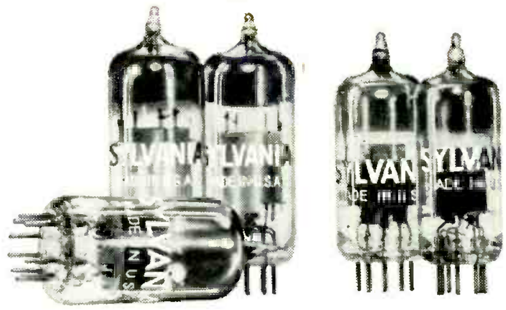



**Fig. 3—Polarity sensitive circuit protects against reversal of dc supply.**



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18FX6 A
18FY6 A
32ET5 A
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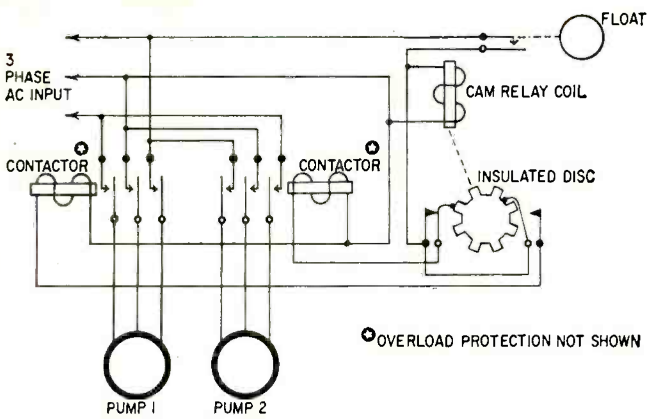


**Fig. 4—Simple alternator circuit. Each time float closes pumping circuit, cam relay steps, alternating between pump 1 and pump 2.**

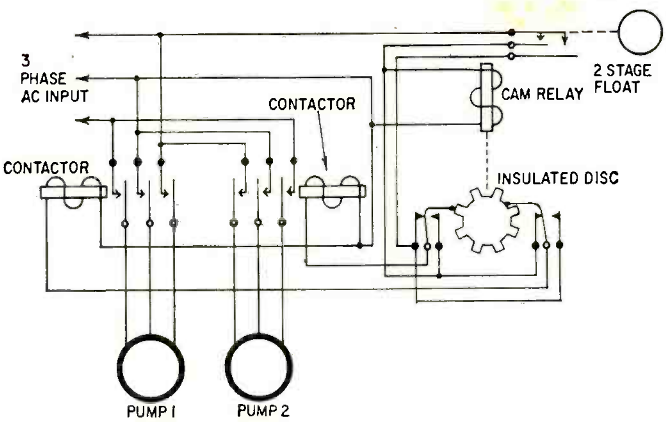


**Fig. 5—With 2-stage float, this alternator determines which pump starts first. Each time float closes top contact, cam relay alternates contacts. When demand increases, closing second float contact, other pump starts.**

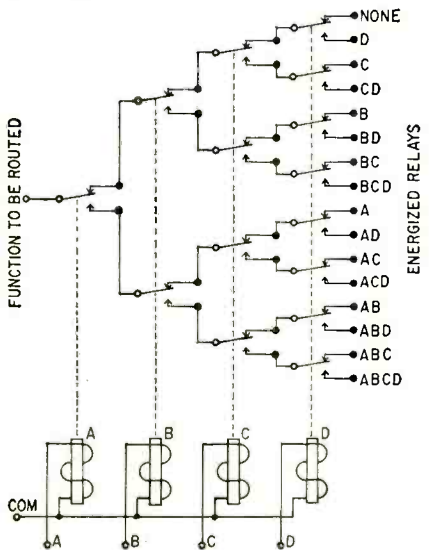


**Fig. 6—Cascading relay contacts allows control of 16 points with only four signal inputs.**

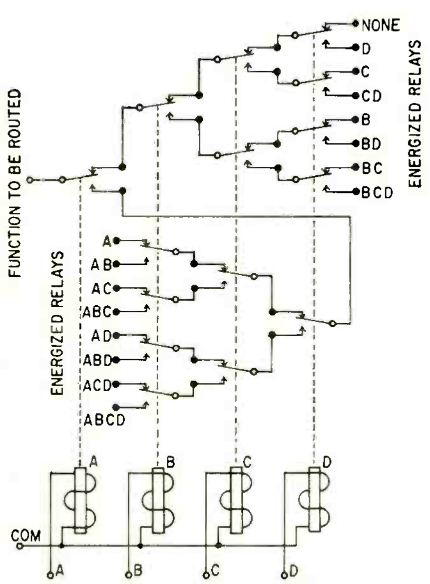


**Fig. 7—Rearranged contacts can allow the same selection as in Fig. 6, but with more even distribution of relay contacts.**

of the large variety of counting circuits, we have selected a few on the basis of general applicability. Since counting usually involves pulses, we must have a simple circuit to generate a pulse each time we push a button. Fig. 9 shows such a circuit. The duration of the pulse is controlled by selecting a relay with a desired operating speed and adjusting the make-before-break contact fingers.

A simple bi-directional counting circuit is shown in Fig. 10. (Single-direction counting circuits are shown in Figs. 11 and 12.) In Fig. 10, two relays are used per step. Each time a pulse is fed into input 1, the circuit adds one step. Each time a pulse is fed into input 2, the circuit subtracts a step, no matter what the total circuit situation. The first pulse to arrive energizes RY1, which is then connected across the line in series with RY2. This connects the pulse line to RY3 and the next pulse energizes that relay and RY4 and so on. When all relays are locked and a pulse arrives at input 2, RY5 is virtually shorted and drops out, also dropping out RY6 and so on. Only three steps are shown, but there is no practical limit to how many steps can be used. Note that the circuit is ideal for counting a difference of incoming pulses from two sources.

A simple unidirectional pulse-operated counting chain is shown in Fig. 11-a. Each pulse adds an energized relay to the chain until all of them are on. Turning the relays off requires a momentary interruption of the supply. Fig. 11-b shows how the same operation requires two relays if the make-before-break contacts are not used.

Fig. 12 is a similar counting circuit, but here the relays are not locked together. Instead, each relay when energized turns off the previous relay. Again the pulses must be measured This counting circuit is what is known as a round-and-round chain. It is so arranged that when RY4 is energized, RY1 is released and ready to be energized, and the cycle starts over again. In fact, with a steady voltage instead of pulses on the pulse line, the circuit would continue to cycle. The relay contacts shown at the bottom of the diagram can be used to generate pulses. Pulse duration depends on relay characteristics. With a slow relay in

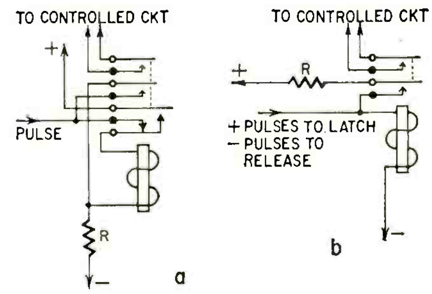


**Fig. 8—These arrangements can replace 2-coil relay. a—first pulse locks relay. Next pulse releases it. Pulses must be measured. b—Positive pulse locks relay. Negative pulse unlocks it.**

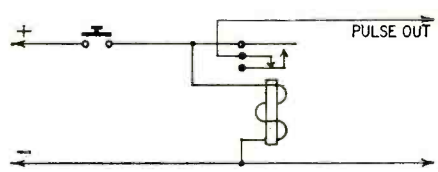


**Fig. 9—Simple circuit produces a single pulse each time button is pressed.**

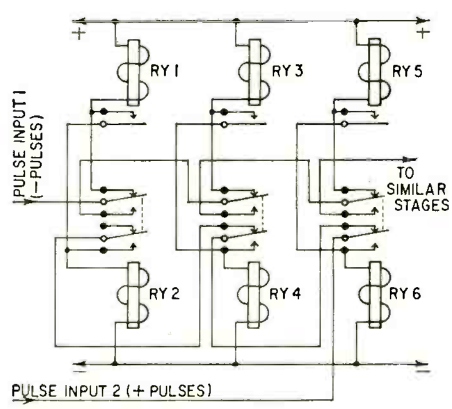


**Fig. 10—Progressive lock and unlock circuit uses two relays per step.**

the chain, for example, a kind of loping rhythm can be developed. This circuit is excellent for life-testing relays since they cycle as fast as they can operate, and an enormous number of relay operations can take place in a day. To make the chain longer than shown, RY4 is not returned through the normally closed contact on RY1, but in-

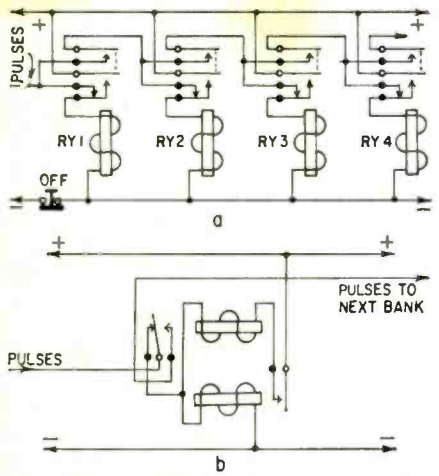


**Fig. 11—a—Simple lock-up counting chain. b—Two relays are needed without make-before-break contacts.**

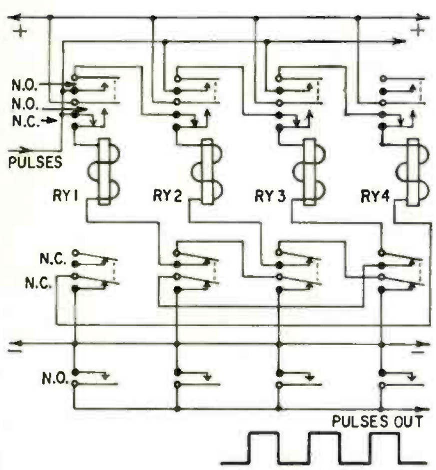


**Fig. 12—Pulse lock-up-lock-down chain. Only one relay is energized at a time.**

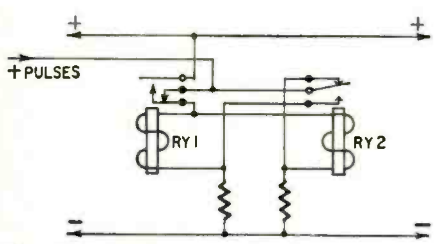


**Fig. 13—Basic two relay flip-flop.**

stead is connected as RY2 and 3 are.

Sequence control can be handled by counting chains when the pulses are derived from the operated devices in turn, as may be desirable when these devices can also be activated by other controls such as pressure switches, etc. The chain then prevents premature operation.

Selection can be handled by a counting chain since the device to be selected can be represented by a number of pulses equal to the position of its control relay in the chain. In such circuits, a slow-release relay is usually added. It disconnects the control voltage from the function by remaining energized as long as pulses come in. This prevents all devices from operating one after another as the proper one is selected.

A basic counting circuit not sensitive

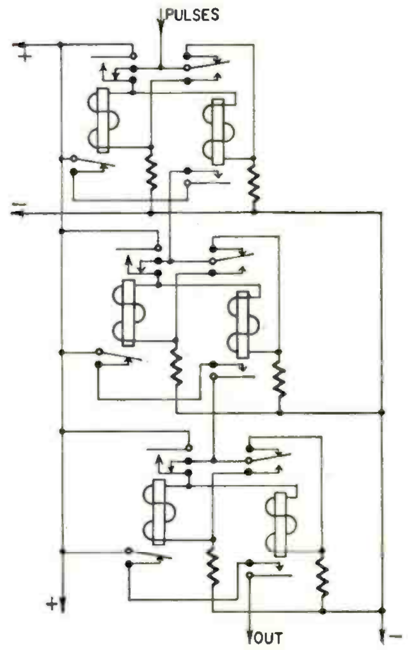


**Fig. 14—Binary counter built from relay flip-flops.**

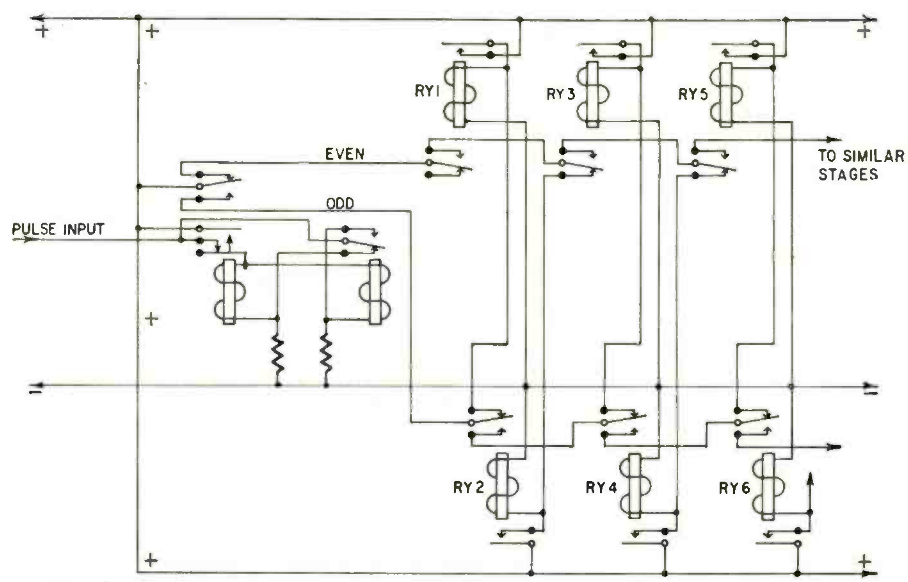


**Fig. 15—Odds and evens counter uses flip-flop and one relay per stage.**

to pulse length is the relay flip-flop shown in Fig. 13. The first pulse arriving energizes RY1 and through the make-before-break contact locks this relay. RY2 does not energize as it is shorted by the pulse. But as soon as the pulse stops, RY2, being parallel to RY1, energizes. When the second pulse starts, the two ends of RY1's coil see the same potential and this relay drops out. This transfers the holding circuit for RY2 back to the pulse line. When the second pulse stops, RY2 drops out. In two pulses the circuit is back to its original state. Note that with a spdt contact on one of the relays, an alternate positive or negative voltage could be provided for every pulse. Since it is a typical binary, the relay flip-flop can be used for binary counting when built into chains, as shown in Fig. 14.

This circuit can also be used as a frequency divider, each stage dividing the pulse frequency of the previous one by two.

The flip-flop circuit can be used for other purposes. For example, in Fig. 15 it activates an odd-and-even counter which has one relay per count. Another practical use is in selecting loads. When connected as in Fig. 16, with a switch instead of a pulse circuit, four loads can be selected, depending on the position of the switch, since the relay position changes at the beginning and the end of each pulse.

There you have some of the counting, selecting, commutating and special circuits that can be built with relays. Many other circuits are possible, and the ones shown here were selected to give an overview of relay use in these functions. Early computers were built with relays but vacuum tubes soon replaced them, and now transistors are beginning to take over the computer trade. But, in industry, relays will be with us for a long time. They are basically economical, rugged and quite dependable, fairly easy to maintain and, with the usual conservatism in operation, familiar to industrial circuit designers.

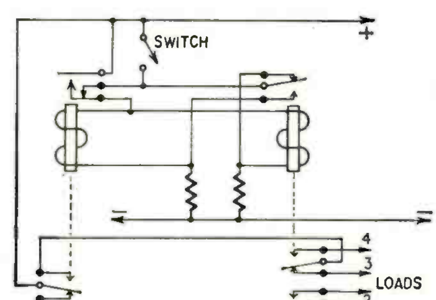


**Fig. 16—How the same flip-flop circuit can be used with a switch instead of pulses to select one of four loads.**

One class of relay has been ignored so far since it is a subject all by itself, the induction relay. In the next article in this series we will tell you how, why and where induction relays are used in industrial circuits. END

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These suggested fees cover diagnosis of trouble, location, installation or repair of component or circuit including mechanical defects. Parts are additional. They are based upon a survey of operational expense of leading service companies, time studies and cost analysis of time required to accomplish the listed service operation on a wide variety of television receivers with operations performed by competent technicians.

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| 2. Audio Circuit | 15.45 |
| 3. Automatic-Frequency-Control System | 18.90 |
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| 5. Control: Single Unit | 6.75 |
| Dual Unit | 9.75 |
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| 9. Focus Circuit | 9.80 |
| 10. Horizontal Oscillator Circuit | 17.85 |
| 11. Horizontal Output Circuit | 14.55 |

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| 18. Selenium Rectifiers | 12.25 |
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| 24. Tuner: Replacement or Removal | 12.50 |
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| 26. Vertical Output Circuit | 12.20 |
| 27. Video Circuit | 12.25 |
| 28. Retrace Blanking Circuit | 8.10 |
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| 32. Sound (Complete) | 8.75 |
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| 35. Tuner: Local Oscillators only | 2.00 |
| 36. Uhf Tuners | Hourly Rate |
| "Local Zone" Average Service Fee | 7.00 |
| Additional TV Shop Fee—per hour or portion thereof | 8.40 |
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*New technique may provide many more high-frequency radio channels. Radio Free Europe tests are pointing the way*

By STANLEY LEINWOLL*

**During the past several months Radio Free Europe schedules have included frequency assignments specifically selected to make use of sporadic-E propagation to reach RFE targets behind the Iron Curtain. These transmissions, initially undertaken on an experimental basis, are expected to have a significant impact on high-frequency communications for the next 5 to 10 years.**

Although sporadic-E ($E_s$) propagation has been known for many years, this is the first time any international broadcast operation has used it in a regular schedule, with antennas specifically suited to exploit this mode of propagation.

This technique has made it possible to schedule frequencies well beyond those ordinarily considered the normal operating range. This effectively expands available spectrum space, and provides a valuable tool in RFE's continuing effort to combat jamming.

**FIRST REPORT ON A NEW SHORT-WAVE TRANSMISSION TECHNIQUE**

Late last May, Radio Free Europe included a 15-mc frequency in its schedule of Hungarian broadcasts from Biblis, Germany. This was during daylight hours, when the normal maximum usable frequency over this path is of the order of 9 mc.

The maximum usable frequency (MUF) is the highest frequency that is reflected by the regular F-layers of the ionosphere at any given time over a particular circuit. It is generally the highest frequency assigned to a circuit over which some degree of reliability is required. Scheduling a frequency 75% above the MUF as we did in the Biblis tests would result in extremely poor effectiveness figures with satisfactory reception unlikely more than 5% of the time.

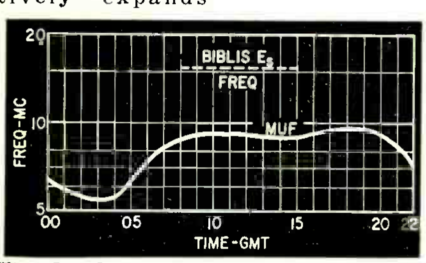



**Fig. 1—Curve showing maximum usable frequency over the Biblis, Germany, to Hungary circuit for August, 1961. Radio Free Europe Es frequency is shown by dashed line.**

Fig. 1 is an MUF curve for August, 1961. It shows how maximum usable frequency normally varies with time over the Biblis/Hungary path. The 15-mc signals from Biblis were propagated off the E-layer of the ionosphere, making use of a summertime anomaly occurring in the E-layer which is referred to as sporadic-E. While this anomaly has been known for some time, it is not well understood.

Fig. 2 shows the layers of the ionosphere on a typical summer day. These layers, made up of ionized gases of differing densities, can return obliquely incident radio waves to earth, thus making long-distance high-frequency radio communication possible.

Sporadic-E occurs as clouds or patches of high ionization density which form for no apparent reason, exist for up to several hours at a time, then disappear just as mysteriously. Sporadic-E clouds reflect radio waves of considerably higher frequency than those reflected by the normal F-layers of the ionosphere.

In mid-latitudes, $E_s$ is most prevalent during the summer months, occurring over 50% of the time at mid-day. Many

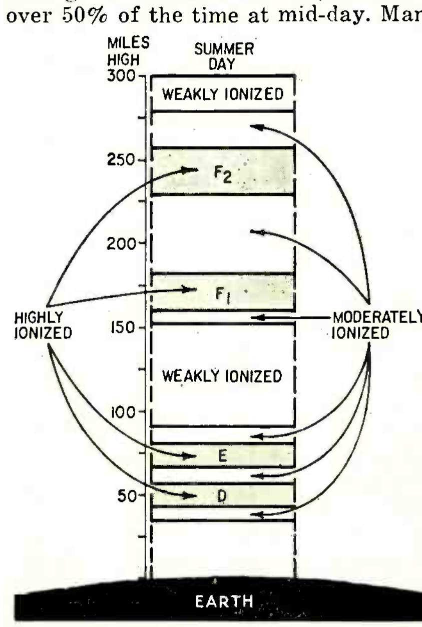



**Fig. 2—Ionosphere layers on typical summer day. Most long-distance high-frequency communication takes place via F-layers, most ionospheric absorbtion in the D-layer.**

*Radio-frequency and propagation manager, Radio Free Europe.

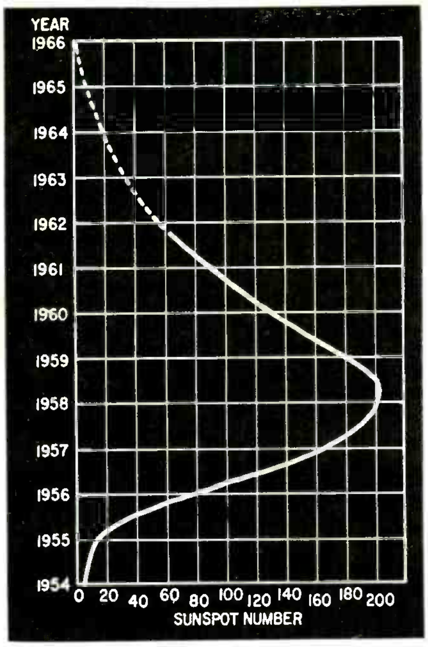



**Fig. 3—Sunspot cycle from 1954 to now (solid line). Values to expected sunspot minimum in 1965 (dashed line).**

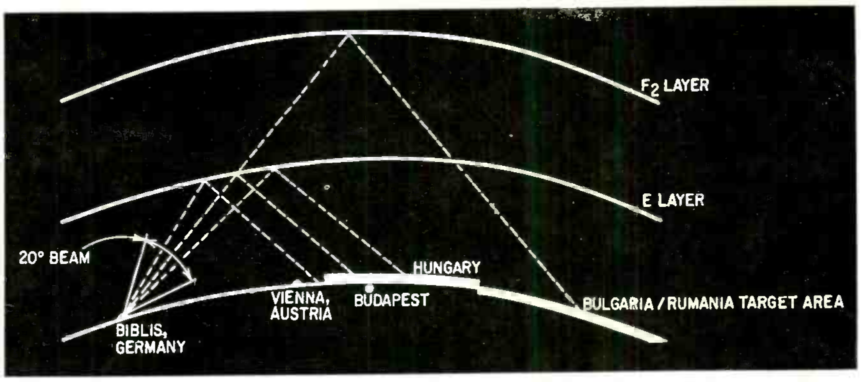



**Fig. 4—How antenna designed to cover Rumania–Bulgaria via $F_2$-layer propagation was used to transmit signals to Hungary via reflection off the E-layer.**

scientists have agreed that sporadic-E is a very important effect, but up to now methods for taking its effects into account have been poor.

Sporadic-E is most evident during years of low sunspot activity. Since MUF's vary with sunspot number, $E_s$ activity is most in evidence when MUF's are low. During years of high solar activity, MUF's are high, normally approaching the upper limit of the short-wave spectrum over many paths. At such times $E_s$ effects are scarcely noticeable in the high-frequency bands.

Fig. 3 shows sunspot activity during the past 7 years. You can see that sunspot numbers have been declining steadily since 1958. The broken line is a projection of the sunspot cycle and indicates that, if the present trend continues, the cycle minimum will occur sometime in 1965. The decrease in sunspot number and the accompanying decrease in MUF will result in a corresponding decrease in the amount of propagationally useful high-frequency radio spectrum. In addition, world-wide demands for additional spectrum space in the high-frequency broadcast bands are expected to double in the coming decade.

The combination of decreasing spectrum space brought about by a decline in sunspot activity and increased demands for spectrum space resulting from an increase in short-wave broadcasts throughout the world has been of great concern to broadcasters, who anticipate that the amount of useful spectrum space will fall far short of what is needed.

## About RFE tests

As part of an extensive program to determine what countermeasures can be taken to deal with the problem of the dwindling spectrum, RFE has undertaken a series of tests to find out whether consistent broadcast operation above the MUF is possible and practical. Fig. 4 shows how these tests are being conducted.

Since the E-layer of the ionosphere is considerably lower than the F-layers, an antenna with a relatively low radiation angle is required to bounce a signal off the E-layer.

RFE antennas are designed for normal F-layer propagation. Consequently, radiation angles for normal F-layer operation to targets in nearby Central Europe are relatively high. The problem of choosing a proper antenna was solved by scheduling broadcasts to Hungary on an antenna designed for beaming broadcasts to Rumania.

Fig. 4 shows that the vertical radiation angle of the Rumanian antenna is optimum for E-layer propagation of programs beamed to Hungary.

Results thus far have been excellent, with reception comparable to that observed on lower frequencies via normal F-layer propagation. At present, plans for incorporating regular $E_s$ transmissions into our schedules are under way.

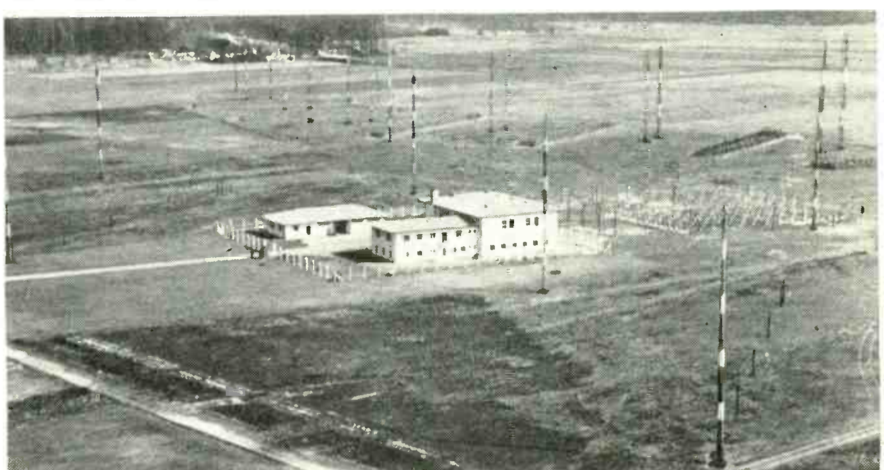
Although the E-layer of the ionosphere exists principally during daylight hours, $E_s$ activity is observed around the clock during the summer. Tests are under way to determine whether nighttime $E_s$ transmissions above the F-layer MUF are practical.

Irrespective of the results of these nighttime tests, the success of the daytime $E_s$ tests is a significant step toward solving a serious problem for broadcasters. In effect, it expands the available spectrum space at a time when additional channels are a valuable commodity.

Although $E_s$ is observed about 50% of the days during the summer months, the RFE transmissions on 15-mc indicate that the signal is propagated considerably more than 50% of the time leading to the conclusion that, in addition to $E_s$, some other E-layer propagation mode is also a factor. It has been suggested that the phenomenon be referred to as anomalous E-layer propagation, rather than the misleading $E_s$.

In addition, using frequencies above the MUF has proved valuable in countering the effects of jamming.

Jamming is defined as the creation and transmission of various kinds of radio interference for the purpose of preventing normal reception of radio broadcasts. The Communists have been jamming Radio Free Europe broadcasts since 1951.



**Radio Free Europe operates this transmitting station in Biblis, Germany.**

Since most of the jamming transmitters in Central Europe are designed for relatively high-angle operation, we have found that jamming from the satellites during the $E_s$ tests has been relatively ineffective, and that it has been necessary for jammers at more distant locations, principally the Soviet Union, to be called into operation.

In addition to putting an additional strain on the Communist jamming system, the strength of the delivered jamming signal is weaker than it would be were the transmitter located closer to the target areas. END

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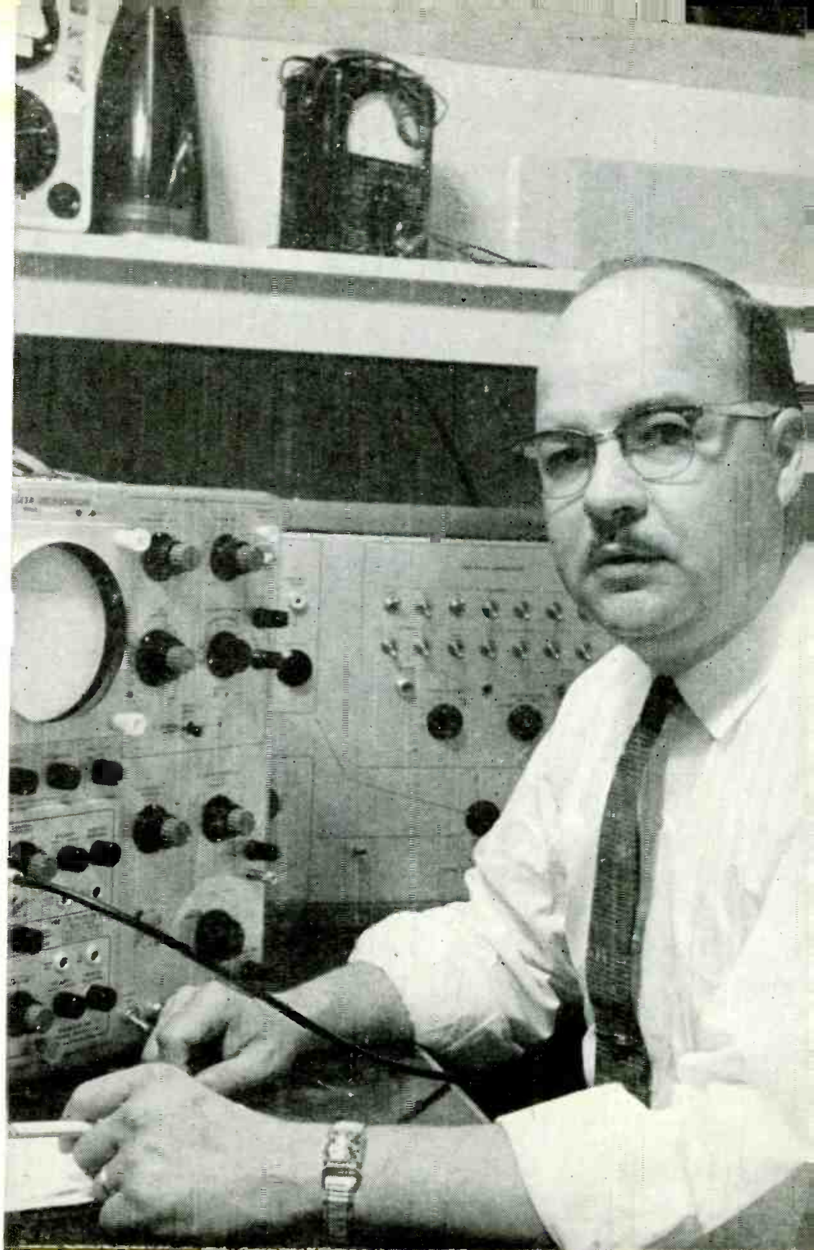
*Mearl Martin, Jr.*, SENIOR ENGINEER
*Field Support Manager, Tektronix, Inc., Portland, Ore.*



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# TRANSISTOR BIAS REGULATOR

By A. K. TAYLOR

SHUNT VOLTAGE REGULATORS SUCH AS gas-filled regulator tubes and Zener diodes have a dynamic resistance (dE/dI) much lower than their static resistance (E/I), but are not available for very low voltages. For fractions of a volt, use a semiconductor diode or the surviving diode of a half-burnt-out transistor.

Fig. 1 shows the E-vs-I characteristics for three diodes, taken by varying a high resistance in series with the diode and plotting diode voltage against current. The voltage varies but little for currents over 5 ma. The slope of the flatter part of the curve, approximately $\Delta E/\Delta I$, corresponds to 10 ohms for the high-perveance diode and 5 ohms for the other two.

This is the dynamic resistance which the load sees. The static resistance (E/I) which determines the necessary bleeder current is around 10 times as much. Bleeder current, which would have to be 40 ma to develop 0.4 volt across 10 ohms or 0.2 volt across 5 ohms, need be only 5 ma plus the maximum current drawn by the load. Diodes with still flatter characteristics and various voltage drops can probably be found among the innumerable types manufactured.

This represents a real saving in biasing class-B transistor amplifiers.

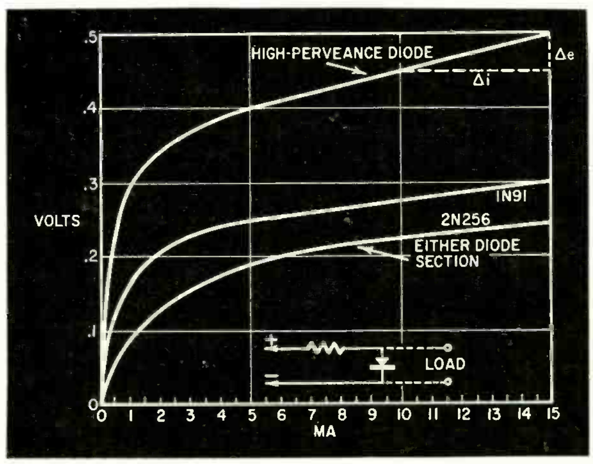



Fig. 1

The low-resistance bleeders ordinarily used not only waste batteries but can seriously load driver stages in transformerless circuits. Fig. 2 shows typical applications to transformer-coupled and complementary push-pull amplifiers. A diode-connected 2N256, or two in parallel, is most nearly right for Fig. 2-a, and the high-perveance diode or two of the others in series are right for the complementary circuit (Fig. 2-b).

Current distribution varies with individual transistors. With a typical complementary pair, the transistor bases draw 1 ma and the diode 14 ma when idle. With full signal and 10-ohm load, the transistors draw 10 ma, the diode draws 5 ma and the bias drops to 0.4 volt, which is still enough to prevent crossover distortion. The negative temperature coefficients of the diodes stabilize the idle current in either amplifier well enough so that with good heat sinks no other temperature stabilization is necessary. END

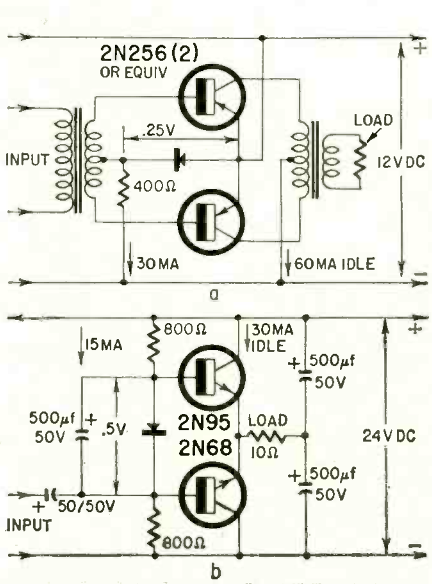



Fig. 2

# TECHNICIANS' NEWS

## ANOTHER LICENSING LAW DIES

*Miami, Fla.*—A proposed licensing law for Dade County was killed by the Metro Commission by a vote of 10 to 1. The commission stated that the law, which was backed by TESA-Miami, might "become an open door for the complete control of the industry by the wishes and desires of the few." The County Manager's office also reported that it would cost $20,000 to adminster such a law during the first year.

## TRI-STATE COUNCIL NEWS

*Gloucester, N. J.*—The Allied Electronic Technicians Association elected Tony DeFranco, president, and Ray Dellinger, vice president. Joseph Papovich was re-elected secretary and Joseph Eberhardt, treasurer.

*Trenton, N. J.*—Bob Kroeson of the Trenton Chamber of Commerce was the guest speaker at a recent meeting of the Radio Servicemen's Association of Trenton. His topic was Business Malpractices, with the accent on TV.

## MORE JOURNEYMAN TECHNICIANS

*Santa Clara, Calif.*—Ten radio–TV service technicians joined the ranks of California State journeyman technicians when they received state trade certificates at a ceremony sponsored by the Santa Clara Valley and Santa Cruz County Chapters of the California State Electronics Association. Five of the new journeymen also received the designation of Master Technician. They are first to receive this rating which was established by CSEA last year.

Those receiving the CSEA Master Technician certificates and State of California Journeyman certificates were Keiji Aochi, William G. Cleveland, Melvin Haury, Evrett A. Hunter and Oliver Sharrai.

Completing the apprenticeship course and receiving journeymen certificates were Alvin H. Bowers, Roderick A. Curry, Willis G. Jensen, Sandy Lunares and Joseph R. Twitchell.

## POLICE GIVEN TALK

*Seattle, Wash.*—A TSA representative recently spoke before the weekly meeting of the Detective Division (Robbery-Burglary) of the Seattle Police Department on the means and methods of identifying electronic equipment. He cited the ease with which paper serial number tags can be removed, and the alternate methods of identification by hidden serial numbers and the serial numbers on replacement picture tubes which are a part of the service records of most shops, and which appear on the customer's picture-tube warranty card. Also mentioned were ways of looking up the serial number from sales records, service records, etc. Captain Shaunessy expressed the department's appreciation for the information, and for the continued running of the stolen-set information in TSA *Service News.*

### 50% HAVE COLOR TV

*Mulberry, Ind.*—Is it true that this town has a color TV saturation of 50%? It's said that Charlie Maish, parts salesman for Associated Distributors, has an RCA color set and the other resident owns a black-and-white set.—*Hoosier Test Probe*

### INDIANA ELECTION

*Richmond, Ind.*—The banquet room of the Rathskeller was the scene of the annual banquet and election of officers of RETA–Richmond. Following the feast W. F. Barnett was elected president; Robert Reed, vice president; Victor Ballman, secretary, and Charles H. Norman, treasurer.

### AGAINST WARRANTY EXTENSION

*Ephrata, Pa.*—"We're against extending warranties" was the cry from delegates to the Federation of Television & Radio Service Associations of Pennslylvania at a recent meeting. This refers to extensions of warranties beyond 90 days for parts and labor and more than one year on picture tubes.

### COLOR TV TRAINING

*Philadelphia, Pa.*—The Television Service Association of Delaware Valley will conduct a color TV service program. It is being handled with the cooperation of Raymond Rosen & Co., Inc., the local RCA distributor.

Raymond Rosen Inc. is making available to association members a color TV chassis and test equipment. The RCA Service Co. is contributing specially prepared material for the program and is providing Howard Spencer, administrator of technical training, as an instructor.

### FTC GETS TSADV RECORDS

*Philadelphia, Pa.*—Herman Shore, president of the Television Service Association of Delaware Valley, has been ordered by a US District Court to identify TSADV records requested by the FTC. Until now, the association has refused to give any records to the FTC unless individual members were ordered to do so. This was done by the group following their lawyer's instructions not to turn over any records unless a subpoena were issued to individuals so they would be, in testifying, legally immune from possible future prosecution.

The FTC has not said why they wish to examine TSADV records but it appears that they may wish to look into an alleged boycott of certain parts distributors by members of the association.

Commenting on the court order, Mr. Sidney Black, the association's lawyer, said: "We have never tried to keep our records from the FTC. We simply objected to the subpoena being issued to the group and not an individual so that immunity against future possible prosecution would protect those who testify.

"We would like to bring the practice of certain distributors to the eyes of the FTC so that these problems could be solved. We feel it is impossible for the FTC to see all these accusations against distributors and not investigate distributor practices."

## REPORT ON LICENSING

*California*—The following is a report on state Licensing Bill No. 265 that appeared in the *Modern Electronic Service Dealer* (Los Angeles, Calif.)

The licensing bill backed by CSEA (California State Electronics Association) has come to a halt. The bill as it now stands is in the Senate Business and Professions Committee and is scheduled for interim hearing.

Briefly, before the bill was submitted, it had 47 co-authors from the Assembly. During the next 5 months, the bill was amended six times as recommended by different departments within the state. The only change that affected the bill was made in the Governmental and Efficiency Committee hearing. It was to leave out certification of technicians for the time being. The bill then went to the Finance Committee and was stalemated because the state budget had not passed. Then the bill finally got to the floor of the assembly where it was passed by a vote of 58 to 6.

The bill next went to the Business and Professions Committee for their approval. From there it was supposed to go to the Finance Committee and then to the Senate floor in time to be passed this year. But the bill got tied up by the Business and Professions Committee who moved that it be sent to the Interim Committee for more study.

## NATESA GETS NEW PRESIDENT

*Chicago, Ill.*—Ralph Woertendyke of Salina, Kan., was elected president of the National Alliance of Television & Electronic Service Associations. He succeeds A. A. Benoit, Jr. Other officers elected at the annual convention at the Pick-Congress hotel were John Stefanski, secretary general; Nelson Burns, treasurer; Irving J. Toner, eastern vice president; George Carlson, eastern secretary; T. R. Nabor, west central vice president; B. R. Moon, west central secretary; Pat Barr, west vice president; Les Quigley, western secretary. Frank Moch remains as executive director. His term still has a year to run.

## WARRANTY EXTENDED

*Chicago, Ill.*—Westinghouse Electric has announced that they are including a 90-day labor warranty on all products made by the company's television–radio division.

A feature of the plan is a telephone service that gives customers the address of the nearest independent authorized service company. All service work will be done by independent service dealers appointed by local distributors, Westinghouse states.

## ELECTION RETURNS

*Butte, Mont.*—The Electronic Service Association of Butte has a new slate of officers: Pat Gordon, president; Harry Carroll, recording secretary; Kenneth Venner, treasurer. Outgoing president Raymond G. Tuszynski was elected corresponding secretary. Al Laurvick and Bjarne Johnson were voted trustees.

## KARL W. HEINZMAN PASSES

*Detroit, Mich.* — The independent service industry lost one of its best leaders and sharpest minds with the passing of Karl W. Heinzman. His death followed two weeks in the Art Center Hospital, where he was recuperating from his second heart attack within the year. He was planning to return home when the fatal attack occurred.

## CSEA CHAPTER NEWS

*Burbank, Calif.* — At the regular meeting of the Burbank-Glendale Chapter at Genio's Restaurant Robert Hahn spoke on servicing video amplifiers and remote controls. He is service manager for Philco, Los Angeles. Later, members discussed the state licensing bill.

*San Diego, Calif.*—Annual elections were the business of the day. The new directors are Clifford T. Coons, P. E. Fort, Howard Ellis, G. S. Lowell, Walt Meekins, Gene O'Brien and Earl Robbins. The new board then elected its officers for the coming year: president, Gene O'Brien; vice president, Howard Ellis; secretary-treasurer, G. S. Lowell. Guest speaker for the evening was Wm. A. Stone, regional manager of Simplified Tax Records Inc. He presented a tax preparation, record keeping and business management system for the small businessman.

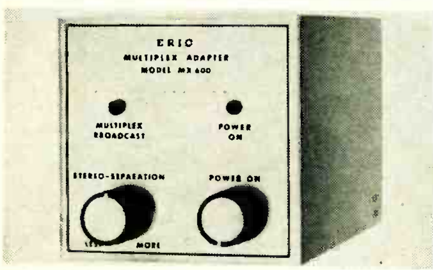

**"We've checked your credit references and you may charge any service required—up to a dollar."**

# new PRODUCTS

**AM/FM STEREO TUNER,** *T300X.* Built-in multiplex section. Sensitivity 0.95-$\mu$v for 20-db

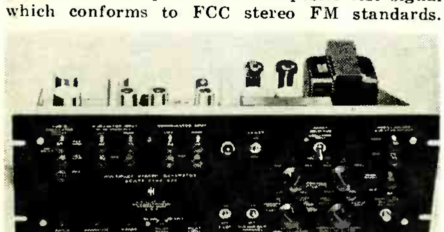
quieting. 3.2-$\mu$v usable sensitivity (IHFM standards). Distortion less than 0.1% at 100% modulation. Response 10–35,000 cycles ±1 db.—**Harman-Kardon Inc.**, Ames Court, Plainview, N. Y.

**FM STEREO ADAPTER,** *MX600D.* For manufacturer's FM tuners and other makes having wide bandwidths. Stereo Announcer lights when



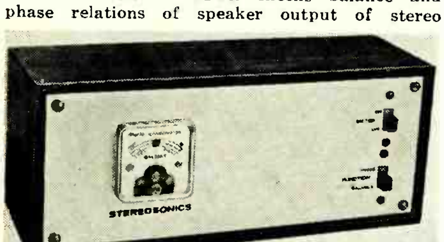

stereo program is being broadcast. Uses Compactron tubes.—**Eric Electronics Corp.**, 1823 Colorado Ave., Santa Monica, Calif.

**FM STEREO GENERATOR** *type 830.* Provides composite stereo signal for modulating an FM generator. This produces a composite test signal which conforms to FCC stereo FM standards.



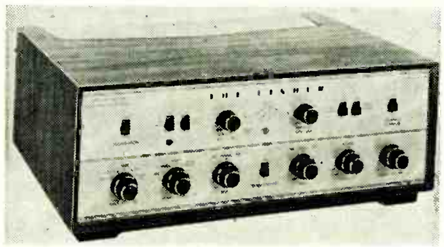
Audio oscillator and oscilloscope needed to complete test setup.—**H. H. Scott Inc.**, Instrument Div., 111 Powder Mill Rd., Maynard, Mass.

**PHASE COORDINATOR** checks balance and phase relations of speaker output of stereo




system. Direct-reading meter clearly indicates correct setting.—**Jesse M. Kohler Co.**, 1566 E. 91 St., Brooklyn 36, N. Y.

**STEREO AMPLIFIER,** *model X-101-B.* Combination stereo preamp, dual 26-watt amplifiers. Response, 20–20,000 cycles ±1 db. Harmonic distortion 0.5% at full output. IM distortion 0.8% at rated output. 6 pairs of inputs. High- and




low-frequency filters. 4-, 8- and 16-ohm outputs. 19 front-panel controls.—**Fisher Radio Corp.**, 21-21 44th Drive, Long Island City 1, N. Y.

**STEREO RECEIVER,** *model 200-A.* Dual 16-watt amplifiers, AM, FM tuners and transistorized stereo preamp. FM sensitivity 2 $\mu$v for 20-db quieting. Scratch and rumble filters.


Frequency response 20–20,000 cycles. Channel separation better than 52 db.—**Monarch Electronics International Inc.**, 7035 Laurel Canyon Blvd., No. Hollywood, Calif.

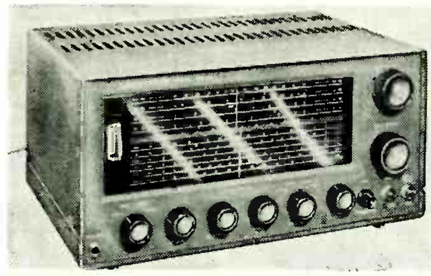
**CB MIKE,** *B-213AC.* Ceramic high-impedance unit. 50–8,000-cycle frequency response. Output

level −58 db. Push-to-talk dpst switch.—**American Microphone Mfg. Co.**, 412 S. Wyman St., Rockford, Ill.

**CB TRANSCEIVER,** *model 772.* Superhet receiver has rf stage for high sensitivity. 4-position transmitter switch selects any of 4 crystal-

controlled channels. Kit or fully wired and tested. Transmitter crystal oscillator and rf final prewired, tuned and sealed at factory in kit version.—**Electronic Instrument Co. Inc. (EICO)**, 33-00 Northern Blvd., Long Island City 1, N. Y.

**COMMUNICATIONS RECEIVER,** *model HE-30.* Covers 550-kc to 30-mc in four bands. Calibrated electrical bandspread for amateur bands.



Sensitivity, 1 $\mu$v for 10-db signal-to-noise ratio. Selectivity 10 kc at −60 db. Speaker and headphone outputs. 7 x 15 x 10 in.—**Lafayette Radio Electronics Corp.**, 165-08 Liberty Ave., Jamaica 33, N. Y.

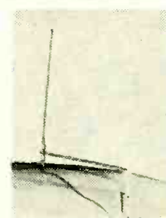
**COLLAPSIBLE CB ANTENNA,** *model CB-27.* 60 inches extended, 27 inches collapsed. Etched tuning scales in top rod section. One for Citi-

zens band, other for amateur (28–30-mc) band. Mounts on front fender. Supplied with coax cable.—**New-Tronics Div.**, 3455 Vega Ave., Cleveland 13, Ohio.

**CB ANTENNAS.** *model GP-1* (illus.) groundplane unit has 1-inch-diameter driven element

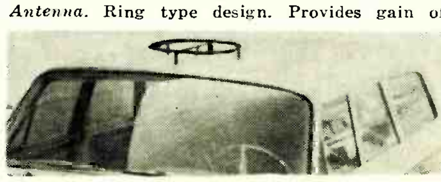
and drooping radials. *Model CBY3* is 3-element Yagi.—**Clear Beam Antenna Corp.**, 21341 Roscoe Blvd., Canoga Park, Calif.

**MOBILE ANTENNA** clamps onto car window. No tools needed. No holes to drill. Bracket rubber-lined. Interchangeable antennas for CB,



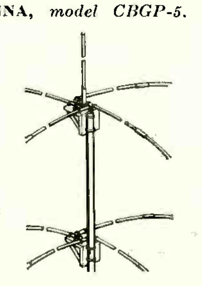
1¼-, 2-, 6- and 10-meter amateur bands and 155-mc businessman's band.—**Electrophono & Parts Corp.**, 530 Canal St., New York 13, N. Y.

**CB MOBILE ANTENNA.** *Omni-Slot Boundary Antenna.* Ring type design. Provides gain of



¼-wave whip. Only 2 inches high.—**General Electromagnetics Corp.**, 11719 E. Washington Blvd., Whittier, Calif.

**CB ANTENNA,** *model CBGP-5.* Ground-plane

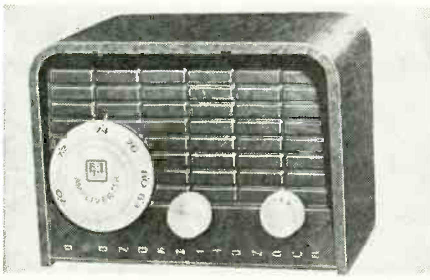


type. Aluminum elements are telescopic and made in two sections. Anodized cadmium-plated mounting brackets. Matches 52-ohm line. —**Master Mobile Mounts Inc.**, 4125 W. Jefferson Blvd., Los Angeles 16, Calif.

**CB BASE-STATION ANTENNA**, *Mark II Super Beacon*. For 27-mc. 19 feet tall. Requires no ground radials or skirts. Precipitation static

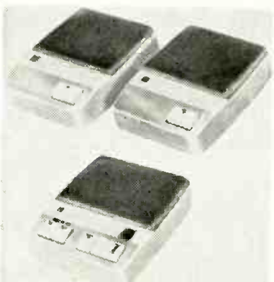
suppressed by plastic overcoating on antenna. VSWR less than 1.5:1 over entire Citizens band. Matches 50-ohm coax.—**Mark Mobile Inc.**, 5441 Fargo Ave., Skokie, Ill.

**CONVERTER–AMPLIFIER**, *BT-70 Ampliverter* for low-power translator areas which use uhf



channels 70–83. Converts vhf channels 5 or 6 into any uhf channel between 70 and 83.—**Blonder-Tongue Labs. Inc.**, 9 Alling St., Newark, N. J.

**TRANSISTOR INTERCOM SYSTEMS**, *PA-265*. 3-station system. Any station can be called from master without disturbing other remote. 3-transistor circuit operates off 3 size-C flashlight

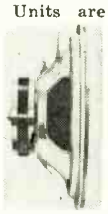


cells. 3¼-inch speakers. Each unit 1¼ x 5 x 6¾ in.—**Lafayette Radio Electronics Corp.**, 165-08 Liberty Ave., Jamaica 33, N. Y.

**VOICE CASE**, complete PA system in 12 x 18-

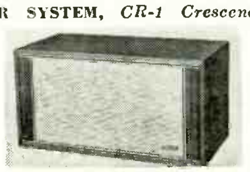
inch attache case. Battery-powered. With lavalier mike and 25 feet of cord. Volume control in mike base.—**Siegler Corp.**, 875 S. Arroyo Pkway., Pasadena, Calif.

**THIN SPEAKERS**, *models 52C10* and *8C10PA* (illus). Both use 10-ounce ceramic (barrium ferrite) magnets. Units are thin enough to



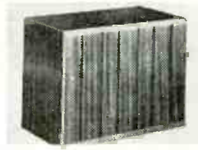
mount between standard wall studs.—**Quam-Nichols Co.**, 234 E. Marquette Rd., Chicago 37, Ill.

**SPEAKER SYSTEM**, *CR-1 Crescendo*. 3-way



system uses 10-inch bi-axial transducer and 4-inch tweeter. Built-in crossover. Frequency response from 25 to 18,500 cycles. 24 x 12 x 12 in.—**Mercury Electronics Corp.**, 111 Roosevelt Ave., Mineola, N. Y.

**REMOTE SPEAKER.** No grille. 8 x 10¼ x 6⅜ in. *Model SH-3* has random-width wood paneling design which replaces grille cloth. Tiny slots load 6 x 9 speaker. Blond, mahogany or

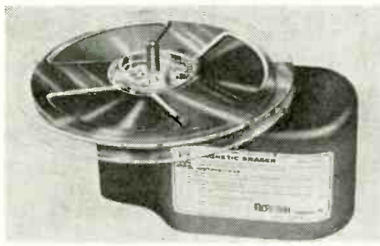


walnut.—**Utah Radio & Electronic Corp.**, Huntington, Ind.

**REPLACEMENT SPEAKERS** for electronic organs. 12-inch units withstand sustained low-

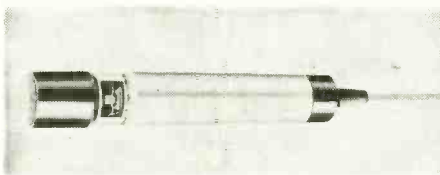
frequency notes. *Model OR12J-8*, 8-ohm voice coil; *OR12J-16*, 16-ohm voice coil. Both handle 15 watts of peak audio.—**Utah Radio & Electronic Corp.**, Huntington, Ind.

**BULK TAPE ERASER**, *model HD-11*. Handles



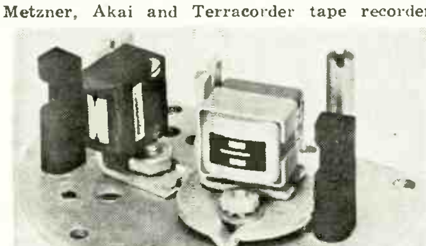
5- to 10½-inch reels. Erases all recorded material simultaneously.—**Microtran Co. Inc.**, 145 E. Mineola Ave., Valley Stream, N. Y.

**DYNAMIC MIKES**, *models 70* and *71*. Response 50–18,000 cycles. Output level into high-impedance input 28 mv/10 dynes/cm². For tape re-



corders, ham rigs and PA installations.—**University Loudspeakers Inc.**, 80 S. Kensico Ave., White Plains, N. Y.

**CONVERSION KIT** *R-67* converts Roberts, Metzner, Akai and Terracorder tape recorders



to 4-track stereo playback. Uses TLB-2 laminated core head that has 100 micro-inch gap.—**Nortronics Co. Inc.**, 1015 S. 6th St., Minneapolis 4, Minn.

**SOUND METER**, *model 450*. Sound-level range:

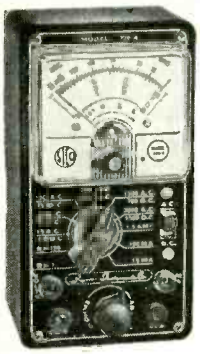
(*Continued on page 120*)

# EXAMINE ANY OF THESE TESTERS *BEFORE* YOU BUY!!

Yes, we offer to ship at our risk one or more of the testers described on these pages.

SUPERIOR'S NEW MODEL 770-A

## VOLT-OHM MILLIAMMETER



**FEATURES:**

- Compact—measures 3⅛" x 5⅞" x 2¼".
- Uses "Full View" 2% accurate 850 Microampere D'Arsonval type meter
- Housed in round-cornered, molded case.

**SPECIFICATIONS:**

**6 A.C. VOLTAGE RANGES:** 0-15/30/150/300/1500/3000 Volts.

**6 D.C. VOLTAGE RANGES:** 0-7.5/15/75/150/750/1500 Volts.

**2 RESISTANCE RANGES:** 0-10,000 Ohms, 0-1 Megohm.

**3 D.C. CURRENT RANGES:** 0-15/150 Ma., 0-1.5 Amps.

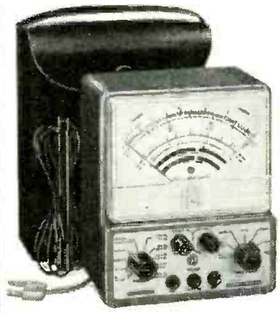
**3 DECIBEL RANGES:** —6 db to + 18 db, + 14 db to + 38 db, + 34 db to + 58 db.

The Model 770-A comes complete with test leads and operating instructions. **Price is $15.85. Terms: $3.85 after 10 day trial then $4.00 monthly for 3 months.**

SUPERIOR'S NEW MODEL 79

## SUPER-METER

### WITH NEW 6" FULL VIEW METER



**SPECIFICATIONS:**

**D.C. VOLTS:** 0 to 7.5/15/75/150/750/1,500.
**A.C. VOLTS:** 0 to 15/30/150/300/1,500/3,000.
**D.C. CURRENT:** 0 to 1.5/15/150 Ma. 0 to 1.5/15 Amperes.
**RESISTANCE:** 0 to 1,000/100,000 Ohms. 0 to 10 Megohms.
**CAPACITY:** .001 to 1 Mfd. 1 to 50 Mfd.
**REACTANCE:** 50 to 2,500 Ohms, 2,500 Ohms to 2.5 Megohms.
**INDUCTANCE:** .15 to 7 Henries, 7 to 7,000 Henries.
**DECIBELS:** —6 to + 18, + 14 to + 38, + 34 to + 58.

The following components are all tested for **QUALITY** at appropriate test potentials. Two separate **BAD-GOOD** scales on the meter are used for direct readings.
All Electrolytic Condensers from 1 MFD to 1000 MFD.
All Selenium Rectifiers. All Germanium Diodes.
All Silicon Rectifiers. All Silicon Diodes.

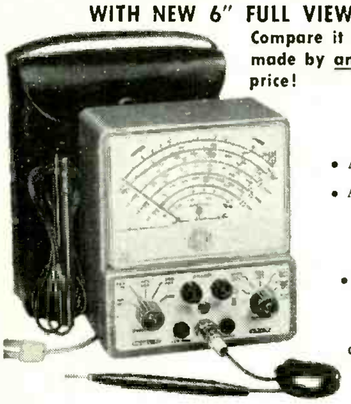
Model 79 comes complete with operating instructions, test leads and carrying case. **Price is $38.50. Terms: $8.50 after 10 day trial then $6.00 monthly for 5 months.**

SUPERIOR'S NEW MODEL 77

## VACUUM TUBE VOLTMETER

### WITH NEW 6" FULL VIEW METER

**Compare it to any peak-to-peak V.T.V.M. made by any other manufacturer at any price!**



**SPECIFICATIONS:**

- **DC VOLTS**—0 to 3/15/75/150/300/750/1500 volts at 11 megohms input resistance.
- **AC VOLTS (RMS)**—0 to 3/15/75/150/300/750/1500 volts.
- **AC VOLTS (Peak to Peak)**—0 to 8/40/200/400/800/2000 volts.
- **ELECTRONIC OHMMETER**—0 to 1000 ohms/10,000 ohms/100,000 ohms/1 megohm/10 megohms/100 megohms/1,000 megohms.
- **DECIBELS**—10 db to + 18 db, + 10 db to + 38 db, + 30 db to + 58 db. All based on 0 db = .006 watts (6 mw) into a 500 ohm line (1.73v).
- **ZERO CENTER METER**—For discriminator alignment with full scale range of 0 to 1.5/7.5/37.5/75/150/375/750 volts at 11 megohms input resistance.

Model 77 comes complete with operating instructions, probe and test leads and carrying case. **Price is $42.50. Terms: $12.50 after 10 day trial then $6.00 monthly for 5 months.**

SUPERIOR'S NEW MODEL 80

## 20,000 OHMS PER VOLT ALLMETER

NOTE: The line cord is used only for capacity measurements. Resistance ranges operate on self-contained batteries.

**6 INCH FULL-VIEW METER** provides large easy-to-read calibrations. No squinting or guessing when you use Model 80.

**MIRRORED SCALE** permits fine accurate measurements where fractional readings are important.

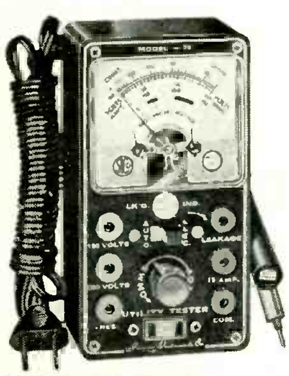
**SPECIFICATIONS:**

**7 D.C. VOLTAGE RANGES:** (At a sensitivity of 20,000 Ohms per Volt) 0 to 15/75/150/300/750/1500/7500 Volts.
**6 A.C. VOLTAGE RANGES:** (At a sensitivity of 5,000 Ohms per Volt) 0 to 15/75/150/300/750/1500 Volts.
**3 RESISTANCE RANGES:** 0 to 2,000/200,000 Ohms, 0-20 Megohms.
**2 CAPACITY RANGES:** .00025 Mfd. to .3 Mfd., .05 Mfd. to 30 Mfd.
**5 D.C. CURRENT RANGES:** 0-75 Microamperes, 0 to 7.5/75/750 Milliamperes, 0 to 15 Amperes.
**3 DECIBEL RANGES:** —6 db to +18 db, +14 db to +38 db, +34 db to +58 db.

Model 80 Allmeter comes complete with operating instructions, test leads and portable carrying case. **Price is $42.50. Terms: $12.50 after 10 day trial then $6.00 monthly for 5 months.**

SUPERIOR'S NEW MODEL 70 UTILITY TESTER

## FOR REPAIRING ALL ELECTRICAL APPLIANCES MOTORS ⋆ AUTOMOBILES




**INCLUDED FREE**

**64 page condensed course in electricity. Profusely illustrated. Written in simple, easy-to-understand style.**

**As an electrical trouble shooter the Model 70:**
• Will test Toasters, Irons, Broilers, Heating Pads, Clocks, Fans, Vacuum Cleaners, Refrigerators, Lamps, Fluorescents, Switches, Thermostats, etc. • Measures A.C. and D.C. Voltages, A.C. and D.C. Current, Resistances, Leakage, etc. • Incorporates a sensitive direct-reading resistance range which will measure all resistances commonly used in electrical appliances, motors, etc. • Leakage detecting circuit will indicate continuity from zero ohms to 5 megohms (5,000,000 ohms).

**As an Automotive Tester the Model 70 will test:**
• Both 6 Volt and 12 Volt Storage Batteries • Generators • Starters • Distributors • Ignition Coils • Regulators • Relays • Circuit Breakers • Cigarette Lighters • Stop Lights • Condensers • Directional Signal Systems • All Lamps and Bulbs • Fuses • Heating Systems • Horns • Also will locate poor grounds, breaks in wiring, poor connections, etc.

Model 70 comes complete with 64 page book and test leads. **Price is $15.85. Terms: $3.85 after 10 day trial then $4.00 monthly for 3 months.**

## DID YOU EVER?

- Order merchandise by mail, including deposit or payment in full, then wait and write... wait and write?
- Purchase anything on time and sign a lengthy complex contract written in small difficult-to-read type?
- Purchase an item by mail or in a retail store then experience frustrating delay and red tape when you applied for a refund?

**Obviously prompt shipment and attention to orders is an essential requirement in our business... We ship at our risk!**

# NO

CONTRACT TO SIGN
CO-MAKERS
EMPLOYER NOTIFICATION

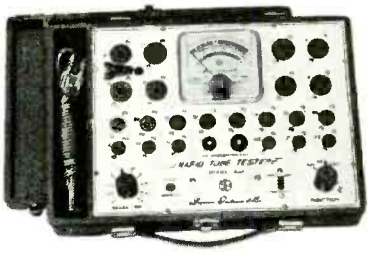
The simple order authorization included in this offer is *all* you sign. We ask only that you promise to pay for or return the goods we ship in good faith.

**EXAMINE ANY ITEM YOU SELECT IN THE PRIVACY OF YOUR OWN HOME**

*Then* if completely satisfied pay on the interest-free terms plainly specified. When we say interest-free we mean not one penny added for "interest" for "finance" for "credit-checking" or for "carrying charges." The net price of each tester is plainly marked in our ads—that is all you pay except for parcel post or other transportation charges we may prepay.

SUPERIOR'S NEW MODEL 82A

## MULTI-SOCKET TYPE TUBE TESTER



**SPECIFICATIONS:**

- Tests over 1000 tube types.
- Tests OZ4 and other gas-filled tubes.
- Employs new 4" meter with sealed air-damping chamber resulting in accurate vibrationless readings.
- Use of 22 sockets permits testing all popular tube types and prevents possible obsolescence.
- Dual Scale meter permits testing of low current tubes.
- 7 and 9 pin straighteners mounted on panel.
- All sections of multi-element tubes tested simultaneously.
- Ultra-sensitive leakage test circuit will indicate leakage up to 5 megohms.

Model 82A comes housed in handsome, portable case.
**Price is $36.50. Terms: $6.50 after 10 day trial then $6.00 monthly for 5 months.**

SUPERIOR'S NEW MODEL TW-11

## STANDARD PROFESSIONAL TUBE TESTER

- Uses the new self-cleaning Lever Action Switches for individual element testing. Because all elements are numbered according to pin-number in the RMA base numbering system, the user can instantly identify which element is under test.
- Free-moving built-in roll chart provides complete data for all tubes. All tube listings printed in large-easy-to-read type.
- **NOISE TEST**: Phono-jack on front panel for plugging in either phones or external amplifier will detect microphonic tubes or noise due to faulty elements and loose internal connections.
- **SEPARATE SCALE FOR LOW-CURRENT TUBES**—Previously, on emission type tube testers, it has been standard practice to use one scale for all tubes. As a result, the calibration for low-current types has been restricted to a small portion of the scale. The extra scale used here greatly simplifies testing of low-current types.

The Model TW-11 comes housed in a handsome, portable, saddle-stitched Texon case. **Price is $47.50. Terms: $11.50 after 10 day trial then $6.00 monthly for 6 months.**

SUPERIOR'S NEW MODEL 83A

## C.R.T. TESTER

**Tests and Rejuvenates ALL PICTURE TUBES**

**ALL BLACK AND WHITE TUBES**
From 50 degree to 110 degree types—from 8" to 30" types.

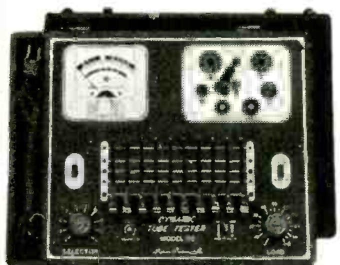
**ALL COLOR TUBES**
Test ALL picture tubes —in the carton —out of the carton —in the set!

Model 83A provides separate filament operating voltages for the older 6.3 types and the newer 8.4 types.
Model 83A properly tests the red, green and blue sections of color tubes individually—for each section of a color tube contains its own filament, plate, grid and cathode.
Model 83A will detect tubes which are apparently good but require rejuvenation. Such tubes will provide a picture seemingly good but lacking in proper definition, contrast and focus.
Rejuvenation of picture tubes is not simply a matter of applying a high voltage to the filament. Such voltages improperly applied can strip the cathode of the oxide coating essential for proper emission. The Model 83A applies a *selective* low voltage *uniformly* to assure increased life with no danger of cathode damage.

Model 83-A comes housed in handsome portable Saddle-stitched Texon case—complete with socket for all black and white tubes and all color tubes. **Price is $38.50. Terms: $8.50 after 10 day trial then $6.00 monthly for 5 months.**

SUPERIOR'S NEW MODEL 85

## TRANS-CONDUCTANCE TYPE TUBE TESTER

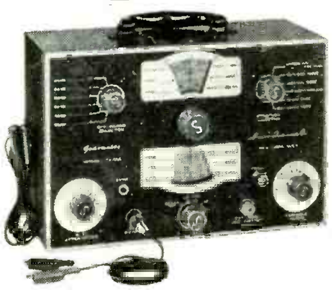


- Employs latest improved **TRANS-CONDUCTANCE** circuit. Test tubes under "dynamic" (simulated) operating conditions. An in-phase signal is impressed on the input section of a tube and the resultant plate current change is measured as a function of tube quality. This provides the most suitable method of simulating the manner in which tubes actually operate in radio, TV receivers, amplifiers and other circuits. Amplification factor, plate resistance and cathode emission are all correlated in one meter reading.
- **SYMBOL REFERENCES**: Model 85 employs time-saving symbols (°, +, ●, ▲, ■;) in place of difficult-to-remember letters previously used. Repeated time-studies proved to us that use of these scientifically selected symbols speeded up the element switching step. As the tube manufacturers increase the release of new tube types, this time-saving feature becomes necessary and advantageous.
- **"FREE-POINT" LEVER TYPE ELEMENT SWITCH ASSEMBLY** marked according to RETMA basing, permits application of test voltages to any of the elements of a tube.
- **FREE FIVE (5) YEAR CHART DATA SERVICE.** Revised up-to-date subsequent charts will be mailed to all Model 85 purchasers *at no charge* for a period of five years after date of purchase.

Model 85 comes complete, housed in a handsome portable cabinet with slip-on cover. **Price is $52.50. Terms: $12.50 after 10 day trial then $8.00 monthly for 5 months.**

SUPERIOR'S NEW MODEL TV-50A

## GENOMETER
## 7 Signal Generators in One!



- **R.F. Signal Generator for A.M.**
- **R.F. Signal Generator for F.M.**
- **Audio Frequency Generator**
- **Bar Generator**
- **Cross Hatch Generator**
- **Color Dot Pattern Generator**
- **Marker Generator**

A versatile all-inclusive **GENERATOR** which provides **ALL** the outputs for servicing:

**A.M. Radio • F.M. Radio • Amplifiers • Black and White TV • Color TV**

The Model TV-50A comes absolutely complete with shielded leads and operating instructions. **Price is $47.50. Terms: $11.50 after 10 day trial then $6.00 monthly for 6 months.**

SUPERIOR'S NEW MODEL 88

## TESTS ALL TRANSISTORS AND TRANSISTOR RADIOS

**AS A TRANSISTOR RADIO TESTER**
An R.F. Signal source, modulated by an audio tone is injected into the transistor receiver from the antenna through the R.F. stage, past the mixer into the I.F. Amplifier and detector stages and on to the audio amplifier. This injected signal is then followed and traced through the receiver by means of a built-in High Gain Transistorized Signal Tracer until the cause of trouble is located and pinpointed.

**AS A TRANSISTOR TESTER**
The Model 88 will test all transistors including NPN and PNP, silicon, germanium and the new gallium arsinide types, without referring to characteristic data sheets. The time-saving advantage of this technique is self-evident. A further benefit of this service is that it will enable you to test new transistors *as they are released!*

Model 88 comes housed in a handsome portable case. Complete with a set of Clip-on Cables for Transistor Testing; an R.F. Diode Probe for R.F. & I.F. Tracing; an Audio Probe for Amplifier Tracing and a Signal Injector Cable. Complete —nothing else to buy! **Price is $38.50. Terms: $8.50 after 10 day trial then $6.00 monthly for 5 months.**

# SEND POSTCARD TODAY (NO POSTAGE NECESSARY)

Try any of the instruments on this or the facing page for 10 days before you buy. If completely satisfied then send down payment and pay balance as indicated on coupon. No interest or Finance Charges Added! If not completely satisfied return unit to us, no explanation necessary.

**MOSS ELECTRONIC, INC., DEPT D-908, 3849 TENTH AVENUE, NEW YORK 34, N.Y.**

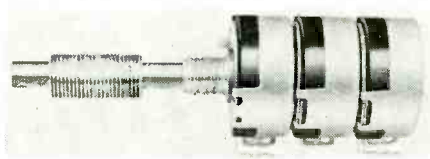
(Continued from page 115)

35 to −142 db. Response: 40 to 8,000 cycles. All-transistor. Rochelle salt diaphragm type mike. Direct-reading scale. 2 x 3 x 6 in. 2 lbs.—**H. H. Scott Inc.**, 111 Powder Mill Rd., Maynard, Mass.

**SHIELDED FLAT PLUG** *No. 228* (2-conductor) and *No. 238* (3-conductor). ¼-inch finger, built-in cable clamp. For guitars, amplifiers, audio,

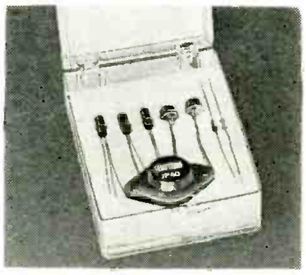
amatuer and communications equipment.—**Switchcraft Inc.**, 5555 N. Elston Ave., Chicago.

**PANEL BUSHING.** *Panel-Juster.* Adapts all of manufacturer's controls to accommodate all panels ¾–⅞ inch thick. Adapter bushing screws



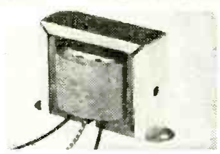
over bushing on control.—**Clarostat Mfg. Co. Inc.**, Dover, N. H.

**REPLACEMENT TRANSISTORS,** *kit 8JP* contains 8 American-made transistors and diodes that replace more than 95% of semi-conductors



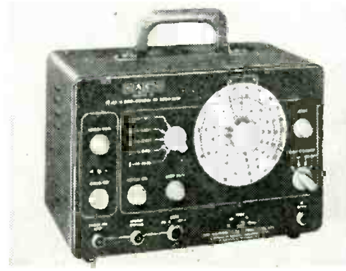
used in Japanese and other foreign radios.—**Semitronics Corp.**, 370 Broadway, New York, N. Y.

**REPLACEMENT TRANSFORMERS.** *A-2986*



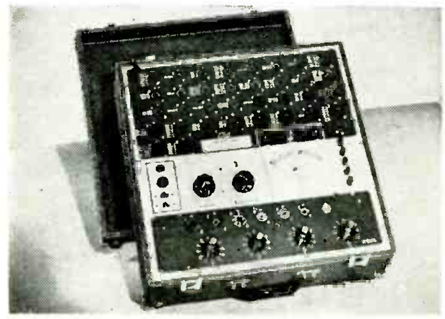
(illus) exact replacement for Admiral 79B43-18 vertical output auto-transformer. *A-4081* replaces Packard-Bell 89460A; *A-2988*, Admiral 79B43-20 and 79C43-20; *A-2984*, Admiral 79B43-19—**Merit Coil & Transformer Corp.**, Merit Plaza, Hollywool, Fla.

**SWEEP GENERATOR / MARKER ADDER,** *model G-32.* Sweep covers frequency range from 3–220 mc. Sweep width from 0 to 20 mc, continuously variable. Crystal-controlled marker oscilla-



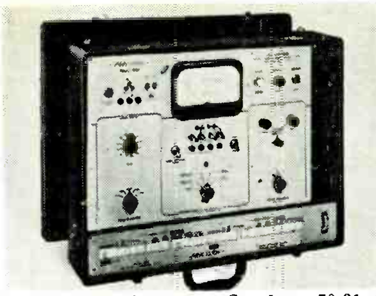
tor. 4.5-mc crystal supplied. Internal blanking eliminates retrace on scope.—**Paco Electronics Co. Inc.**, 70-31 84th St., Glendale 27, N. Y.

**TUBE TESTER,** *Dyna-Quik model 700.* Dynamic mutual-conductance tube tester. Multiple sockets for rapid testing of most TV and radio tubes. Simplified switch section to check new tubes in Dyna-Quik emission circuit. Tests all tubes



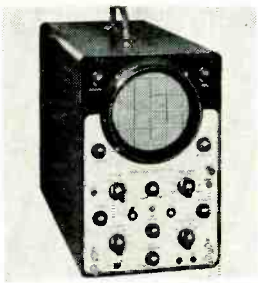
including nuvistors, 10- and 12-pin types. Provision for future new sockets. Checks for shorts, grid emission, leakage and gas. Makes life test.—**B&K Mfg. Co.**, 1801 W. Belle Plaine Ave., Chicago 13, Ill.

**IN-CIRCUIT TRANSISTOR TESTER,** *model 990.* Checks all transistors in or out of circuit. When circuit impedance is more than 500 ohms, transistors are checked with maximum error of about 5%. Higher impedance lowers error. Checks for beta gain, shorts, and collector cur-



rent.—**Precision Apparatus Co. Inc.**, 70-31 84th St., Glendale 27, N. Y.

**WIDE-BAND SCOPE**, *model ES-150*. Laboratory type instrument covers entire range between dc and 5 mc. Dc sensitivity 70 mv/in. Ac sensitivity 25 mv rms/in. Rise time better than .08 μsec. Input impedance 1.5 megohms shunted by 23 μμf.

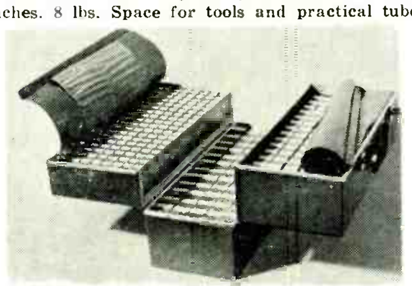


4-step frequency-compensated vertical input attenuator. Built-in voltage calibrator.—**Precision Apparatus Co. Inc.**, 70-31 84th St., Glendale 27, N. Y.

**TRANSISTOR TESTER** *model TR115*. Improved version of earlier TRC4 transistor and diode tester. Checks for leakage, current gain (beta),

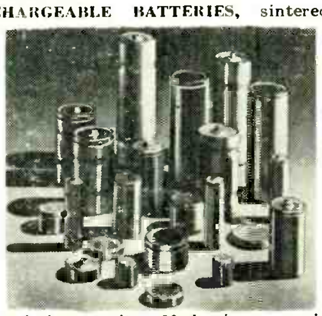
shorts and opens. Beta read direct or on good-bad scale.—**Sencore**, 426 S. Westgate Dr., Addison, Ill.

**SERVICE CASE.** Royalite plastic. 22 x 15 x 9 inches. 8 lbs. Space for tools and practical tube



replacement inventory.—**General Electric**, Distributor Sales, Electronic Components Div., Owensboro, Ky.

**RECHARGEABLE BATTERIES**, sintered-plate



nickel-cadmium units. Made in a variety of sizes and voltages.—**Sonotone Corp.**, Elmsford, N. Y.

**All specifications from manufacturers' data.**

# Technotes

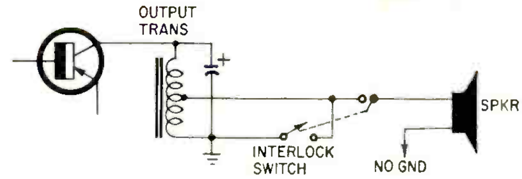


Fig.2

## FORD 67MF

When bench-checking, be sure to observe proper polarity of the 12-volt input or the signal seeker won't seek and the reverse mechanism will fail to operate, resulting in the motor running with the dial pointer at the extreme left or right end. If the signal seeker fails to operate properly, and everything else fails, try several 12AU7 trigger tubes. This circuit is sometimes critical with apparently good 12AU7's.

Clean all mechanical parts of the seeker and lubricate with some light oil and graphite.—*George P. Oberto*

## FLOATING SPEAKER TERMINALS

This could happen to you if you're not careful. A car drives in. You decide it needs a new speaker.

A new universal type is installed. The speaker lead is hooked up and the set turned on. Nothing happens. So you turn the volume control all the way up to make sure it is really dead. Later you find a blown transistor. Why?

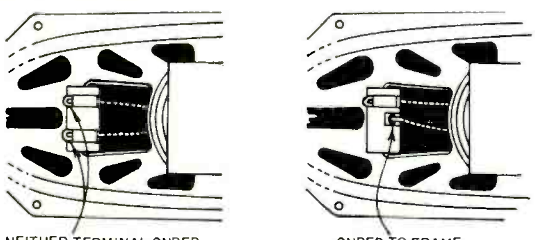


Fig. I

The original speaker had one lug soldered to ground. The universal replacement had floating terminals—neither one was grounded (see Fig. 1). When the replacement was connected to the radio, the circuit was still open because the speaker and radio did not have a common ground (Fig. 2). The interlock switch which protects against no load opened when the new speaker was plugged in. This left the output transformer without a load and caused high audio voltage spikes to be built up across it when the volume control was turned up to a high level. This can ruin the output transistor or shorten its life drastically.—*Delco Radio Testing Tips*

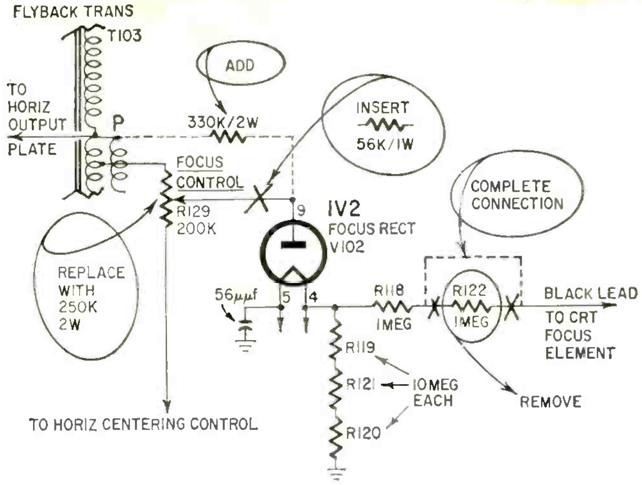
## TICKS ON TAPE

An intermittent ticking noise during tape playback may be caused by oxide deposits along a portion of the tape path. The most likely places for such deposits are around the heads, the capstan and the guides or pressure rollers.

Do not wipe the oxide away—it may only smear. Brush loose particles away. Alcohol is good for cleaning. Use it on a toothpick wrapped with cotton. Do not use pipe cleaners or other implements containing iron wire near the magnetic heads. Rub the cleaner away with a fresh piece of cotton on a toothpick or small wooden stick (or borrow a Q tip from your wife).—*Lawrence Shaw*

## RCA CTC-5 COLOR SET

When adjusted for sharpest picture, focus would drift off after a few minutes, accompanied by loss of horizontal phase




and vertical sync. Also, red and purple streaks appeared across the picture. As I removed the back of the set, I noted the distinctive odor of ozone. The focus control, located in the high-voltage cage, was warm to the touch. When it was removed and examined, the resistance element was found pitted and burned in several places.

I replaced the pot with a new 250,000-ohm 2-watt unit (RCA part 102150-C). When installing the new pot, it is necessary to clip the locating tab. To keep the control from turning when focus is adjusted, the nut holding the pot must be securely tightened. As the terminals of the new control cannot be inserted through the mounting board, I had to solder three 3-inch lengths of buss wire to the control terminals. The bus wire is then inserted through the mounting-board holes.

When installing this new pot, it is necessary to remove the lead from pin 9 of V102 to the center terminal of R129. In its place connect the 56,000-ohm 1-watt resistor supplied with the control. Insulate both resistor leads and position them away from any nearby parts.

## WE BUY TECHNOTES

**RADIO-ELECTRONICS wants Industrial Technotes. These should cover equipment (including closed-circuit television) actually used in industrial work, or technotes on counters, controls and other apparatus whose uses are largely industrial. Unillustrated Technotes pay $5; circuit diagrams raise the price to $9 and acceptable photos are worth $7 each. Send your technotes from industry to Technotes Editor, RADIO-ELECTRONICS, 154 W. 14th St., New York 11, N. Y.**

Once the new control is installed, you may find best focus is off toward one end or the other of the control setting. To get optimum focus near the center of the focus-control rotation, remove the black wire (kine focus lead) from R122 and reconnect to the junction of R118 and R122. Then remove R122, leaving terminal 2 on the terminal board 16 vacant. Next, take a 12-inch length of high-voltage wire (insulated for 10,000 volts )and connect terminal P of T103 (flyback transformer) to terminal 2 of terminal board 16. Lastly, connect a 330,000-ohm 2-watt resistor from terminal 2 of terminal board 16 to pin 9 of V102. Insulate both leads and dress away from any other parts.—*Michael L. Tortariello*

## RCA KCS-107-B

The ¼-amp B-plus fuse would blow at irregular intervals and damper tube failure was unusually high. Also, the horizontal output transformer was running a little hot. I inserted a 200-ohm 20-watt resistor ahead of the damper and bypassed it to ground with a 0.5-μf 600-volt capacitor.

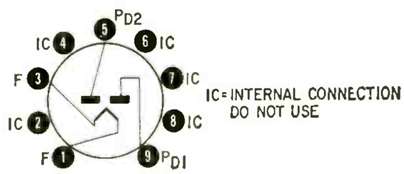
Result—safe horizontal output transformer current, ample width and no more blown fuses. If you run into this problem, but don't have excessive curent through the horizontal output transformer, all you need is the bypass capacitor. It will reduce ripple and prevent needless fuse failure.—*Charles Andrews* **END**

# NEW TUBES and SEMI-CONDUCTORS

THINGS WERE RELATIVELY QUIET THIS month. But even so, we came across a couple of high-speed switching transistors, another novar tube, and a twin-triode for TV vertical deflection circuits.

## 5BC3

A full-wave vacuum rectifier of the novar type intended for use in the power supplies of television and radio receivers and high-fidelity audio equipment hav-




5BC3

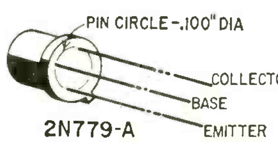
ing high current and voltage requirements.

Typical operating characteristics of the RCA 5BC3 as a full-wave rectifier with a capacitor input filter are:

| | | | |
|---|---|---|---|
| $V_{P\text{-}P}$ (supply rms) | 600 | 900 | 1100 |
| Filter input capacitor ($\mu f$) | 40 | 40 | 40 |
| Total effective plate supply impedance per plate (ohms) | 21 | 67 | 97 |
| $V_{output}$ (dc at input to filter) | | | |
| at 300-ma load | 290 | ...... | ...... |
| 275-ma load | ...... | 460 | ...... |
| 162-ma load | ...... | ...... | 630 |
| 150-ma load | 335 | ...... | ...... |
| 137.5-ma load | ...... | 520 | ...... |
| 81-ma load | ...... | ...... | 680 |

## 2N779-A

A germanium micro-alloy diffused-base transistor specifically designed for very-high-speed switching applications. This p-n-p unit has been reliably used




2N779-A

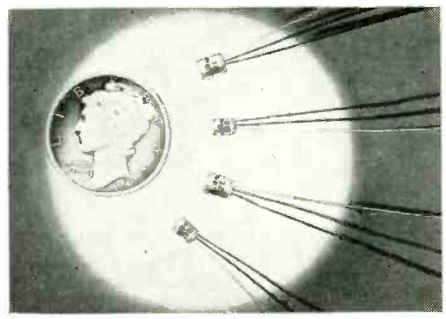
in circuits with speeds of more than 20 mc.

Electrical characteristics of the Philco 2N779-A are:

| | |
|---|---|
| $I_{CBO}$ (typical $\mu a$ when $V_{CB}=5$) | 1 |
| $V_{CBO}$ (minimum) | 15 |
| $V_{EBO}$ (minimum) | 2 |
| $h_{fe}$ (typical when $V_{CE}=-0.5$ $I_C=-10$ ma) | 90 |

## Microminiature transistors

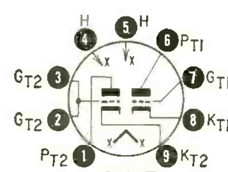
Some tiny new p-n-p germanium alloy transistors are being made by Rauland,



a subsidiary of Zenith. Their R-2 and R-3 units measure only 0.160 x 0.130 and 0.130 x 0.100 inch, respectively. Designed for use as audio or if amplifiers, they have a noise factor of 5 db maximum and beta ranges exceeding 300. Although the units are extremely small, they can dissipate up to 30 mw at 25°C.

## 6EW7

A 9-pin miniature tube containing two dissimilar triodes. One section is a medium-mu unit designed for use in vertical deflection oscillator circuits. The other triode section, a low-mu unit,




6EW7

is intended for use as a vertical deflection amplifier. When used in suitable circuits, it will fully deflect picture tubes having deflection angles up to 110°.

Characteristics of the medium-mu section of the RCA 6EW7 in vertical deflection oscillator use are:

| | |
|---|---|
| $V_P$ | 300 |
| $V_G$ (peak negative pulse) | 400 |
| $I_K$ (peak ma) | 77 |
| (average ma) | 22 |
| $P_P$ (watts) | 1.5 |

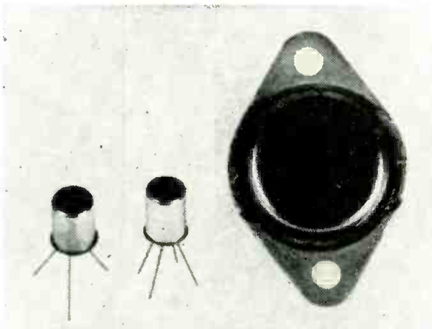
Characteristics of the low-mu section in vertical deflection amplifier use are:

| | |
|---|---|
| $V_P$ (dc) | 330 |
| $V_P$ (peak positive pulse) | 1,500 |

| | |
|---|---|
| $V_G$ (peak negative pulse) | 250 |
| $I_K$ (peak ma) | 175 |
| (average ma) | 50 |
| $P_P$ (watts) | 10 |

### New from TI

Three new lines of germanium consumer type transistors have been announced by Texas Instruments. They include the GAM-1 (*G*ermanium *A*lloy *M*esa), claimed to have the industry's



highest available gain in the broadcast band; the GAM-2, a high-frequency response series for FM use, and the Economy Power series for audio applications.

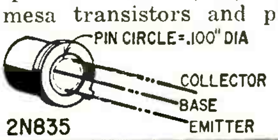
The GAM-1 units are particularly suited for AM–FM receivers, AM receivers and 27-mc CB transceivers. They supply 32–40 db of current gain at 455 kc.

The GAM-2 units for FM applications have high frequency response to 120 mc. Their noise figure at 100 mc is under 6 db.

The Economy Power transistors handle up to 25 watts and have breakdown voltages of 30, 45 or 60.

### 2N835

A high-speed n-p-n silicon epitaxial mesa switching transistor. With its typical storage time of 16 nanoseconds, the unit is one of the fastest silicon switching transistors available. It directly replaces the 2N706, -A, -B and -C silicon mesa transistors and provides





improved circuit performance. It is intended for use in ultra-high-speed logic circuits of data-processing equipment and computers.

Maximum ratings of the Motorola 2N835 are:

| | |
|---|---|
| $V_{CB}$ | 25 |
| $V_{CE}$ | 20 |
| $V_{EB}$ | 3 |
| $I_C$ (ma) | 200 |
| $P_{total}$ (watts at 25°C) | 1 |
| (watts at 100°C) | 0.5 |

END

# new PATENTS

## QUALITY AUDIO OUTPUT

**Patent No. 2,947,947**

*Sergio Bernstein-Bervery, Tarrytown, N. Y. (Assigned to General Precision, Inc.)*

This audio output stage provides quality reproduction with an inexpensive output transformer. Its output impedance is low. It eliminates transients generated in conventional circuits when the load shifts from one half of the primary to the other half. In addition, effects of stray capacitance are minimized.

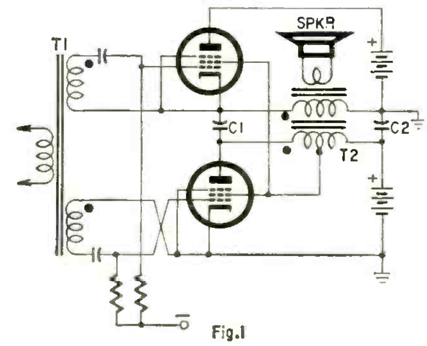



Fig.1

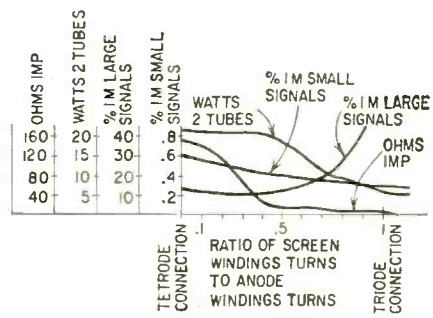



Fig.2

T2 has two primaries which are coupled through C1 and C2 (Fig 1). Thus they carry equal ac at all times and may be considered in parallel. The signal is identical in both windings, so no transients are generated. T2 need not be specially designed for low capacitance and leakage reactance and tight coupling.

Fig. 2 shows how output, distortion and impedance vary with screen-to-anode turns ratio. To take advantage of this, one primary of T2 is center-tapped for the screen.

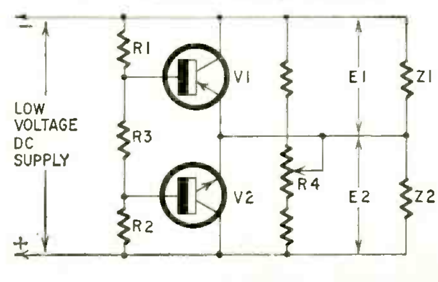
## VOLTAGE REGULATOR

**Patent No. 2,956,172**

*Robt. A. Torkildsen, Milwaukee, Wis. (Assigned to General Electric Co.)*

In this circuit (see diagram) the output voltage ratio E1:E2 tends to remain equal to R1:R2 in spite of variations in Z1 or Z2. For convenience we will assume a 1:1 ratio, or R1 = R2. R3 is relatively small. R4 balances the network to make E1 = E2 when Z1 = Z2.

At balance, both transistors conduct slightly and equally, since V1's base is more negative than the emitters while V2's base is more positive. R4 provides an approximate center tapping of the supply. Actually, it compensates for differences in transistor leakage currents.



Suppose Z1:Z2 rises for any reason, then both emitters go more positive. Then V1's resistance goes down, and V2's resistance rises. Since V1 is across Z1, and V2 is across Z2, the change in Z1:Z2 is compensated by the opposite change in the resistance ratio V1:V2. Therefore the voltage ratio E1:E2 tends to remain constant.

## TEMPERATURE-COMPENSATED AMPLIFIER

### Patent No. 2,963,656

*Samuel R. Parris, Ridley Park, Pa. (Assigned to Burroughs Corp., Detroit, Mich.)*

In Fig. 1, V1 is a silicon n-p-n transistor with positive temperature drift of about 2.4 mv/°C. V2, a germanium p-n-p transistor, drifts about −1.8 mv/°C. This circuit combines them to minimize drift over a wide range of temperatures (Fig. 2). This input diode prevents the input signal from going more than a few tenths of a volt negative.

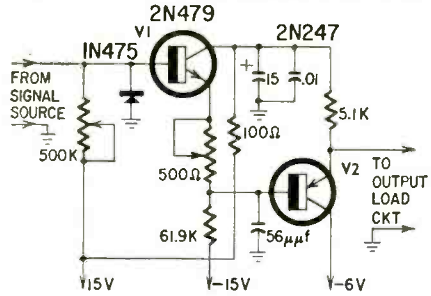



Fig. 1

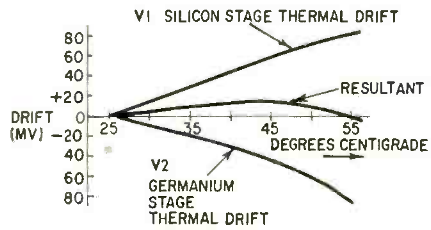



Fig. 2

The passband is from dc to 2 mc. Input impedance is 400,000 ohms, output is only 30 ohms. Source impedance Z should be about 20,000 ohms.

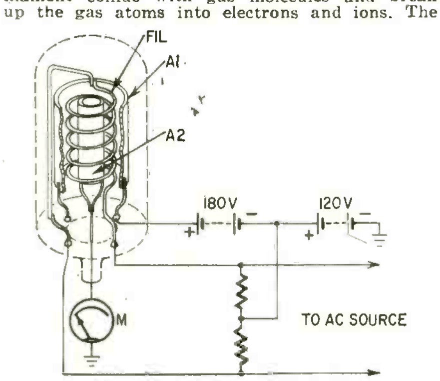
## GAS-PRESSURE GAUGE

### Patent No. 2,963,601

*Lawrence J. Varnerin, Jr., Summit, N. J., and Geo. J. Schulz, Wilkins Township, Pa. (Assigned to Westinghouse Electric Corp.)*

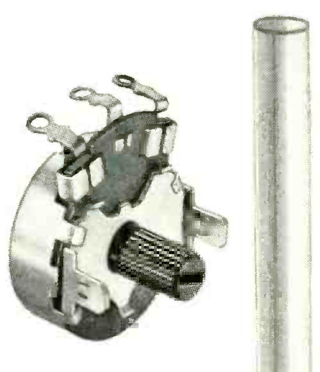
This gauge is especially suitable at pressures between .001 to 10 mm of mercury, a range above the reach of conventional gauges. It contains an outer cylinder, A1; a coiled filament, and an inner cylinder, A2. Diameters may be, respectively, ¾, ½, ⅓ in.

The tube is filled with the gas to be measured, as usual. Electrons emitted from the heated filament collide with gas molecules and break up the gas atoms into electrons and ions. The greater the gas pressure, the more collisions occur. The liberated ions are drawn toward the negative element A2 and are measured by M. Electrons are collected by the positive element A1.




Tube dimensions are such that linearity is maintained even at the high pressures mentioned above. The short electron path makes it unlikely that any electron will cause more than one collision before reaching A1. The short ion path prevents trapping on the tube structure. Also, A2 runs so hot (being close to the filament) that its atoms cannot trap ions. END

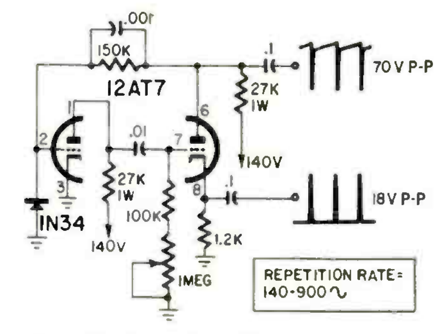


# NOTEWORTHY CIRCUITS

## WAVEFORM GENERATOR

Pulse and sawtooth generators are widely used to develop sweep voltages and timing markers and for many other uses. The circuit shows a simple one-tube waveform generator that will find many applications on the service bench

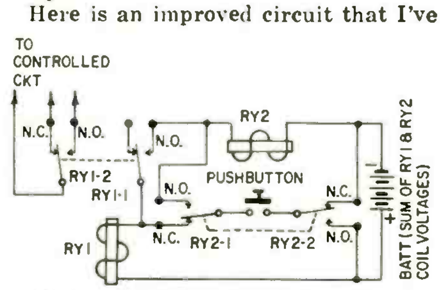



and in the home lab. Seventy-volt peak-to-peak sawtooth voltages with sharp spikes are available at the plate-circuit output and 15-volt positive pulses at the cathode. Repetition rate is variable from 140 to 900 cycles.—*Kenneth E. Walters*

## IMPROVISED IMPULSE RELAY

Impulse or ratchet relays are not readily available from many parts distributors, and they may not be made in the range of operating voltages you want to use. An item on page 142 of the November, 1957, issue of RADIO-ELECTRONICS shows how a spdt impulse relay can be improvised from three dpdt relays.

Here is an improved circuit that I've




used for several years. It is simpler than the one described and uses only two dpdt relays. The circuit is shown with both relays de-energized. The relays have identical coils and each is rated at half the supply voltage.

When the button is pressed, RY1 is energized through contacts RY2-1 and RY2-2. and the circuit to the controlled device is made or broken through RY1-2. As soon as the button is released, RY2 energizes through RY1-1 and RY1's coil. RY1 remains energized through contact RY1-1 and the coil of RY2.

When the button is pressed the second time, RY1 opens (it is shorted out by RY2-1, the pushbutton and RY2-2). Releasing the button opens RY2, leaving both relays de-energized and the controlled circuit ready for another cycle.—*Robert A. Belshe*

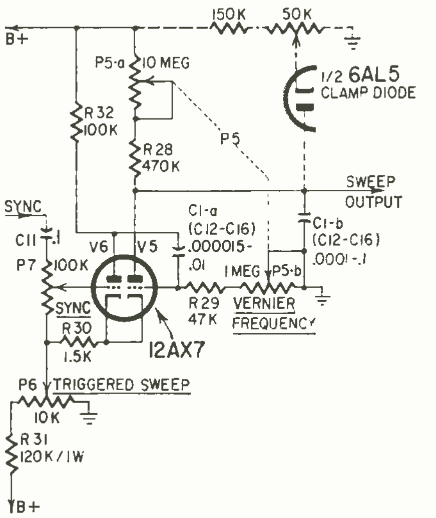
## TRIGGERED SWEEP IMPROVEMENT

The triggered sweep in the Precise 300 and 308 oscilloscopes is a simplified circuit that does not give as clean operation as more expensive models. When using the triggered sweep, the length of the horizontal trace tends to vary with the time interval between the arrival of the signal being viewed and the signal following it. Thus, when viewing random pulses, the time base continually expands and contracts. When sweep amplitude is high, it overdrives the horizontal amplifier and develops a nonlinear trace. Here is a simple circuit modification you can add to your scope to improve its performance.

The original circuit, shown by solid lines, is a conventional cathode-coupled multivibrator. It is repetitive or free-running when the arm of the TRIGGERED SWEEP control is at the ground end. The sawtooth sweep voltage is developed as C1-b charges through P5-a and R28 while V5 is cut off. At the same time, C1-a is discharging through R29 and P5-b, making V5's grid more positive and gradually bringing it out of cutoff. When V5 conducts, it discharges C1-b and the cycle repeats. The time constants of the circuits involving C1-a and C1-b are adjusted so the charge on C1-b does not rise very much above 20 volts between sweeps.

For triggered operation, the arm of P6 is moved toward B-plus, placing a positive bias on the cathodes of V5 and V6. V5's grid returns to ground so it remains cut off and stops free-running operation. C1-b now charges until it reaches full B-plus voltage or until the next incoming signal drives V5 to conduction and stops the sweep. Thus, instead of discharging periodically when its voltage reaches 20, as in the free-running state, C1-b's charge may be close to B-plus before the next signal comes along to discharge it.

This trouble can be eliminated by adding the 6AL5 clamping diode as shown in dashed lines. This circuit prevents C1-b's charge from approaching B-plus and holds it at a level slightly above the peak it would reach in repetitive operation. This level is set by the back bias applied to the




diode's cathode from the 50,000-ohm potentiometer. The charge on C1-b is clamped at the level set by the potentiometer. Thus each sweep is exactly the same length regardless of the rate of occurrence, and all sweeps are linear.

To adjust the circuit, turn the 50,000-ohm pot to the B-plus end and then back down as far as possible without interfering with the normal repetitive sweep operation.

The 6AL5 and pot can be mounted in holes drilled in the long connecting chassis or on a small mounting plate fastened to the rear of the front subchassis by screws holding terminal strip H82A.

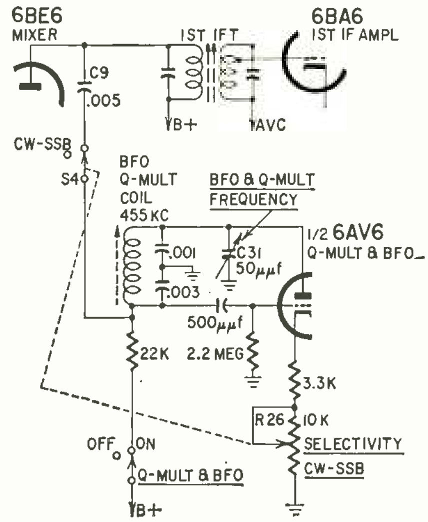
Many general-purpose scopes use cathode-coupled multivibrators in a conventional repetitive sweep circuit. You can adapt these for triggered sweep by installing the trigger control consisting of R31 and P6 and adding the 6AL5 diode clamp.—*Charles Erwin Cohn*

## Q-MULTIPLIER AND BFO

The selectivity of a superhet if circuit can be increased by shunting the if signal path with a tuned circuit that includes a controlled amount of positive feedback to increase its Q. This arrangement is called a Q-multiplier and is gaining popularity in amateur and communications receivers. The diagram shows the combined Q-multiplier and bfo that are used in the new Lafayette Radio Electronics HE-30 communications receiver.

The Q-multiplier and bfo is a Colpitts circuit using a 6AV6. With the SELECTIVITY control in the CW-SSB position, tube gain is high and the circuit oscillates and provides the beat signal needed for CW reception or SSB carrier reinsertion. C31 adjusts the frequency for the desired CW pitch or the clearest SSB signal. Stray coupling is used between the oscillator and the if circuit.

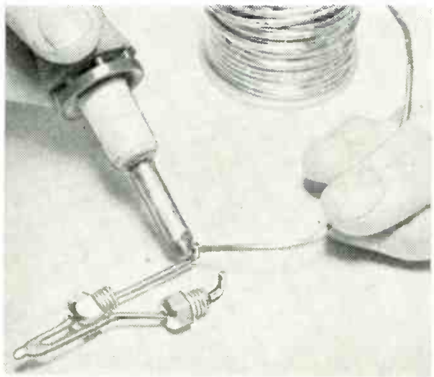
When the SELECTIVITY control is off the CW-SSB position, S4 closes and connects the tuned circuit to the mixer plate through C9. Positive feedback—though not sufficient to produce oscilla-




tion—increases the if selectivity. The amount of selectivity is controlled by R26 which varies the gain of the 6AV6. Response at the −6-db point can be varied from 2 kc (with the Q multiplier off) to 800 cycles. C31 tunes the Q-multiplier through the if pass band to reduce or eliminate interference from adjacent signals. END


### STOP GUN-TIP TARNISH

After prolonged use, the copper tip of a soldering gun becomes tarnished or corroded where the nuts or screws make



electrical contact with the tip. The corrosion causes a poor electrical contact, lowered tip temperature and slow heating. Prevent this by removing the tip and tinning it with a soldering iron or gas flame.—*Clyde A. Compton*

### HEATLESS TRANSISTOR CONNECTIONS

When connecting wires to lead type transistors, there's really no need to solder the connections for good electrical conductivity. Just daub on some printed-circuit silver or copper paint. To insure good mechanical strength, however, twist the wires tightly together before applying the paint.—*Chester A. Clifford*

### LESS NOISE, MORE POISE

Nearly all record changers and turntables have a filter network that absorbs the click or jolt caused by turning them on or off. With high-amplification, however, this is not always fully effective, so some system that gives more complete muting is desirable.

When the added muting is controlled by a pushbutton, it is so useful that it soon becomes indispensable. It not only gives perfectly quiet stops and starts, but, even more important, it permits the operator to silence the pickup at any time. This aids the hand in setting down the stylus or lifting it up in normal playing but especially in the tricky operation of playing a selected part of a record.

Without muting, when the pickup is set down in the run-in groove, you often get a loud plop, either because of a rough spot or inexact placement. Reflexes make the hand jump, causing more noise and possibly damaging the grooves.

When there is separate muting, however, the operator presses a button with his left hand, sets the pickup down with his right and all is quiet even though the volume control is set at a normal listening level.

Similarly, lifting the pickup out of the groove is a maneuver that requires some care. All too often it makes a noise that shakes the hand that lifted the pickup that made the noise. This sequence can be avoided by placing one finger on one little button bearing down on one little switch.

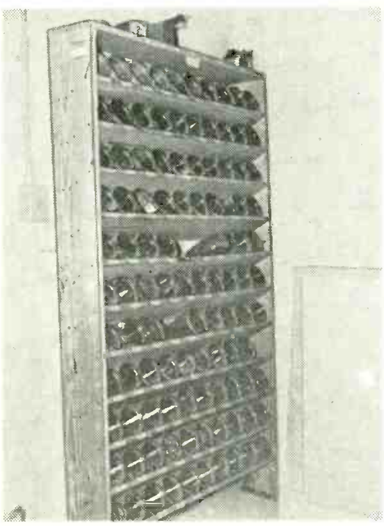
The circuit is simple and can be added by anybody. You need two lengths of insulated wire and a snap-action momentary-contact switch.

Attach the two leads to the speaker terminals on the amplifier. Connect the switch across the other end of the new pair, mount it at the most convenient location and you'll wonder how you ever got along without it.

The degree of silence depends on size of the wire and length of the line. No. 18 is satisfactory for a run of 6 feet or more. A Microswitch is recommended for positive contact. The switch can be concealed under the turntable mounting base with only a small (home-made) plunger showing.—*Nicholas B. Cook*

## PARTS RACK

A simple rack that makes for orderly arrangement and see-able inventory of various components is this parts rack which has shelves sloping downward



toward the rear. Containers are quart cans with their tops cut out and their edges smoothed. The unit provides 110 compartments in a minimum space.—*Harry S. Miller*

## BATTERY-HOLDER REPAIR

Battery holders used in transistor construction projects have solder-lug terminals that are usually riveted to the battery connector. In practically all cases these riveted connections remain good mechanically, but they often develop a high resistance, causing a complete electrical failure. This can be corrected by soldering the solder lug and rivet together. It is advisable to solder all such connections before assembling a new transistor project.—*J. E. Pugh, Jr.*

## MULTIMETER SAFEGUARD

Many multimeters have selector switch positions which leave the internal batteries continually in circuit—for example, the low-ohms range of some meters. If the switch is left in that position when the meter is put aside, the batteries will go dead rapidly. To guard against this, wire a pushbutton in series with the appropriate terminal of the selector switch. Hold down the button to make a measurement. When you release it, the circuit opens.—*Charles Erwin Cohn*

## DEPTH GAUGE STOPS DRILL

Try this any time it's necessary to limit the travel of a drill through a chassis or other objects or materials. Put the drill all the way in the chuck, then drill a hole lengthwise through a piece of dowel or soft pinewood stock.

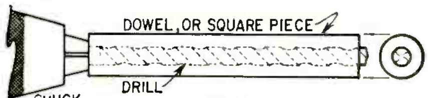



Fig.1

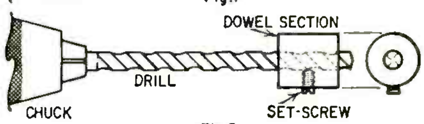



Fig.2

Cut the dowel so just enough drill end protrudes to drill through the chassis or material as in Fig. 1.

Another way of doing it is to cut a ¾- or 1-inch length piece of dowel and cut a small setscrew hole in the side as in Fig. 2. Drill the setscrew hole small, so that the setscrew taps its own threads. If you have one of these depth gauges for each size of drill, you'll never punch a hole in a capacitor or in any other component.—*Frank W. Dresser* END


"Fastest antenna man in the West!"

# BUSINESS and PEOPLE

**James J. Nichols** was appointed manager of the P. R. Mallory & Co. Distributor Div., Indianapolis, Ind. He had been general sales manager of the Mallory Metallurgical Co. He succeeds **J. E. Templeton,** who has been named director of Western operations. **Harold C. Buell,** vice president of Mallory, has been placed in charge of customer relations. **William H. Starbuck** was appointed director of markets. He comes from Stromberg-Carlson.

**Joseph S. Ramer** (top left) joined Stancor Electronics, Inc., Chicago, as director of engineering. He comes to the company from Heath Co., where he was chief engineer. **C. Edwin Williams** (top right) joins Stancor as technical consultant at the Easton, Pa., plant. He had been with Measurements, Inc.

**C. Kenneth Juno** was appointed sales promotion manager of the Progress Webster Corp., Rochester, N.Y., a subsidiary of Progress Webster Electronics Corp. He comes to the company from General Dynamics/Electronics (Stromberg-Carlson Div.).

**Milton S. Coleman** was appointed national sales manager by Eric Electronics, Santa Monica, Calif., for its line of high-fidelity components and sound equipment. He was formerly with Philco Corp.

**John de Leon** (left) also joined the Easton plant as engineer. He had been with ITT Federal Laboratories.

**H. H. Scott, Inc.,** Maynard, Mass., has increased its manufacturing space by 50% through leasing a portion of Maynard Mills, less than a mile from its present facilities. The present plant will continue to manufacture wired components and will remain as the executive office.

**C. E. (Pete) Seaman** was appointed field marketing manager of Electro-Voice, Inc., Buchanan, Mich. He formerly headed needle and cartridge sales.

**The Electronic Industry Show Corp.,** Chicago, announced that a recent study conducted by an independent consultant recommended the continuation of one 3-day electronic industry show each year in Chicago in May. It further recommended that the show be oriented toward distributors rather than their customers.

**Joseph J. Kaleba** joined Shure Brothers, Inc., Evanston, Ill., as manager of the product design and specifications section. He had been engineering supervisor at Controls Co. of America.

**Jerry Borrevik** joined the sales staff of Electro-Voice, Inc., Buchanan, Mich. He was an electrical engineering major at MIT.

**Aerovox Corp.,** New Bedford, Mass. introduced a new slogan, Technical Leadership—Manufacturing Excellence, which will be used on all trade advertising and sales promotion material. A


modernized trademark was also introduced. Matthew Simon, sales manager, Distributor Div. (left) is shown discusssing the trademark with Charles Golenpaul, vice president of the division. Aerovox also recently introduced a 2-year warranty on capacitors and resistors in all markets. A 1-year warranty has been traditional in the industry.

**Duane L. Billiet** was named manager, marketing services, in an expansion of the Sales Dept. of the Delco Radio Div. of General Motors Corp., Kokomo, Ind. He recently completed a year's study on a Sloan Fellowship at Stanford University. **Don C. Cripe,** former sales analyst, was promoted to manager, sales operations analysis. He will be assisted by **Clifford H. Baker,** a new employee who will act as a marketing specialist. **Richard L. Gerhart** was named sales engineer for static machine controls. At the same time, **Calvin E. Fields** joined the semiconductor sales engineering staff.

**United Catalog Publishers, Inc.,** Hempstead, N. Y., has established an in-plant typesetting shop to service its

various publications. Arthur L. Rabb (left), general manager of the company, is shown welcoming Robert Steinberg, manager of the new plant.

**Lloyd F. Taylor** was named vice president of Casco Products Corp., a subsidiary of Standard Kollsman Industries, Chicago. He will continue to serve as executive assistant to **Leonard F. Cramer,** president of Casco. **Roland J. Fernekes,** former assistant to the vice president, operations, was promoted to director of engineering.

**Centralab,** Electronics Div. of Globe-Union, Inc., Milwaukee, Wis., developed a new two-color envelope stuffer for distributor use for its L- and T-pad attenuators.

**Sonotone Corp.,** Elmsford, N. Y., introduced a new three-color display for


its line of more than 200 electronic tube types.

**B&K Manufacturing Co.,** Chicago, has established a twice-yearly picture-tube chart information service covering past and present B&K CRT models. For a small subscription fee, mailings will be made in May and November to all owners.

**Shure Brothers, Inc.,** Evanston, Ill., is offering a prize of 20 cartridges to each of 17 distributors who have most successfully promoted its Limited Edition recording. END

# new LITERATURE

Any or all of these catalogs, bulletins, or periodicals are available to you on request direct to the manufacturers, whose addresses are listed at the end of each item. Use your letterhead—do not use postcards. To facilitate identification, mention the issue and page of RADIO-ELECTRONICS on which the item appears. UNLESS OTHERWISE STATED, ALL ITEMS ARE GRATIS. ALL LITERATURE OFFERS ARE VOID AFTER SIX MONTHS.

**NEW AND SURPLUS** electronic equipment for aircraft, industrial, amateur, experimental and other electronic uses fill the 38 pages of *Catalog No. 105*. Antennas, radios, books, signal generators and other electronic gear are included.—**Bill Slep Co.**, P.O. Box 178, Ellenton, Fla.

**SILICON TRANSISTORS**, *Designers Handbook*. A comparative study of the Raytheon 2N338 and similar high-frequency silicon transistors produced by four major manufacturers is presented in this 28-page illustrated booklet. Each manufacturer's transistor is analyzed as to electrical and mechanical characteristics, parameter distribution, design requirements, etc. Use your letterhead to request copy.—**Raytheon Co.**, Warren Schoonmaker, Semiconductor Div., 150 California St., Newton, Mass.

**SILICON RECTIFIER BULLETINS** describe a series of miniature Trim-Line rectifiers. Data sheets give mechanical and electrical specifications. — **Slater Electric Co.**, 241 Sunrise Highway, Rockville Centre, N. Y.

**ELECTRONIC TEACHING AID** for schools, experimenters, plants and laboratories are detailed in an 8-page brochure, *The DeVry Electronics Trainer System*.—**Paromel Electronics Corp.**, 3956 Belmont Ave., Chicago 18, Ill.

**SEMICONDUCTORS**, *Short Form Catalog/Fall 1961*. Shows complete line of diodes and transistors. Includes silicon and germanium transistors and diodes, and silicon capacitors.—**Hughes Aircraft Co.**, Semiconductor Div., Newport Beach, Calif.

**INDUSTRIAL TUBES** of all types are listed in *Electronic Tubes for Industry*. Transmitting, special-purpose, industrial receiving tubes and semiconductors are among the hundreds of items in the 14-page catalog.—**United-National Labs Inc.**, 90 President St., Passaic, N. J.

**ELECTRONIC DEVICES**, 288 illustrated pages of them are in this *1961 Indus-*

*trial Electronic Catalog 97.* More than 50,000 items are described, illustrated and indexed. For the engineer and industrial service technician. — Radio Shack, 730 Commonwealth Ave., Boston 17, Mass.

**TAPE RECORDER** purchasing and servicing are subjects of this 12-page illustrated booklet. It describes briefly the tape recorder mechanism and how it works, and clarifies the guarantees and service offered by the manufacturer. Prepared by the National Better Business Bureau in cooperation with the Magnetic Recording Industry Association. Available from your local Better Business Bureau or hi-fi dealer.

**HI-FI COMPONENTS** are described and illustrated in *Catalog AL 1302-1.* All components in this manufacturer's line are shown. This includes tuners, amplifiers, complete receivers, speakers, microphones and custom installations. —**Altec Lansing Corp.**, Dept. LD, 1515 S. Manchester Ave., Anaheim, Calif.

**ELECTRONIC KITS** of all kinds are offered in this 1961 catalog. Printed in three colors, the 28-page brochure gives illustrated descriptions of stereo and mono hi-fi gear, test instruments, ham gear, CB and transistor radios. More than 80 items are covered.—EICO, Electronic Instrument Co., Inc., 33-00 Northern Blvd., Long Island City 1, N. Y.

**TEST EQUIPMENT** and accessories made by this manufacturer are described in detail in *Electronic Instruments.* The little pocket-sized booklet includes meters, generators, scopes and tube testers. 16 pieces of equipment and 12 accessories in all.—RCA, Electron Tube Div., Harrison, N. J.

**THE TAPE RECORDER** *in Business and Industry* shows how tape recorders can be used in business. All phases are covered including management communications, personnel, sales, advertising, public relations.—**Minnesota Mining & Manufacturing Co.**, 900 Bush Ave., St. Paul, Minn.

**ELECTRONIC WIRE, CABLE AND TUBING,** *No. 62,* completely indexed alphabetically, numerically and by Government and industrial specifications in new 52-page catalog. Eight new wire and tubing lines introduced in addition to already-existing 6,000 stock products. "E-Z" index chart for prompt location of any catalog item by number of conductors, wire size and whether it is shielded or not.—**Alpha Wire Corp.**, 200 Varick St., New York 14, N. Y.

**REPLACEMENT GUIDE** to instrument rectifiers helps the technician keep his test equipment working. It tells which of this manufacturer's instrument rectifiers to use in a particular piece of test equipment. Listings are arranged alphabetically, by equipment makers' names. — **Conant Laboratories**, 6500 O St., Lincoln, Neb.

**MULTI-STATION INTERCOM,** Ektacom series G. 4-page folder hits important outstanding features of this new intercom. Last page catalogs the units available and the possible options.—Fisher

Berkley Corp., 1475 Powell St., Emeryville 8, Calif.

**STOCK BUSINESS FORMS** *for Radio-Television-Service.* This 32-page catalog offers every type of business form the technician may need. It includes items like salesbooks, file systems and job tickets. Each item is illustrated.—**Oelrich Publications,** 4308 Milwaukee Ave., Chicago 41, Ill.

**SELENIUM PHOTOVOLTAIC CELLS** discussed in *Bulletin No. 03-201-A.* Text, photographs and drawings demonstrate their features, selection and applications. 6 pages—Daystrom Inc., Weston Instruments Div., 614 Frelinghuysen Ave., Newark 12, N. J.

**ELECTRONIC COMPONENTS** line outlined in 60-page 1961 *Catalog No. 61.* Detailed schematic drawings and technical data on all items. Partial listing of products' electrical ratings. — **Herman H. Smith Inc.,** 2326 Nostrand Ave., Brooklyn 10, N.Y. END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Some larger libraries still have copies of Modern Electrics on file for interested readers.

**In October, 1911, *Modern Electrics***

Hot-Wire Meter, by E. E. Ely.

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New Compact Wireless Set, by Walter Neuman.

A Miniature Tesla Coil, by Carl Dreher.

Wireless Range Increaser, by Joseph E. Frisbee.

# new BOOKS

**BASIC TRANSISTORS, edited by A. Schure. John F. Rider Publisher Inc., 116 W. 14 St., New York 11, N. Y. 6 x 9 in. 146 pp. $3.95.**

This book tells what a transistor is and what it can do. It is a picture-text course. Each page is devoted to one basic idea, and includes large illustrations. A handy book for beginners and nontechnical readers.—*IQ*

**ELECTRONIC FUNDAMENTALS AND APPLICATIONS (2nd Edition), by John D. Ryder. Prentice-Hall, Inc., Englewood Cliffs, N. J. 6 x 9 in. 721 pp. $13.35.**

This new edition emphasizes the growing importance of semiconductors in electronics. It begins with a discussion of particles and of circuit theory, leading to detailed studies of tubes and transistors. Engineering math, diagrams and tables help to analyze circuits and devices including amplifiers, oscillators, gas tubes, power rectifiers and photoelectric devices. The volume is comprehensive and detailed. It is excellent for reference or study.

**TELEVISION TAPE RECORDING, by George B. Goodall. Robins Industries Corp., Flushing 54, N. Y. 6 x 9 in. 47 pp. $1.**

TV tape recording is comparatively new, but it need not remain a mystery. The mechanism and characteristics of the Ampex Videotape machine are explained clearly and without math. Photos illustrate important parts of the machine. How to splice, edit and duplicate are also covered.

**ELECTRICAL SAFETY, by H. W. Swann. Philosophical Library, 15 E. 40 St., New York 16, N. Y. 5¼ x 8½ in. 292 pp. $15.**

This author calls on his wide experience as senior inspector to describe approved methods for avoiding hazards of shock, fire and explosion. He quotes from British electrical regulations and tells how to comply with them.

Among the topics are overload protection, grounding, inflammable surroundings, static charges, lightning. The book covers safety in the factory, hospital, power plant and the home.

**101 KEY TROUBLESHOOTING WAVEFORMS FOR HORIZONTAL AFC-OSCILLATOR CIRCUITS, by Robert G. Middleton. Howard W. Sams & Co. Inc., 1720 E. 38 St., Indianapolis, Ind. 5½ x 8½ in. 128 pp. $2.**

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# SCHOOL DIRECTORY

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**OSCILLATOR CIRCUITS, by Thomas M. Adams. Howard W. Sams & Co. Inc., 1720 E. 38th St., Indianapolis, Ind. 5½ x 8½ in. 125 pp. $2.95.**

Many students feel the need for detailed and complete *physical* explanations of electronic phenomena. This book uses four colors to show current direction, feedback paths and phase relationships in circuits. It covers several types of oscillators, multivibrators and sawtooth generators. This approach is sure to clarify the inner workings of oscillators.—*IQ*

**SEMICONDUCTOR DEVICES, by Rufus P. Turner. Holt, Rinehart & Winston Inc., 383 Madison Ave., New York 17, N. Y. 6 x 9 in. 278 pp. $6.95.**

This handbook is for the nonmathematical technician and student. Experimenters will also find interesting circuits and useful data. In simple language the book describes such devices as rectifiers, transistors, Zener diodes, thermistors, photocells and parametric devices. Diagrams show typical applications, with the text giving component values and discussing circuit operation. A chapter on tests and measurements shows how to make setups to check the devices.

**AN INTRODUCTION TO THE THEORY AND PRACTICE OF TRANSISTORS, by J. R. Tillman and F. F. Roberts. John Wiley & Sons Inc., 440 Park Ave. South, New York 16, N. Y. 5½ x 8½ in. 340 pp. $8.**

This book goes deep into mathematical analyses. It is written for engineers, physicists and specialists in semiconductors. Part 1 covers the properties of semiconductors and junctions. Part 2 discusses fabrication of semiconductors and their applications.—*IQ*

**SEMICONDUCTORS AND TRANSISTORS, edited by Alexander Schure. John F. Rider Publisher Inc., 116 W. 14 St., New York 11, N. Y. 5½ x 8½ in. 138 pp. $2.90.**

This volume will provide a solid foundation for readers who understand simpler types of mathematical equations. It begins with the study of atom structure and proceeds to the junction diode. Numerical examples show how to design circuits for optimum power, minimum distortion and proper impedance match.

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You get 11 tubes (same type) . . . pay for only 10
Offer limited to the following types only:
1R5 - 1U5 - 3BC5 - 3BU8 - 5BK7 - 5U8 - 6AQ5 - 6BN6
6BU8 - 6CD6 - 6EA8 - 6U8 - 12CU6 - 12BH7 - 12W6

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## BRAND NEW TUBES

500 MA SILICON RECTIFIER Epoxy construction, size of 1-watt resistor
I reverse at 450 Volts .3 ma
30¢ ea. lots of 20 | 35¢ ea. lots of 10 | 45¢ ea.
Each rectifier "Performance Tested" on an American TV Set

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| Qty. Type | Price | Qty. Type | Price | Qty. Type | Price | Qty. Type | Price | Qty. Type | Price |
|---|---|---|---|---|---|---|---|---|---|
| 0C3 | .80 | 2AF4 | .96 | 3Q5 | .80 | 5AV8 | 1.01 | 5Y4 | .59 |
| 0Z4 | .79 | 2D21 | 1.20 | 3S4 | .61 | 5BC8 | .79 | 6A8G | 1.20 |
| 1AX2 | .62 | 2EN5 | .45 | 3V4 | .58 | 5BE8 | .83 | 6AB4 | .46 |
| 1B3 | .79 | 3A3 | .76 | 4AU6 | .54 | 5BK7 | .82 | 6AC5 | 1.05 |
| 1DN5 | .55 | 3A4 | .60 | 4BA6 | .51 | 5BQ7 | .97 | 6AC7 | .96 |
| 1G3 | .79 | 3AF4 | 1.02 | 4BC5 | .58 | 5BR8 | .79 | 6AF3 | .73 |
| 1H5 | .54 | 3AL5 | .42 | 4BC8 | .96 | 5BT8 | .83 | 6AF4 | .97 |
| 1J3 | .79 | 3AU6 | .51 | 4BN6 | .75 | 5CG8 | .76 | 6AG5 | .68 |
| 1K3 | .79 | 3AV6 | .41 | 4BQ7 | 1.01 | 5CL8 | .76 | 6AH4 | .81 |
| 1L4 | .68 | 3BA6 | .51 | 4BS8 | .98 | 5CM8 | .90 | 6AH6 | .99 |
| 1LC5 | .59 | 3BC5 | .54 | 4BU8 | .71 | 5CQ8 | .84 | 6AK5 | .95 |
| 1LD5 | .69 | 3BE6 | .52 | 4BZ6 | .58 | 5CZ5 | .72 | 6AL5 | .47 |
| 1LG5 | .69 | 3BN6 | .76 | 4BZ7 | .96 | 5EA8 | .80 | 6AL7 | 1.43 |
| 1LN5 | .59 | 3BU8 | .78 | 4CS6 | .61 | 5EU8 | .80 | 6AM4 | 1.50 |
| 1R5 | .62 | 3BY6 | .55 | 4DE6 | .62 | 5J6 | .68 | 6AM8 | .78 |
| 1S2A | .76 | 3BZ6 | .55 | 4DK6 | .60 | 5T4 | .79 | 6AQ5 | .53 |
| 1S4 | .59 | 3CB6 | .54 | 4DT6 | .55 | 5T8 | .81 | 6AR5 | .55 |
| 1S5 | .51 | 3CF6 | .60 | 4EW6 | .58 | 5U4 | .60 | 6AS5 | .60 |
| 1T4 | .58 | 3CS6 | .52 | 5AM8 | .79 | 5U8 | .81 | 6AS6 | .80 |
| 1U4 | .57 | 3DG4 | .85 | 5AN8 | .86 | 5V3 | .90 | 6AT6 | .43 |
| 1U5 | .50 | 3DK6 | .60 | 5AQ5 | .52 | 5V6 | .56 | 6AT8 | .79 |
| 1V2 | .50 | 3DT6 | .50 | 5AS8 | .86 | 5X8 | .78 | 6AU4 | .82 |
| 1X2B | .82 | 3Q4 | .63 | 5AT8 | .80 | 5Y3 | .46 | 6AU6 | .52 |

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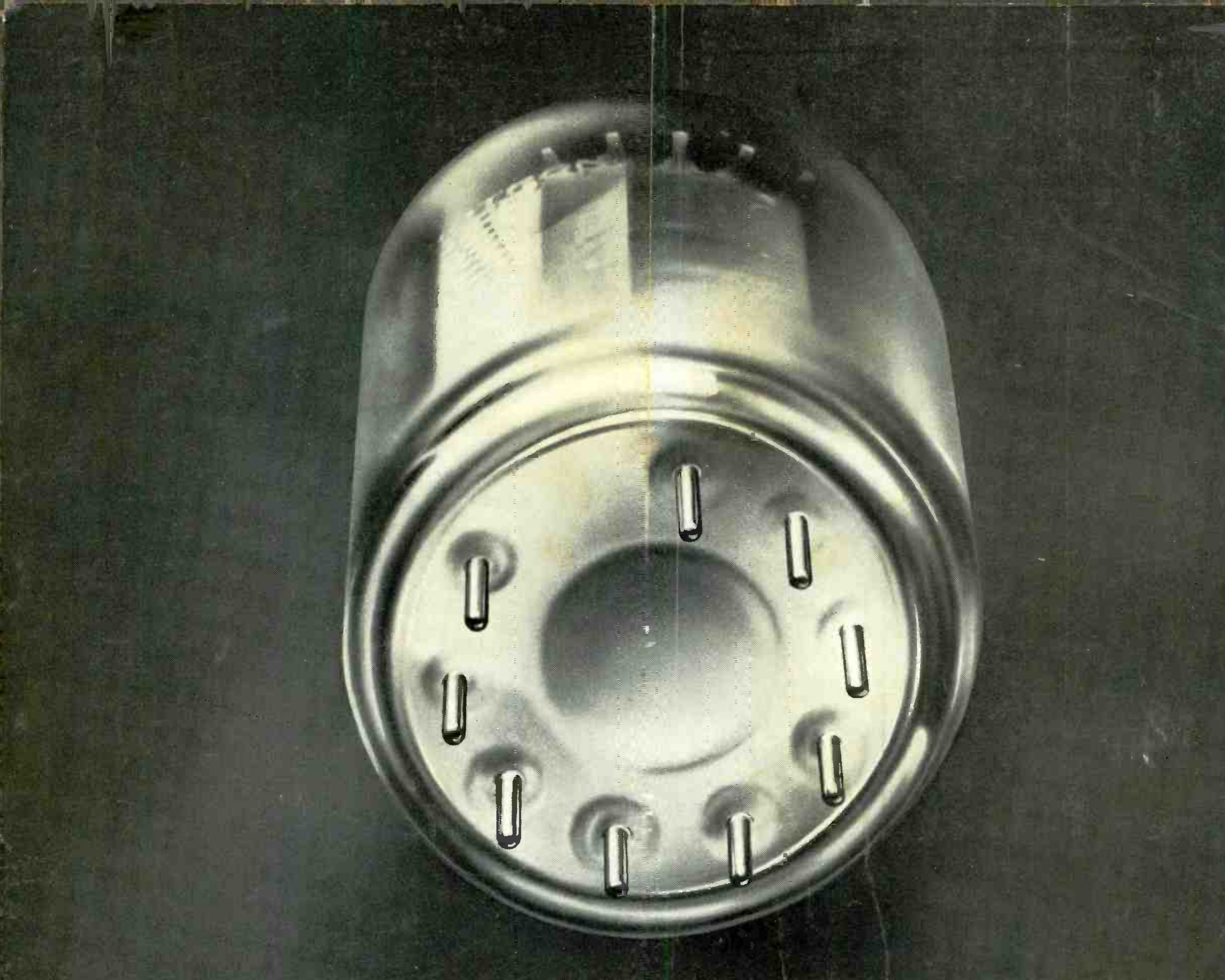
EACH TUBE INDIVIDUALLY & ATTRACTIVELY BOXED

| Qty. Type | Price | Qty. Type | Price | Qty. Type | Price |
|---|---|---|---|---|---|
| 6AU7 | .61 | 6J6 | .67 | 12D4 | .69 |
| 6AU8 | .87 | 6J7 | .62 | 12DB5 | .69 |
| 6AV6 | .41 | 6K6 | .63 | 12DE8 | .75 |
| 6AW8 | .90 | 6L6 | 1.06 | 12DL8 | .85 |
| 6AX4 | .66 | 6N7 | .98 | 12DM7 | .67 |
| 6AX5 | .74 | 6S4 | .51 | 12DQ6 | 1.04 |
| 6AX7 | .64 | 6S8 | .76 | 12DS7 | .79 |
| 6AX8 | .92 | 6SA7GT | .76 | 12DT5 | .76 |
| 6BA6 | .50 | 6SG7GT | .41 | 12DT7 | .79 |
| 6BA7 | .84 | 6SH7GT | .49 | 12DT8 | .79 |
| 6BA8 | .88 | 6SJ7 | .88 | 12DW8 | .89 |
| 6BC5 | .61 | 6SK7GT | .74 | 12DZ6 | .56 |
| 6BC7 | .94 | 6SL7GT | .80 | 12EG6 | .54 |
| 6BC8 | .97 | 6SN7GT | .65 | 12EK6 | .56 |
| 6BD5 | 1.25 | 6SQ7 | .73 | 12EL6 | .50 |
| 6BD6 | .57 | 6T4 | .99 | 12EM6 | .79 |
| 6BE6 | .55 | 6T8 | .85 | 12EN6 | .78 |
| 6BF5 | .90 | 6U8 | .83 | 12EZ6 | .53 |
| 6BF6 | .44 | 6V6GT | .54 | 12F8 | .66 |
| 6BG6 | 1.66 | 6V8 | .86 | 12FA6 | .79 |
| 6BH6 | .65 | 6W4 | .60 | 12FM6 | .43 |
| 6BH8 | .87 | 6W6 | .71 | 12FR8 | .91 |
| 6BJ6 | .62 | 6X4 | .39 | 12FX8 | .85 |
| 6BJ7 | .79 | 6X5GT | .53 | 12GC6 | 1.06 |
| 6BK7 | .85 | 6X8 | .80 | 12J8 | .84 |
| 6BL7 | 1.00 | 6Y6G | .65 | 12K5 | .65 |
| 6BN4 | .57 | 7A8 | .68 | 12L6 | .58 |
| 6BN6 | .74 | 7AU7 | .61 | 12S8 | .62 |
| 6BQ5 | .65 | 7B6 | .69 | 12SA7 | .92 |
| 6BQ6 | 1.05 | 7EY6 | .73 | 12SF5 | .50 |
| 6BQ7 | 1.00 | 7F8 | .90 | 12SF7 | .69 |
| 6BR8 | .78 | 7Y4 | .69 | 12SH7 | .49 |
| 6BS8 | .90 | 8AU8 | .83 | 12SJ7 | .67 |
| 6BU8 | .70 | 8AW8 | .93 | 12SK7 | .74 |
| 6BX7 | 1.02 | 8BH8 | .90 | 12SL7 | .80 |
| 6BY5 | 1.15 | 8BN8 | .75 | 12SN7 | .67 |
| 6BY6 | .54 | 8BQ5 | .60 | 12SQ7 | .78 |
| 6BY8 | .66 | 8CG7 | .62 | 12U7 | .62 |
| 6BZ6 | .55 | 8CM7 | .68 | 12V6 | .53 |
| 6BZ7 | 1.01 | 8CN7 | .97 | 12W6 | .69 |
| 6BZ8 | 1.09 | 8CS7 | .74 | 12X4 | .38 |
| 6C4 | .43 | 8CX8 | .93 | 17AX4 | .67 |
| 6C8 | .90 | 8EB8 | .94 | 17BQ6 | 1.09 |
| 6CB6 | .55 | 8SN7 | .66 | 17D4 | .69 |
| 6CD6 | 1.42 | 9CL8 | .79 | 17DQ6 | 1.06 |
| 6CE5 | .57 | 11CY7 | .75 | 17L6 | .58 |
| 6CF6 | .64 | 12A4 | .60 | 17W6 | .70 |
| 6CG7 | .61 | 12AB5 | .55 | 18FW6 | .49 |
| 6CG8 | .77 | 12AC6 | .49 | 18FX6 | .53 |
| 6CK4 | .70 | 12AD6 | .57 | 18FY6 | .50 |
| 6CL8 | .79 | 12AE6 | .43 | 19AU4 | .83 |
| 6CM6 | .64 | 12AE7 | .94 | 19BG6 | 1.39 |
| 6CM7 | .66 | 12AF3 | .73 | 19T8 | .80 |
| 6CM8 | .90 | 12AF6 | .49 | 19V8 | .79 |
| 6CN7 | .65 | 12AJ6 | .46 | 21EX6 | 1.49 |
| 6CQ8 | .84 | 12AL5 | .45 | 25AV5 | .83 |
| 6CR6 | .51 | 12AL8 | .95 | 25AX4 | .70 |
| 6CS6 | .57 | 12AQ5 | .60 | 25BK5 | .91 |
| 6CS7 | .69 | 12AT6 | .43 | 25BQ6 | 1.11 |
| 6CU5 | .58 | 12AT7 | .76 | 25C5 | .53 |
| 6CU6 | 1.08 | 12AU6 | .51 | 25CA5 | .59 |
| 6CY5 | .70 | 12AU7 | .60 | 25CD6 | 1.44 |
| 6CY7 | .71 | 12AV6 | .41 | 25CU6 | 1.11 |
| 6DA4 | .68 | 12AV7 | .75 | 25DN6 | 1.42 |
| 6DB5 | .69 | 12AX4 | .67 | 25EH5 | .55 |
| 6DB6 | .51 | 12AX7 | .63 | 25L6 | .57 |
| 6DE6 | .58 | 12AY7 | 1.44 | 25W4 | .68 |
| 6DG6 | .59 | 12AZ7 | .86 | 25Z6 | .66 |
| 6DK6 | .59 | 12B4 | .63 | 32ET5 | .55 |
| 6DN6 | 1.55 | 12BA6 | .50 | 32L7 | .90 |
| 6DQ6 | 1.10 | 12BA7 | .84 | 35B5 | .60 |
| 6DT6 | .53 | 12BD6 | .50 | 35C5 | .51 |
| 6DT8 | .79 | 12BE6 | .53 | 35L6 | .57 |
| 6EA8 | .79 | 12BF6 | .44 | 35W4 | .42 |
| 6EB5 | .72 | 12BH7 | .77 | 35Z5 | .60 |
| 6EB8 | .94 | 12BK5 | 1.00 | 36AM3 | .36 |
| 6EM5 | .76 | 12BL6 | .56 | 50B5 | .60 |
| 6EM7 | .82 | 12BQ6 | 1.06 | 50C5 | .53 |
| 6EU8 | .79 | 12BY7 | .77 | 50EH5 | .55 |
| 6EW6 | .57 | 12BZ7 | .75 | 50L6 | .61 |
| 6EY6 | .75 | 12C5 | .56 | 5763 | 1.00 |
| 6F5GT | .39 | 12CN5 | .56 | 70L7 | .97 |
| 6F6 | .69 | 12CR6 | .54 | 7025 | .69 |
| 6GK6 | .79 | 12CU5 | .58 | 84/6Z4 | .46 |
| 6GN8 | .94 | 12CU6 | 1.06 | 807 | .70 |
| 6H6 | .58 | 12CX6 | .54 | 117Z3 | .61 |
| 6J5GT | .51 | | | | |



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