JULY

# Radio-Electronics

TELEVISION • SERVICING • HIGH FIDELITY

HUGO GERNSBACK, Editor

## Citizens-Band Transceiver From Your Car Radio

## Build a Sensitive Directional Light Meter

## The New Full-Range Electrostatic Speakers

## Troubleshooting The Sweep Generator


Simplify Color ...

50c

# PROFITS GOING UP IN "SMOKE" OVER TUNER TUBE "BURNOUTS"?

## Sylvania 6BZ7 and 6BQ7A "douse" the major cause of tuner tube failures.

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# Radio-Electronics

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## editorial



## radio



## electronics



## audio-high fidelity



## television



## test instruments



## what's new



## industrial electronics



## the departments



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### —on the cover—

The service technician can signal-inject his way to spot TV troubles with the B & K Analyst. The color pattern on the screen of an RCA color receiver in the background is one of many that the instrument can produce.

**(Story on page 34)**

*Color transparency by Irving Kaufman*

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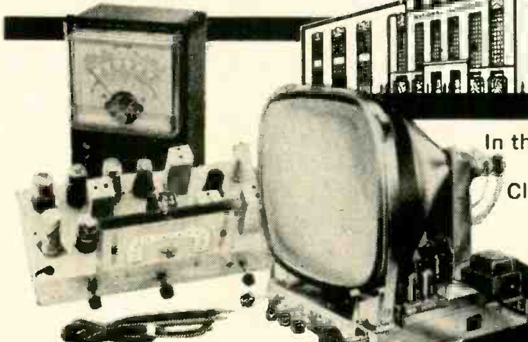


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# News Briefs

## Plenty of FM Multiplexing

Forty-five per cent of all FM stations intend to add stereo service via FM multiplex, according to a recent survey by Motorola. This means that about 370 FM stations will have stereo programs on the air by the end of 1963. Ninety-two expect to be on before the end of this year. With replies in from 204 stations (25% of those polled), the totals show that 27% intend to start stereo broadcasting before the end of the year; 9% during 1962, and 9% in 1963.

## New System May Track Tornados

A new technique originated by the Boulder (Colo.) Laboratories of the Bureau of Standards for investigating static disturbances (sferics) may have value in tracking tornados and hurricanes. The system, called "Ephi," uses three 125-foot towers spaced about 4 miles apart and forming the vertices of an equilateral triangle. These towers pick up signals that originate from lightning discharges and feed them over coaxial cables to a central station. Electronic equipment then determines the relative difference in time of arrival of the sferic signal from each antenna. From this information, the direction of the lightning source is determined automatically, and with greater accuracy than with direction-finding systems used in the past.

Ephi also has potential value as a tracker of severe weather phenomena, since tornados and intense storms are usually accompanied by high-intensity sferics. Two stations located a few hundred miles apart could fix the position of a storm, even though it might be hundreds of miles from either station.

## Electronics May Fight Cancer

Reports at the recent St. Petersburg (Fla.) meeting of the American Cancer Society indicate it may be possible to use radio waves of specific frequencies to halt enzyme reactions that could aid the development of malignant cell growth while not interfering with normal reactions. Research has indicated very strongly that different specific materials may be affected exclusively by given frequencies. For example, the reactivity of samples of gamma globulin was increased by irradiation with radio waves. Results, according to Dr. Heller of the New England Institute of Medical Research, were "provocative," but experiments have not gone far enough to assess the possibilities.

## Communications Channels Shrinking

Decreasing sunspot activity bids fair to crowd present short-wave activities into a little less than half of the present available spectrum within the next year or two. During periods of intense sunspot activity increasingly higher frequencies are usable, and, as the number of sunspots fall off, one after another of the higher bands drops off.

As an example, George Jacobs, head of the frequency division of the Voice of America, speaking to the IRE convention, reported that during sunspot minimum only the 6- and 9-mc bands are usable more than one half the time, while during sunspot maximum the 11-, 15- and 17-mc bands are also usable more than half the time. The coming minimum is expected in 1964, with a maximum again in 1970. Experts believe, however, that the next few sunspot maxima will fall considerably below the 1958–59 sunspot peak.

Satellites, greater development of tower-to-tower microwave systems, and even optical masers have been suggested as possibilities of relieving the congestion when present communications facilities will be squeezed into half the present available spectrum space.

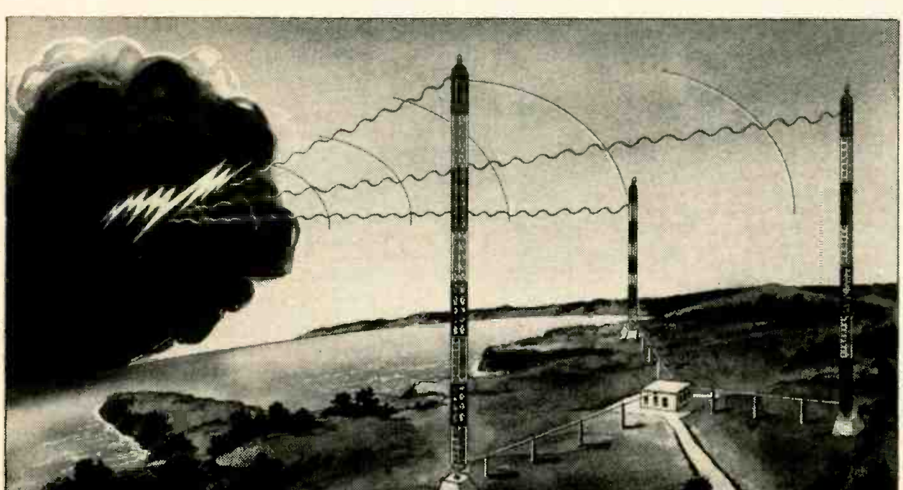
## Radio's Heaters Don't Turn Off

The tube heaters in two new AM–FM receivers, the Westinghouse H-761-N7 and the 762 in the same series, light when the set is plugged in and remain lighted during the life of the set. While presumably the main reason for including this feature was to eliminate drift during warmup periods, it has long been considered a theoretically good idea to keep heaters burning constantly. Tubes are supposed to have a longer life when heating and cooling cycles are eliminated. The surges that occur when current is turned into cold filaments or the high voltages which are sometimes due to rectifier tubes delivering plate voltage before amplifier tubes are warm enough to pass current may also damage other parts of the receiver.

In spite of the theoretical advantages, Westinghouse is the first to put the system into practice, though it is likely to be followed by others, particularly in equipment where reduction of drift is important.

## "Wireless" Stereo Receivers?

General Electric is reported to have demonstrated a "wireless" speaker for an FM stereo system in which the speaker, which would normally be attached to the equipment cabinet by a cable, will have absolutely no physical connection with the rest of the set. Instead, it

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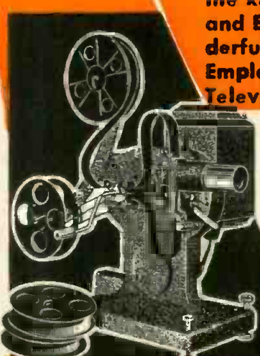

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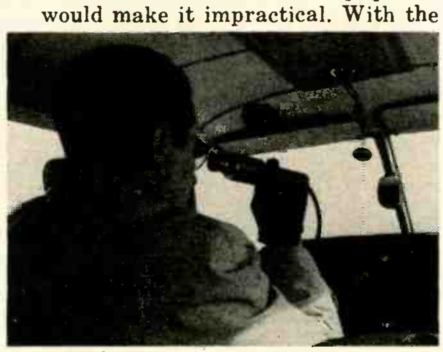
1001 Canadian residents: Write DeVry Tech of Canada, Ltd., 970 Lawrence Avenue West, Toronto 19, Ontario will receive its single-channel signal over a beam of "black light" (presumably infrared). The system could of course play monophonically or stereophonically, and would be as suitable for phonograph reproduction as stereo FM reception. It is by no means certain that the experimental system will reach the market, since economic factors will have to be balanced against the advantages of the "free" speaker.

## Smallest Radar–TV Screen

A new radar and television display device that can be picked up and used like a small telescope has been announced by Westinghouse. It is expected to make possible the installation of radar on small boats and light aircraft where the weight and bulk of conventional equipment would make it impractical. With the



hand-held viewing device, the rest of the equipment can be stowed where there is room for it (or for best weight distribution in aircraft).

Because the display can be viewed by only one person at a time, Westinghouse has dubbed it the Private Eye. The entire assembly is only 8½ inches long and weighs a little more than a pound. The tube itself is 7 inches long and has a 0.6-inch diameter screen, the image on which is viewed through a magnifying eyepiece, giving an image equivalent to that from a 6-inch screen viewed at a distance of 10 inches.

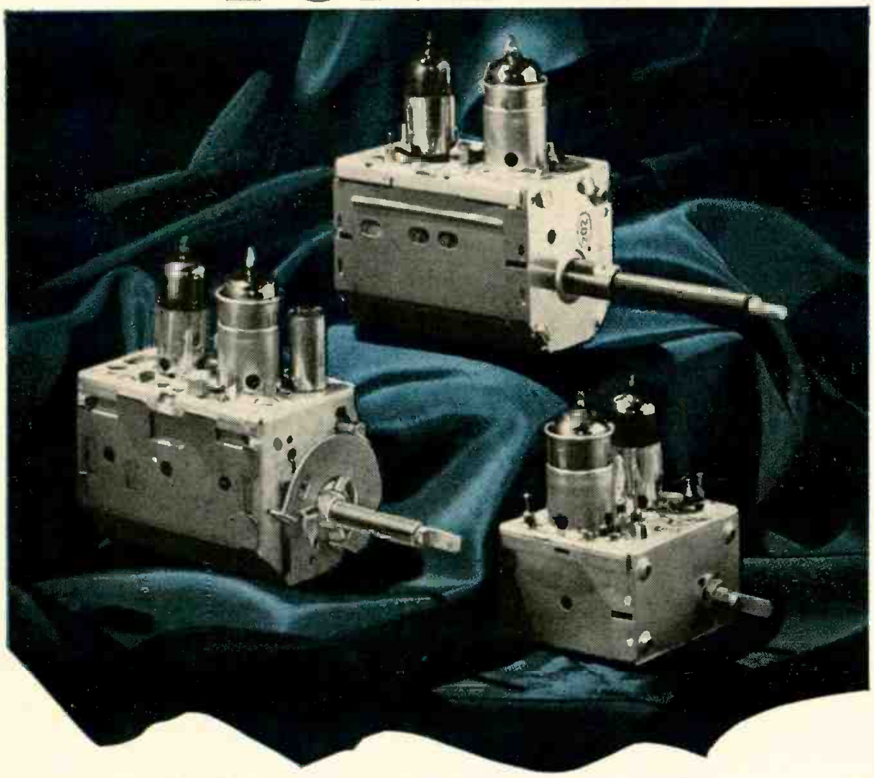
The Private Eye, besides being used for weather radar and other radar purposes on small planes and boats, may also find applications for industrial and laboratory use in the three-dimensional TV field, using one for each eye.

## East–West TV Rapprochement

The sharp competition between West and East to get a man into space first was immediately followed by an incident of cooperation that marked a first in European history. Moscow was linked in with London and other centers on the European network for a live television transmission of Yuri Gagarin's welcome in Moscow.

## New Light on Earth's Field

Data obtained from the satellite Explorer X, which was launched to study the plasma (ionized gas) and magnetic fields in interplanetary space, indicates that the sun's magnetic field may extend well beyond





the earth. A preliminary analysis of these data give strong support to the theory that the magnetic field around the earth is mainly an extension of the sun's magnetic field. According to this theory, the sun's magnetic field is stretched out by the magnetic pressure of charged particles blown out by the sun.

During periods of stable, strong magnetic fields in space, the lines of force were found to extend nearly radially from the sun. This was the crucial piece of evidence supporting the theory that the solar winds stretch the solar magnetic field.

On the basis of normal magnetic behavior, the lines of force could have been expected to loop around the sun in the same manner that iron filings line up around a bar magnet.

During other periods of the flight, the magnetic field was violently disturbed, fluctuating in intensity between 5 and 40 gammas, and reversing direction rapidly.

The satellite also made the first direct measurements of the density and energy of plasma in interplanetary space.

## New Venus Radar Contacts

For the first time, immediately recognizable radar signals have been returned from Venus. The first radar contact with that planet, in 1958, resulted in signals buried so deep in noise that nearly a year of work with computers was required to filter out and detect the tape-recorded signals (RADIO-ELECTRONICS, May 1959, page 47). In this experiment, the echoes were clearly detectable upon their return.

The experiment was made by Caltech's Jet Propulsion Laboratory at Goldstone, Calif. Two 85-foot paraboloidal antennas were used, with a beam only 0.4° wide. Transmitting frequency was 2,388 mc. The signal transmitted from one antenna was picked up by the other after a delay of 6 minutes, and processed through receiving apparatus that included both a ruby maser and parametric amplifier.

## AIEE Honors Dr. Du Mont

Dr. Allen B. Du Mont has been named an honorary member of the American Institute of Electrical Engineers, an honor extended to only 48 persons since the institute was founded in 1884, and the highest

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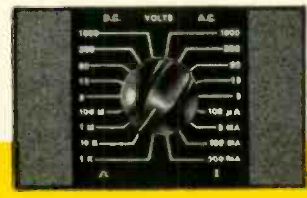

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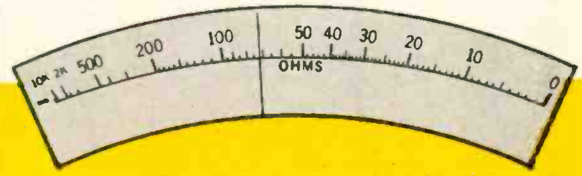


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Dr. Du Mont, born in Brooklyn in 1901, was operating his own wireless transmitter and receiver in 1912. Obtaining his first-class operator's license in 1915, he worked as "Sparks" on ocean vessels during his high school and college vacations. After a period with Westinghouse, he became vice president and chief engineer of the de Forest Radio Co.

In 1931, he struck out on his own to develop cathode-ray tubes for oscilloscopes and TV use. He invented the electron-ray tuning indicator and sold it to RCA, who made it famous as the Magic Eye. The money obtained from that invention was invested in a factory for the production of C-R tubes. Du Mont's inventions also included one for locating objects, in 1933, but his patent application was withdrawn at the request of the Army Signal Corps, for security reasons.

## New Analgesic Device

Apparatus using a diode to produce white noise for audio analgesia in dentistry has been announced by Solitron, a New Jersey company. Audio analgesia has been finding considerable favor among dentists, who find that a mixture of music and random (white) noise tends to render patients less sensitive to pain. The patient wears headphones, and, while the exact action is not clear, it appears that concentration on the sound distracts the brain's attention to pain signals.

Future analgesic applications of white noise may eventually eliminate the use of anasthesia in medicine entirely, believes Benjamin Friedman, president of Solitron.

## Jap Color TV Good, Say Visitors

Japanese color television is "impressive," according to visitors to the International Trade Fair at Tokyo this spring. Twelve television manufacturers showed color TV sets at the fair, though some of them were said not to be ready to mass-produce receivers at once. The visitors, mostly Government or commercial electronics men, classed them from "good" to "excellent."

Visitors also expressed surprise at the advances in the field of thermoelectric devices, but stated that the development of electroluminiscence lags far behind the United States.

## World's Most Precise Dish

A 120-foot parabolic antenna with a surface that is designed to vary not more than 1/13 (.076) inch is being constructed for the Air Force. It will be erected on Haystack Hill at Tyngsboro, Mass., not far from the famed Millstone Hill antenna of the Lincoln Laboratory, which sent and received the first signals reflected from Venus. The new antenna will be used for research into, and de-

(*Continued on page* 16)

# What Does F.C.C. Mean To You?

### What is the F.C.C.?

F. C. C. stands for Federal Communications Commission. This is an agency of the Federal Government, created by Congress to regulate all wire and radio communication and radio and television broadcasting in the United States.

### What is an F.C.C. Operator License?

The F. C. C. requires that only qualified persons be allowed to install, maintain, and operate electronic communications equipment, including radio and television broadcast transmitters. To determine who is qualified to take on such responsibility, the F. C. C. gives technical examinations. Operator licenses are awarded to those who pass these examinations. There are different types and classes of operator licenses, based on the type and difficulty of the examination passed.

### What are the Different Types of Operator Licenses?

The F. C. C. grants three different types (or groups) of operator licenses—commercial radiotelePHONE, commercial radioteleGRAPH, and amateur.

COMMERCIAL RADIOTELE*PHONE* operator licenses are those required of technicians and engineers responsible for the proper operation of electronic equipment involved in the transmission of voice, music, or pictures. For example, a person who installs or maintains two-way mobile radio systems or radio and television broadcast equipment must hold a radiotelePHONE license. (A knowledge of Morse code is NOT required to obtain such a license.)

COMMERCIAL RADIOTELE*GRAPH* operator licenses are those required of the operators and maintenance men working with communications equipment which involves the use of Morse code. For example, a radio operator on board a merchant ship must hold a radioteleGRAPH license. (The ability to send and receive Morse is required to obtain such a license.)

AMATEUR operator licenses are those required of radio "hams"—people who are radio hobbyists and experimenters. (A knowledge of Morse code is necessary to be a "ham".)

### What are the Different Classes of RadiotelePHONE licenses?

Each *type* (or group) of license is divided into different *classes*. There are *three* classes of radiotelephone licenses, as follows:

(1) Third Class Radiotelephone License. No previous license or on-the-job experience is required to qualify for the examination for this license. The examination consists of F.C.C. Elements I and II covering radio laws, F.C.C. regulations, and basic operating practices.

(2) Second Class Radiotelephone License. No on-the-job experience is required for this examination. However, the applicant must have already passed examination Elements I and II. The *second class* radiotelephone examination consists of F. C. C. Element III. It is mostly technical and covers basic radiotelephone theory (including electrical calculations), vacuum tubes, transistors, amplifiers, oscillators, power supplies, amplitude modulation, frequency modulation, measuring instruments, transmitters, receivers, antennas and transmission lines, etc.

(3) First Class Radiotelephone License. No on-the-job experience is required to qualify for this examination. However, the applicant must have already passed examination Elements I, II, and III. (If the applicant wishes, he may take all four elements at the same sitting, but this is not the general practice.) The *first class* radiotelephone examination consists of F. C. C. Element IV. It is mostly technical covering advanced radiotelephone theory and basic television theory. This examination covers generally the same subject matter as the second class examination, but the questions are more difficult and involve more mathematics.

### Which License Qualifies for Which Jobs?

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

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

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

### How Long Does it Take to Prepare for F.C.C. Exams?

The time required to prepare for FCC examinations naturally varies with the individual, depending on his background and aptitude. Grantham training prepares the student to pass FCC exams in a minimum of time.

In the Grantham *correspondence course,* the average beginner should prepare for his *second class* radiotelephone license after from 200 to 250 hours of study. This same student should then prepare for his *first class* license in approximately 75 additional hours of study.

In the Grantham *resident course,* the time normally required to complete the course and get your license is as follows:

In the DAY course (5 days a week) you should get your *second class* license at the end of the first 9 weeks of classes, and your *first class* license at the end of 3 additional weeks of classes. This makes a total of 12 weeks (just a little less than 3 months) required to cover the whole course, from "scratch" through *first class.*

In the EVENING course (3 nights a week) you should get your *second class* license at the end of the 15th week of classes and your *first class* license at the end of 5 additional weeks of classes. This makes a total of less than 5 months required to cover the whole course, from "scratch" through *first class,* in the evening course.

The Grantham course is designed specifically to prepare you to pass FCC examinations. All the instruction is presented with the FCC examinations in mind. In every lesson test and pre-examination you are given constant practice in answering FCC-type questions, presented in the same manner as the questions you will have to answer on your FCC examinations.

### Why Choose Grantham Training?

The Grantham Communications Electronics Course is planned primarily to lead to an F.C.C. license, but it does this by TEACHING electronics. This course can prepare you *quickly* to pass F. C. C. examinations because it presents the necessary principles of electronics in a simple "easy to grasp" manner. Each new idea is tied in with familiar ideas. Each new principle is presented first in simple, everyday language. Then after you understand the "what and why" of a certain principle, you are taught the technical language associated with that principle. You learn more electronics in less time, because we make the subject easy and interesting.

### Is the Grantham Course a "Memory Course"?

No doubt you've heard rumors about "memory courses" or "cram courses" offering "all the exact FCC questions". Ask anyone who has an FCC license if the necessary material can be memorized. Even if you had the exact exam questions and answers, it would be much more difficult to memorize this "meaningless" material than to learn to understand the subject. Choose the school that teaches you to thoroughly understand—choose Grantham School of Electronics.

### Is the Grantham Course Merely a "Coaching Service"?

Some schools and individuals offer a "coaching service" in FCC license preparation. The weakness of the "coaching service" method is that it presumes the student already has a knowledge of technical radio and approaches the subject on a "question and answer" basis. On the other hand, the Grantham course "begins at the beginning" and progresses in logical order from one point to another. Every subject is covered simply and in detail. The emphasis is on making the subject easy to understand. With each lesson, you receive an FCC-type test so you can discover daily just which points you do not understand and clear them up as you go along.

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

| | License | Weeks |
|---|---|---|
| Hugh J. Stock, Box 446, Lander, Wyo. | 1st | 11 |
| Orlie W. McCool, 414 W. South St., Neosho, Mo. | 1st | 12 |
| Eugene R. Kraus, Moore Drive, Peru, N. Y. | 1st | 12 |
| Robert E. Sullivan, 2475 E. Douglas, Des Moines, Iowa | 1st | 12 |
| Jack Hughes, 101 4th Street, Sebring, Fla. | 1st | 22 |
| Dennis K. Bingaman, R.D. #1, Dalmatia, Penna. | 1st | 14 |
| Earl Howard Tolley, RR #3, Eaton, Ohio | 1st | 11 |
| Victor B. Arroyo, 3633 Gangel Ave., Pico Rivera, Calif. | 1st | 20 |
| Henry N. Wright, 160 Cedar Street, Springfield, Mass. | 1st | 12 |

### Resident Classes Offered at Four Locations

To better serve our many students throughout the nation, Grantham School of Electronics maintains four separate schools—located in Hollywood, Seattle, Kansas City, and Washington, D.C.—all offering the same resident courses in F.C.C. license preparation. (Correspondence courses are conducted from Hollywood.)

*For further details concerning F.C.C. licenses and our training, send for our FREE booklet, "Careers in Electronics". Clip the coupon below and mail it to the School nearest you.*

**Get your First Class Commercial F.C.C. License Quickly by training at**

**GRANTHAM SCHOOL OF ELECTRONICS**

| 1505 N. Western Ave. Hollywood 27, Calif. (Phone: HO 7-7727) | 408 Marion Street Seattle 4, Wash. (Phone: MA 2-7227) | 3123 Gillham Road Kansas City 9, Mo. (Phone: JE 1-6320) | 821 - 19th Street, N.W. Washington 6, D.C. (Phone: ST 3-3614) |
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Please send me your free booklet telling how I can get my commercial F.C.C. license quickly. I understand there is no obligation and no salesman will call.

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Address ____________

City ____________ State ____________

**I am interested in:** ☐ Home Study, ☐ Seattle classes ☐ Hollywood classes, ☐ Kansas City classes, ☐ Washington classes

14K

(*Continued from page* 12)

velopment of, transmitting and receiving equipment for satellite relay communications. It will also be used to study atmospheric irregularities that may limit possible beam sharpness or have other effects on satellite communications.

To maintain surface regularity, it will be built up of 96 panels mounted in 5 concentric rings interconnected by tension rods. Tightening these rods with turnbuckles brings the antenna surface to perfect shape. The correct tension will be measured by listening to the pitch to which the rod is tuned, thus creating a new field of activity for piano tuners.

The antenna will be 150 feet across and will be enclosed completely in a weatherproof radome.

### Calendar of Events

**IRE National Conference on Broadcast & Television Receivers**, June 19–20, O'Hare's Inn, Des Plaines, Ill.

**IRE National Convention on Military Electronics**, June 26-28, Shoreham Hotel, Washington, D. C.

**ISA-IRE-AIEE Joint Automatic Control Conference**, June 28-30, University of Colorado, Boulder, Colo.

**British IRE Convention**, July 5-9, Christ Church, University of Oxford, England.

**International Conference on Medical Electronics**, July 16-21, Waldorf-Astoria, New York.

**NATESA Convention**, Aug. 11–13, Pick-Congress Hotel, Chicago.

**Western Electric Show and Convention**, (WESCON) Aug. 22–25, Cow Palace, San Francisco, Calif.

**Television and Phonographic Industries German Radio Exhibition**, Aug. 25–Sept. 3, Berlin, Germany.

## "Missile" Seismograph Tested

A seismograph shaped like a missile and dropped to the floor of the ocean has been tested by Columbia University research scientists. It is expected to pick up many disturbances that could not be detected by land-based instruments, since the sea bottom is comparatively noise-free.

The instrument is about 14 feet long, 3½ inches in diameter at the nose and about 18 inches at the tail. It contains transducers that convert the vibrations of the earth into electric signals, amplify them, convert them into sound and transmit them acoustically to the surface, where they can be recorded on tape.

According to Dr. Maurice Ewing of Columbia, the device might pick up "tiny quakes" such as the disturbances caused by small underground nuclear disturbances. It may also solve the problem posed by quakes originating at sea, recorded by island stations and failing to register on mainland seismographs, which has led scientists to wonder whether there is a "barrier" between sea and land areas. END

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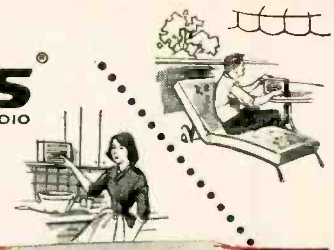

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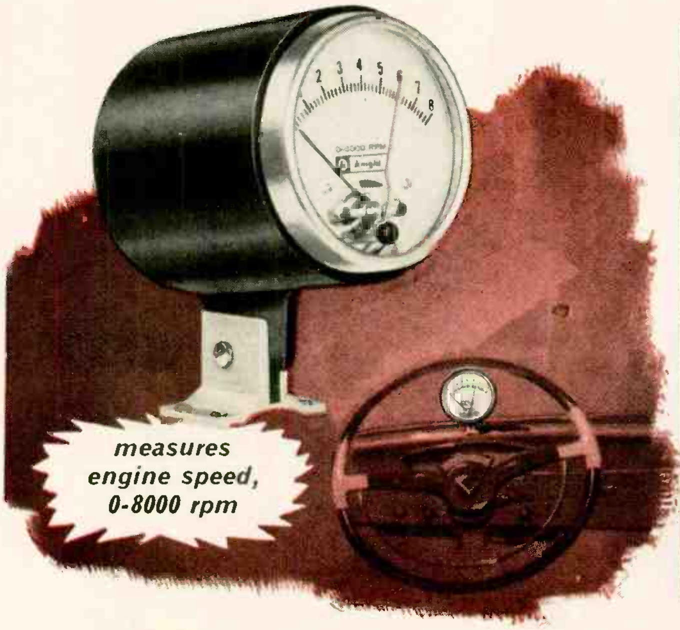



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**83 Y 944.** For negative ground systems (American cars).
**83 Y 980.** For positive ground systems (Foreign cars).
*No Money Down.* INTRODUCTORY PRICE EITHER TYPE... **$19.95**

### Deluxe Wireless Intercom System Kit at Lowest Cost

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PAIR **$37.90** No Money Down

This easy-to-assemble intercom operates without installation or wiring—just plug into any AC or DC wall outlet for step-saving communication! Change locations easily—anywhere. Ideal for home, office or store. In the home, you can communicate with nursery, garage, basement or patio. In office or shop, provides time-saving communication. Will operate between adjacent buildings that are on same electric-company line transformer. Perfect for baby sitting. Features power-line noise silencing circuit for absolutely quiet "standby"; premium quality throughout. Has Talk-Listen switch, with lock-on feature for constant listening. Handsome cream-toned plastic cabinet, 9 x 5½ x 5½". Can be used in systems consisting of 2 or more units, as desired. Shpg. wt., 3½ lbs.

**20 YX 272-2.** Complete 2-Station System. NET........ **$37.90**
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☐ 83 Y 980 Tachometer Kit. ☐ 83 Y 941 Intercom Station
$.................enclosed

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Address______________________________
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# ALLIED RADIO

# Correspondence

## ABOUT TAPE RECORDERS

*Dear Editor:*

I would like to comment on Jack Darr's article, "Servicing Tape Recorders," in the May issue.

1. The article states: "*The narrower the gap (of the recording head) the higher the efficiency of the head, especially at high frequencies.*" This is not so. A recording head's efficiency goes down as the gap narrows because the gap then tends to act as a short circuit for the magnetic flux. The optimum gap for recording is about .0005 inch, several times larger than playback gaps.

2. The article states: "*. . . some hi-fi playback machines have gaps of only .00025 inch!*" The fact is that *good* hi-fi machines have gaps ranging from .00015 inch down to .00009 inch.

3. The article states: "*Mikes used with these (tape recorders) are usually small crystal types with an output of about —55 db. This is a bit higher than the output of broadcast and high-grade PA mikes which run about —70 db.*" The difference between —55 and —70 db is more than a little. The —70-db mike may well be impossible to use with most tape recorders for their gain will be inadequate and the signal-to-noise ratio will therefore be poor. However, there are several broadcast quality mikes that do have a —55 db output.

4. The article states that the bias frequency usually runs between 30 and 50 kc. This may be true taking all home tape machines into account. But hi-fi machines usually have bias frequencies between 50 and 100 kc to avoid the possibility of audio beats between the bias frequency and the upper audio frequencies.

5. The article states: "*Changes in operating frequency (of the bias oscillator), unless very drastic, should have little effect on recorder operation.*" This is true as far as the erase head goes. But when we get to the record head, a moderate change in frequency can produce a slight change in bias, which in turn can have a significant effect on treble response and distortion.

6. The caption under Fig. 7 reads: "*Components in the 6AQ5 output circuit form an integrating network which changes the sine-wave signal into a series of pulses or spikes.*" This is puzzling. I have never come across such a waveform for the signal fed to a record head, for the current through the head or for the voltage across the head.

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• • • • • •

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*E. H. Rietzke, President*
*Capitol Radio Engineering Institute*

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After reading the article, I placed a 100-ohm resistor in series with the ground lead of the record head and connected an oscilloscope across it. The oscillator tube was pulled. A variety of audio signals were fed into the recorder, but the scope always showed a sine wave. Then I checked the voltage waveform across the record head and found essentially the same thing.
HERMAN BURSTEIN
*Wantagh, N. Y.*

[A copy of Mr. Burstein's letter has been sent to Jack Darr, who will comment on it in the next issue. Meanwhile it might be well to point out that the article was aimed at the service technician handling run-of-the-mill tape recorders and players, and to whom the type used by the audiophile would be a rarity. As Jack says, " . . . this article will deal only with home tape recorders, since they are what the average technician sees most."—*Editor*]

## PACO REPLIES

*Dear Editor:*

We read with interest Mr. Dorf's letter in your June issue discussing the advertising campaign for our Paco kits currently appearing in the electronic hobbyist publications. His position, which is somewhat like Mr. Nixon's "Don't knock America down in order to build her up" campaign advice to Mr. Kennedy, is a provocative one. But, in our opinion, it just isn't valid. Before developing this advertising program, we and our advertising agency Smith/Greenland Co. Inc. did a lot of research. We asked scores of kit builders about their problems in assembling electronic kits. In all too many instances, we found the problems of complex, hard-to-maneuver instruction manuals, missing or hard-to-identify parts, etc. were discouraging the do-it-yourselfer from further efforts in kit building. (In one case, the disappointed individual threw a one-third-finished and hopelessly balled-up amplifier into his garbage pail.)

We have spent years of research in the development of our Paco kits. Our instruction manuals, our labeling and identification of small parts, our checks and rechecks of all components are matters of great pride to us.

We are flattered by the interest shown by our esteemed competitor and by thousands of hobbyists in the Paco advertising campaign. We will be even more pleased when all kits are as easy, fast and fun to build as ours are. Because when that point *is* reached, the building of electronic kits will be double—perhaps ten times what it is today. We, at Pacotronics Inc., are just as interested in the growth of the kit market as is Mr. Dorf. We think that by developing and advertising a kit line which lives up to the fondest hopes of the aspiring kit builder, we are doing our part.
SOL SPARER
*Pacotronics Inc.*

## 90-DAY PARTS AND LABOR

*Dear Editor:*

I would like to comment on "90-Day Parts and Labor—Good or Bad" (page 103, April issue). I am working with same thing from the industrial electronics end. I say this warranty period by the factory is OK ***as long as the technician is getting his normal rates for his services.*** After all, what does it matter who pays you?

The real gripe comes when a technician commits himself to some warranty situation at a reduced fee. For this he has no one but himself to blame. After all, he is just as important to the factory as the factory is to him. The song and dance from the factory is the prestige of the factory name and the free mention of the technician as their authorized service station. Not one word is said about the terrific value and prestige a good technician adds to *their* product.
THOMAS L. BARTHOLOMEW
*Washington, D.C.*

[Anyone have a different viewpoint? Let us know about it.—*Editor*]

## I'D BUY A KIT

*Dear Editor:*

I read with interest "Quality Stereo Amplifier" in the May issue. Then I sat down and figured out how much such a unit would cost. It comes to about $80.

As I am interested in getting the very best for as little as possible, I seriously question the usefulness of ordering


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parts and assembling units from scratch when one can buy a similar unit in kit form for about $50. Note too that the chances of getting a successful amplifier from a kit are much greater.

From a practical view, such articles and your going to the trouble of building and bench-testing are quite useless, except as purely and strictly reading material.

LOUIS W. HENRY
*Fort Myers, Fla.*

[It is definitely true that you can often buy an amplifier kit for less than what it would cost you to go out and buy all the parts yourself, and that such kits have additional advantages in construction and finish. But it is also true that there are many designs and circuit features that are rare in commercial equipment. For example, an article on an audio amplifier that uses fixed bias in all the stages will appear in RADIO-ELECTRONICS. The experimenter who would like to build a circuit of this type and try it for himself cannot buy a kit that has this feature.

Another factor, which you may have overlooked, is that many electronic builders have a junkbox to go to. They find that many components needed to build a particular amplifier are already on hand. So that $80 cost may drop to an actual cash outlay of $40 or even $30.

Then, too, we do not wish to forget the man who wants to do it himself, who doesn't get any satisfaction out of building a kit and following instructions, who wants to try new things, to modify and adapt. We have such among our readers, as our correspondence shows, and it is to them that this type of article is dedicated.—*Editor*]

## HOT INSULATION

*Dear Editor:*

I thoroughly enjoyed the hint by Mr. H. Linton in the April issue on stripping twin-lead by burning it with a match. For the less experienced craftsman, as I was several years ago, this sounds swell. But if Mr. Linton ever drops a big gob of melted insulation on his thumb, as I did, he'd soon be looking for another method.

This hot insulation stays hot, will not shake off and, if you try to wipe it off, simply covers a larger area on what is becoming a very, very sore thumb. Also, in the customer's home, when repairing the broken ends of the lead-in at the set, a drop of molten goo on a hardwood floor or a rug is good insurance against ever being called for another repair job.

RICHARD D. COLE
*Brandon, Man., Canada*

[The type of difficulty you have just described is in the same order as using a soldering iron in the customer's home. Here you have to be careful not to drop molten solder on floor or furniture. The basic precaution of a large, heavy drop-cloth covering the work area will prevent either molten solder or twin-lead insulation from doing any damage. The skilled craftsman is a careful craftsman—you don't avoid using a power saw because you may get cut.—*Editor*] END

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- Tuneable Receiver Over Full 23 Channels • High Output Crystal Microphone • Complete with Transmitting Crystal for Channel 9

A compact, precision transmitter and receiver covering up to a 20 mile or more radius, depending upon conditions. The HE-15A features an effective full-wave variable noise limiter, RF jack on front panel, planetary vernier tuning, 5-prong microphone jack for easy relay addition, and 12 tube performance from 4 dual-function tubes, 2 single-function tubes, 2 rectifiers.

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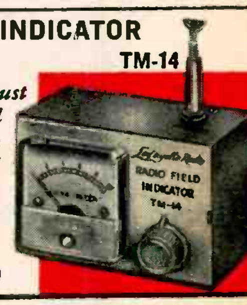


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# RADIO POWER

*... A New Electronic Era is in the Making ...*

IT was in 1899 that Nikola Tesla succeeded in transmitting power without wires. He probably was the first to light electric lamps at a distance of more than 15 miles from the transmitter, as he did in his historic Colorado experiments. Transmission at that time was by means of his high-frequency Tesla currents running into millions of volts. While his wireless power transmission was never practically successful, due to its excessive cost, it was nevertheless epoch-making, as were many of his other outstanding inventions.

We should not be too surprised at the phenomenon of transmitting power through space without conductors. After all, it has been going on for billions of years. The Sun, 92,000,000 miles distant, has supplied this planet with inconceivable amounts of radiant energy for eons.

Because radio waves are in the same electromagnetic spectrum as sunlight, there is, therefore, no reason why we should not be able to radiate power via radio. What form this power should take eventually does not seem to matter greatly at present: Whether the power is primarily radiant heat, as in sunlight, or high-frequency electric energy to be transformed into electricity or subsequent heat, is of little importance now. The point is that it IS possible to transmit radio power. What is difficult to believe is that it is not in actual practical use at this moment.

For a partial answer we must look to the transmitter needed, which, until very recently, was only a theoretical possibility. When we compare the usual radio or TV transmitter with an electric power plant, the output of the former is puny compared with the latter. The output of the most powerful radio or TV station is microscopic at a distance of 1 mile. Only because our receivers can amplify thousands of millions of times the comparatively weak signals that reach them can we receive such signals.

During the international IRE convention last March, W. C. Brown of Raytheon disclosed its new amplitron tube, less than 6 inches in diameter, that produces over 1,000 kilowatts of radio-frequency power at microwave frequencies. This is one of the first tubes designed and built to radiate radio power. It is a history-making beginning.

Certainly much work remains to be done before radio power will become an established industry. But it will come, we are positive, during the next few decades.

There certainly is no reason why radio power stations of from 100,000 kw to 500,000 kw and more should not be built in the foreseeable future, once all the engineering problems have been solved. And while it is true that radio power—like all electromagnetic radiation—decreases as the square of the distance, radio power at first probably will not be sent over great distances.

The coming new radio power will have its most important uses wherever it is impossible or impractical to use conductors or string wires. Automobiles, particularly in cities, in the future no longer will spew their poisonous fumes—they will be electrically powered from overhead street-corner *radiotors* (short for radio-radiators). Radio power will come into its own somewhat later when new techniques will have been evolved to make it far more economical than its present contemplated uses. We refer to *coherent quasi-optical beams,* wherein very little energy is wasted. Even by using parabolic reflectors, as we do now with microwaves, far too much energy is lost. By using "tight" non-spreading beams (as we do with the ruby maser today), we can transmit radio power over respectable distances.

It may sound fanciful now that future spaceships traveling between the earth and the moon will be energized from distant radio power transmitters, yet 50 years hence it probably will be accomplished.

Long before that the space-weather-astronomical stations, 22,000 miles up, which will orbit "stationary" above the earth, would be supplied with radio power for heat and energy, necessary to their personnel and maintenance.

When one brings up the subject of radio power and beaming large amounts of energy into space, the inevitable "death ray" of science fiction necessarily comes to mind.*

While under *certain conditions* strong radio power beamed on a subject might prove lethal, it is known that with specific precautions, radio energy will not be more dangerous than present-day electric power transmission lines or ordinary house current. After all, our modern civilization offers no more dangers than prehistoric man faced in his "civilization". Progress may bring *new forms* of dangers, but modern man takes them in his stride. Progress brings untold advantages, too, and radio power will bring many. —*H.G.*

*See *Lethal Radio Waves*, RADIO-ELECTRONICS, August 1959.

# CLEAR ROAD FOR FM STEREO

*How the Zenith/G-E multiplex system works and why it was approved over its competitors.*

**By NORMAN H. CROWHURST**

WE HAVE BEEN WAITING FOR WHAT TO some people has seemed an inordinate length of time, for a decision from the FCC that will enable stereo broadcasting to move ahead. Now the green flag has come and a lot more people want to know what it means.

People are still asking how one stylus can get two-channel stereo out of a single record groove; they are going to be equally puzzled about the transmission of two-channel stereo over a single FM radio channel. The two techniques are parallel to a certain extent. Both start with one microphone picking up the sound for the left channel; another for the right. Then, for the benefit of people with "regular" monophonic FM receivers, the right and left channels are blended into a single program and transmitted. The program is sent out from the FM transmitter with a reduction of about 1 db in amplitude from normal monophonic transmissions, to make room for the stereo information which, we shall see, is also being transmitted.

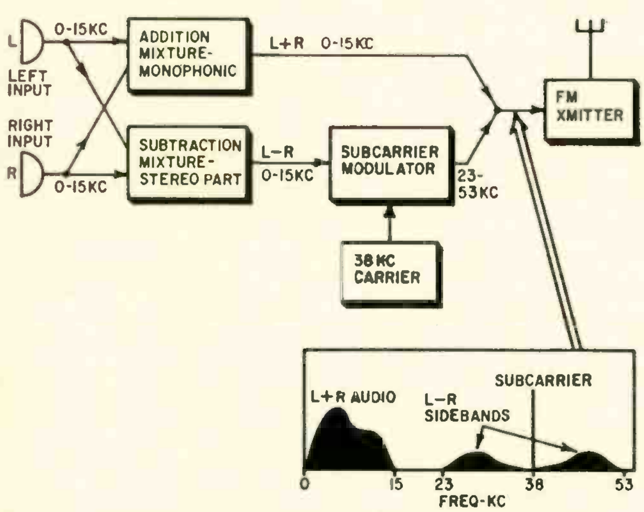



**Fig. 1—This block diagram shows how equipment might be hooked up to produce a stereo FM signal. The pattern at bottom shows how the two program components (L + R and L — R) modulate the FM transmitter.**

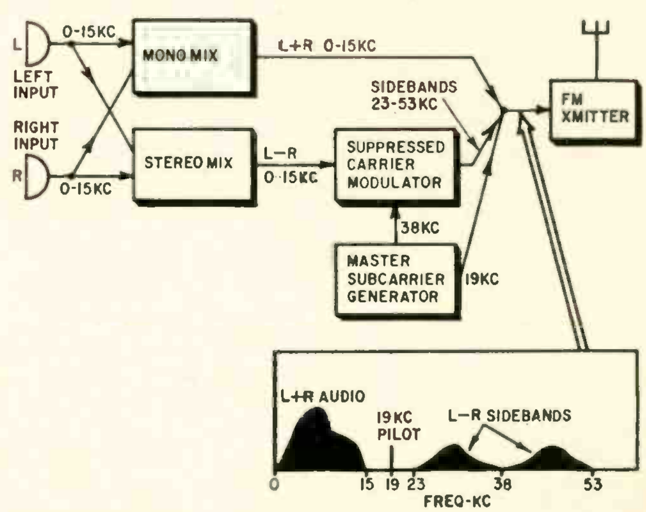



**Fig. 2—Removing the subcarrier improves transmission quality; 19-kc pilot helps receiving equipment reinsert the subcarrier.**

To supply a stereo program to those listeners who have—or soon will have—a stereophonic receiver or adapter, the output from the same two microphones is picked up and combined in a different way. Instead of containing the monophonic program—the *sum* of left and right—this combination contains the details in which left *differs* from right. Instead of being called the sum, it can be—and is—called the *difference* program. The sum can then be referred to as L plus R and the difference, L minus R.

Full fidelity for FM transmission consists of frequencies up to 15 kc. The stereo mixture is handled with the same full fidelity as the mono channel. It is used to modulate a *subcarrier* of 38 kc. *Amplitude* modulation of this subcarrier by frequencies up to 15 kc produces "sidebands" between 23 kc and 53 kc (Fig. 1).

Amplitude modulation concentrates most of the energy in the carrier. To enable this channel to be transmitted at higher level, improving its signal-to-noise ratio, the carrier is removed, leaving only the sidebands. To demodulate this channel at the receiver, the carrier has to be put back first.

To make this possible, a frequency exactly half the carrier frequency—19 kc—is transmitted. This comes between the highest main monophonic channel frequency (15 kc) and the lowest subchannel sideband frequency (23 kc), making it easy to separate from everything else without any mistake (Fig. 2).

The receiver has two filters: a band filter to separate the sidebands of the subcarrier from the main carrier modulation; a single-frequency filter to separate the 19-kc pilot subcarrier. A frequency doubler reproduces the subcarrier, which is added to the sidebands, so the stereo channel can be demodulated (Fig. 3).

Now we have two signals, the monophonic, or sum (L + R), and the difference (L − R). As readers who have followed the discussions on multiplex will remember, it is necessary to mix these, one in phase and one out of phase, to produce right and left channels. To the newcomer, it must be explained that mixing the signals in phase is equivalent to adding (L + R) to (L − R), which comes out 2L. (It works out electrically as well as mathematically, as a little consideration of aiding and opposing currents will show.) For the right channel, we *subtract* the two channels (add them out of phase). (L + R) − (L − R) is equivalent to (L + R) + (−L + R), or 2R.

The matrix circuit that reproduces these left and right channels from mono (or sum) and stereo (or difference) signals, and the usual de-emphasis to restore the balance compensating for transmission pre-emphasis, complete the necessary conversion. A simple adapter containing these parts, which G-E claims can easily be built into a one-tube circuit, comes between the normal FM (single-channel) receiver and the inputs to a normal stereo left-and-right two-channel system (Fig. 4). Other manufacturers believe that a more complex adapter may be needed for satisfactory operation under all conditions, and adapters with as many as six tubes are in the works.

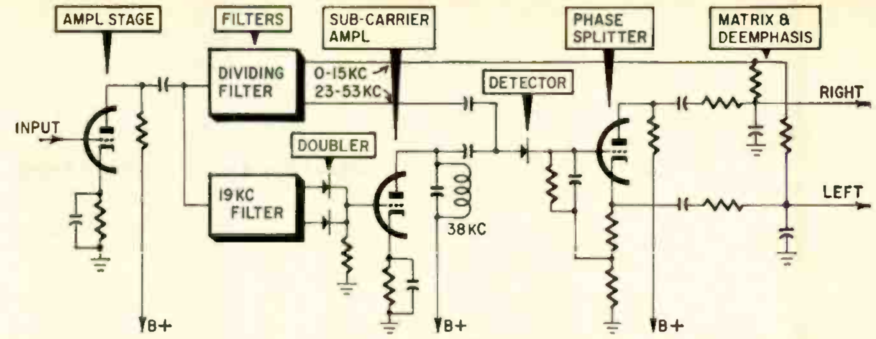



**Fig. 3—Essential parts in a simple adapter for the new system. (This diagram is the author's interpretation only and does not represent a design or working schematic.)**

## Reasons for the choice

In earlier articles we discussed the contenders who proposed various systems.* The final contenders were slightly different from the ones we discussed then. The systems between which the FCC decided were:

1. Crosby
2. Calbest
3. Multiplex Development
4. EMI (Percival)
5. G-E/Zenith

The Crosby and Calbest systems were the same as we previously described; the Multiplex Development system we previously called the Burden system; the EMI (Electric & Musical Industries) Percival system we briefly mentioned—it used a code signal to "direct" the distribution of monophonic program between the stereo channels at the receiver; the G-E/Zenith system is the final choice we have described.

Systems 2 to 4 were eliminated in earlier "heats" for various reasons. The Calbest and Burden systems were rejected for essentially the reasons we criticized: they involve a basic limitation in stereo separation at the transmitter; the Calbest on the basis of frequency, the Burden over the entire range, by cross-mixing.

The EMI system was found quite successful in many respects. It did not degrade either quality or dynamic range for either monophonic or stereo reception. If the code signal were made part of original recordings—if discs were made by Percival instead of 45/45—the system might well have been chosen as best. But the recording industry is already committed to 45/45 and that's the kind of program that has to be transmitted, most of the time. Existing stereo records need automatic means to provide coded monophonic program. The FCC found EMI's system for doing this failed to maintain stereo separation on some passages; notably, sustained tones became essentially monophonic.

That left the systems numbered 1 and 5. The Crosby system uses a frequency-modulated subcarrier with a proposed frequency of 50 kc and a deviation of 25 kc. The G-E/Zenith system uses an amplitude-modulated subcarrier with a proposed frequency of 38 kc; the carrier is suppressed and a 19-kc half-frequency pilot carrier is transmitted instead.

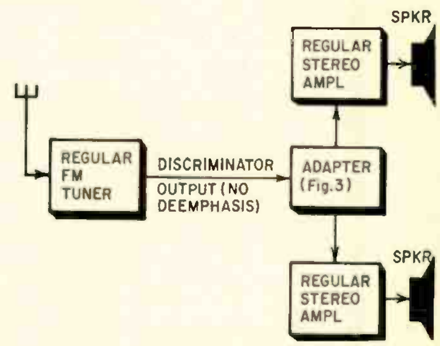



**Fig. 4—Stereo adapter connects between any (good) single-channel FM tuner and the inputs to a stereo audio amplifier system.**

At first hearing, this sounds complicated. But it permits maximum use of the amplitude modulation for stereo without detracting from the main monophonic modulation appreciably. Removing the subcarrier enables the sidebands to be transmitted at much higher level, giving the stereo (difference) signal a

*Radio-Electronics, March and July, 1959.

## How signal-to-noise ratio of stereo systems compares with standard FM transmission and reception

| TYPE OF SIGNAL | SYSTEM 1 CROSBY | SYSTEM 5 GE/ZENITH |
|---|---|---|
| Stereo received monophonically | − 6 db* | less than 1 db* |
| Subcarrier output only | −13 | −23 |
| Left-channel output from adapter | −13 | −20 |
| Right-channel output from adapter | −15 | −20 |

*Compared to 0 db for standard FM transmission and reception better signal-to-noise ratio.

Even at this, the G-E/Zenith system does not achieve the signal-to-noise ratio on subcarrier that the Crosby system can. The table on page 27 gives the relative degradation in signal-to-noise ratio for various signal components of the two systems (theoretical) compared with full-deviation monophonic transmission.

There are three main reasons for the FCC decision in favor of the G-E/Zenith system, the most important of which derives from the information shown in the table. An important practical question is, "How will conversion of stations for stereo affect their service area?" When they don't transmit stereo, it will not be affected with either system, of course, but what happens during a stereo transmission?

The Crosby system considerably reduces service radius, whether the program is heard in mono or stereo, but more on stereo than on mono. The G-E/Zenith system only slightly reduces the service radius for monophonic reception of stereo, although the reduction is somewhat greater for stereo reception than in the Crosby system. The range for stereophonic reception would be only two-thirds as great as for monophonic reception of the same program.

The fact that the Crosby system would deprive a larger area of *any* service during a stereo transmission means either that the effective audience is reduced during a stereo transmission, or power must be boosted.

This may be out of the question for many stations, already operating at maximum power. But even if possible, it is undesirable, because of the greater possibility of interference with either geographically separated channels on the same frequency or adjacent frequency allocations in the same area.

The G-E/Zenith system can serve substantially all the area with at least a monophonic signal during stereo transmissions, while a smaller area can receive the superior stereo with the necessary adapters.

Theoretically, both systems are capable of full-frequency-range separation between left and right, and of minimum distortion on both mono (sum) and stereo (difference) channels. But adapters for the Crosby system have proved critical in achieving minimum distortion.

Because it uses FM subcarrier modulation, with a wide deviation, the Crosby system adapter has to eliminate any amplitude modulation at the subcarrier detector. This is not easy to do. First a bandpass filter must pass frequencies from 25 to 75 kc, while stopping frequencies below 25 kc. And then frequencies from 25 to 75 kc must be limited and FM detected without any amplitude fluctuation.

The FCC felt the G-E/Zenith system offers the best prospect for producing receivers that will consistently demodulate the subcarrier without introducing distortion. Also, in their opinion, low-cost receivers of reasonable performance are a better prospect with this system.

### Subsidiary services

The other reasons that favor the G-E/Zenith system over Crosby concern the use of an additional subcarrier for other services (private) such as background music. Although Crosby has maintained that his system does not exclude a background-music channel, it does appear that the full advantage for stereo transmission and stereo reception (which is where his system admittedly offers best potential) will disappear if another subcarrier is squeezed in.

While a second subcarrier will degrade both systems, the G-E/Zenith system suffers less than the Crosby system. Of 250 stations now authorized to use multiplex for background music or other private purposes, 81 are in locations where there is no other FM service. This would force an unfortunate choice if no second subcarrier were permitted. The station must decide whether its listeners may have stereo, at the cost of canceling an existing contract for private use. The G-E/Zenith system makes it far more feasible for stations to do both if they have to.

Further, if the Crosby system were used, a relatively minor modification to any stereo receiver would enable it to receive the *private* multiplex transmissions, because they also use a frequency-modulated subcarrier (of different frequency). The G-E/Zenith system, by using an amplitude-modulated subcarrier, avoids this possibility. Additionally, the use of a different kind of modulation makes it much easier to separate the stereo subcarrier from a private subcarrier.

One more question is going to be asked: How about people who already have Crosby type adapters, a few of which have been made by some manufacturers? This question concerned the FCC somewhat in making their decision. Their conclusion was a sensible one. Tests on a number of these adapters found that none of them consistently met high-fidelity standards. It would be just as foolish to decide on a system merely because a relatively small number of people have equipment for it (especially if that decision would predudice the quality of reception for everyone else) as it would be to choose a system for its so-called compatibility with AM–FM experimental transmissions.

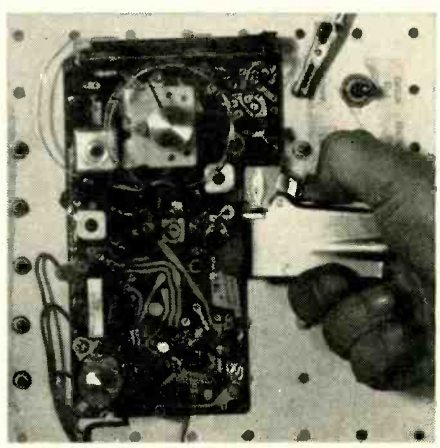
Such AM–FM transmissions will continue for a while, until the majority of people have the new adapters. But the AM–FM variety of stereo can never hope to produce good quality as the new multiplex. So it would be foolish to limit the whole future of stereo, merely because some people already have some enjoyment from this system, while waiting for something better. Now we've got the something better—let's have it. That's the substance of the FCC decision. We agree. END

**The new Fisher multiplex adapter.**

## EXPLODING A MYTH

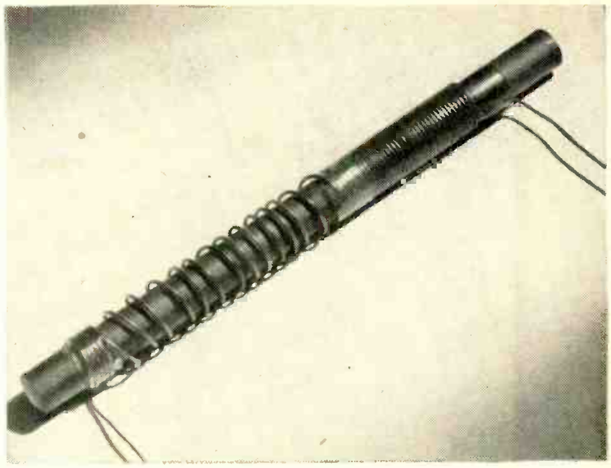
The oft-repeated warning that transistors are so susceptible to heat damage that they require special soldering techniques is effectively challenged in the demonstration illustrated here. At dozens of service meetings all over the country, Carl Finzer, of Motorola Inc., demonstrates the ability of present-day transistors to recover fully from damage inflicted by excessive heat.

During each demonstration, he deliberately causes transistor breakdown by subjecting the unit to the open flame of a cigarette lighter. After a few moments of this abusive treatment, the transistor registers its objection with an apparent collector-to-emitter "short" indicated by a rise in voltage shown by a vtvm connected across the emitter resistor in a normally operating R-C-coupled amplifier stage. In each case, however, the short circuit clears up completely and permanently after the transistor has been allowed to cool. "Although we have made this same test hundreds of times," Finzer says, "we have yet to cause permanent damage to a single transistor."



According to Finzer, many technicians are overly conscious of the widely publicized cautions regarding the overheating of transistors. As a result of trying to solder transistor leads too rapidly, poor connections and cold-solder joints often cause intermittent operation, resulting in callbacks, lost service time and dissatisfied customers.

**By GEORGE E. LYTLE**



# Wind your own ferrite-core antenna

*Economical and highly efficient, custom-wound ferrite-core antenna can improve an aging AM receiver. Installed and properly adjusted, the increased Q often triples the receiver's front-end sensitivity, and the stations roll in with surprising clarity and volume.*

AS EXPECTED, FERRITE-CORE ANTENNA construction, installation and final adjustment follows a rather basic general plan. However, each receiver presents an individual set of problems —internal electrical characteristics, mounting space, lead length, etc. A nominal amount of experimenting is a natural part of the job.

The coil-winding procedure in this text supplies the basic information required for most ferrite antennas. You may want to use a slightly different wire size. If not too far from the original size, try winding a coil on the ferrite rod and see what happens. Slight changes are permissible in wire size, turns and spacing, individual ferrite rods, and the number of turns necessary in a specific case to give a certain inductance. Don't be afraid to experiment; one of the changes may improve your antenna. Check your results by observing receiver sensitivity and the ability of the coil to tune properly at the desired frequency.

## Winding the antenna

Fig. 1 and the photograph show exactly how the finished coil looks. Winding the coil is actually a minor project and takes less than one half hour. Approximately 10 feet of plastic-covered No. 22 solid hookup wire is used to wind the coil. Leave a 1-foot lead (A) for grid connection, start the coil 2 inches from the end of the core and close-wind 40 turns. Then tape in place securely. Next wind 15 double-spaced turns and close-wind 5 more turns. Tape here temporarily, for the last 20 turns will be moved for adjustment. Leave a 1-foot lead at B and cut off any excess. Cement the 40 close-wound turns with coil dope, as their position will not be changed. The antenna is now completely wound and ready to be connected to a receiver.

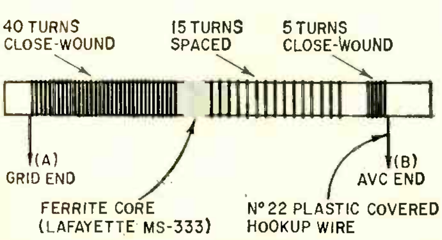



**Fig. 1—Details of the finished ferrite antenna.**

## Antenna adjustments

The vtvm or the human ear can be a versatile and sensitive output indicator for adjusting a ferrite antenna. Fig. 1 shows the antenna, coil spacing and number of turns. The coil's grid lead is A, and the avc lead is B. It is usually more convenient to adjust the coil before mounting the unit. Remove the loop antenna, and connect ferrite antenna leads A and B to the proper place on the receiver (Fig. 2). Connect a vtvm to the receiver's avc line for avc voltage output indications. Turn on the radio and tune in a local station in the vicinity of 1400 kc. Adjust the antenna trimmer on the tuning gang for maximum avc voltage.

Next, tune the receiver to a station around 600 kc. Remove a couple of turns from the B end of the coil. If voltage output increases, remove turns for maximum voltage output. If voltage output decreases, add turns until voltage output is maximum. Tape the five close-wound turns at B so they can be moved back and forth as a group. Tune the receiver to a station close to 600 kc. Move the B end of coil to a position for maximum voltage output. The antenna has highly directional properties, so observe receiver sensitivity.

While making adjustments, avoid touching the grid end of the coil. Ferrite material responds to the influence of body capacitance as if ferrite had been added or taken away from the inductance. If the ear is used as the output indicator, use the same procedure. A back-and-forth procedure on all adjustments, until no additional output indication can be obtained, is usually required. The antenna is now properly adjusted and ready to be installed.

## Mounting techniques

Magnetic fields, metal and limited space are the worst offenders in mounting the antenna. They rarely offer a serious problem. Try to mount the antenna at least 2 or 3 inches away from magnetic fields of power transformers, chokes or speakers. If the chassis is jam-packed into the cabinet and the antenna just won't fit, mount it on the back, outside the case. It is rugged and not easily damaged.

After the antenna is properly mounted and the receiver is returned to its cabinet, turn the set on and tune to a station around 1400 kc. Adjust the antenna trimmer for loudest (noise) output. Tune to 600 kc and slide the 5 turns to find the position that will give the loudest (noise) output. Usually a little more gain is obtained by this method. The ferrite antenna is now completely tuned and adjusted, and ready to use. END

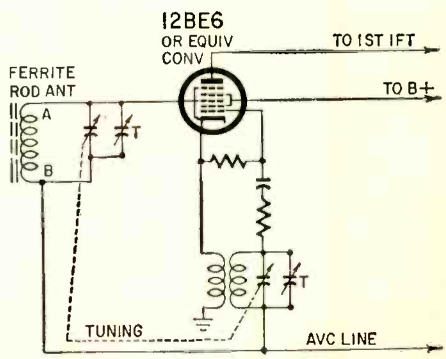



**Fig. 2—How to hook up the ferrite antenna.**

# FULL-RANGE electrostatics ARE HERE

## How the new speakers work and the advantages they offer

By IRVING M. FRIED

WHY HAS THERE BEEN A SWITCH TOWARD ELECTROSTATIC SPEAKER SYSTEMS by design engineers? The answer is plain: by switching to electrostatic speakers and free standing principles, the engineer gains exciting new design tools which permit him to develop better speakers for any environment or listening requirement. He is, in effect, immediately freed from the limitations of dynamic speaker development:

- Mass, which introduces resonances and unpredictable operation.
- The piston problem—how to compromise between rigidity and distortion.
- The baffle.
- Homogeneity—making a speaker seem uniform, continuous.
- Variability of performance—from materials, aging, temperature and humidity, and from mass variations.
- The "loudspeaker–room relationship" or how the speaker works in a typical listening room. (More on this very important point later.)

Electrostatic speakers have been, and will be, designed to overcome all the limitations imposed on dynamic speaker design. They can be essentially massless within their operating parameters. They can dispense with the baffle. They can overcome the problem of uniform drive over the surface, by driving the entire surface. They can be designed with any desired degree of intimacy and homogeneity. They can be made virtually identical in performance. They are generally constructed of chemically inert materials, so response does not change with humidity or temperature. They can be designed to propagate sound in any desired pattern, in any room.

Let's review the development of the modern electrostatic speaker, which began during World War II. That war provided both the materials and incentives for progress in many fields, including acoustics. The very first of the modern electrostatics was developed by F. V. Hunt and A. Janszen as part of anti-submarine warfare projects. They needed a virtually perfect sound source—and an electrostatic was developed that was a "perfect" propagator.

### Early units

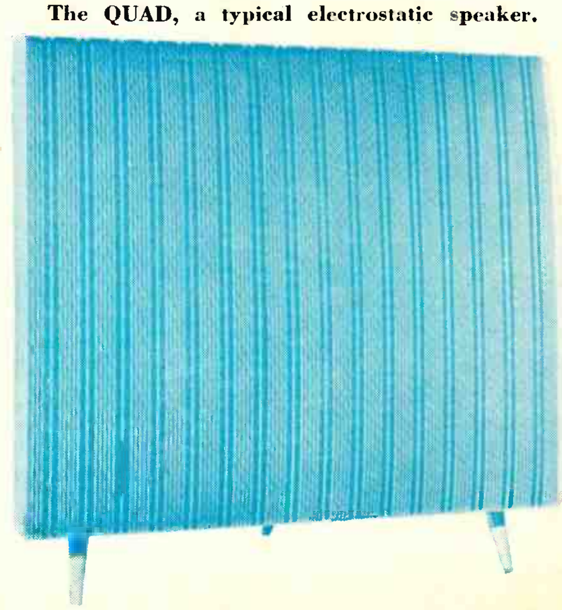
The first commercial applications of the new electrostatics were in postwar German radios, where they were used as supertweeters. These were the old-fashioned single-ended electrostatics of the 1920's, refurbished with new materials. These supertweeters consist of two parts, a fixed electrode and a moving diaphragm, between which is a polarizing voltage (Fig. 1). Provided that the signal voltage is small compared to the polarizing voltage, only a fractional variation in the compression (from the polarizing voltage) is caused. The acoustic output then becomes a replica of the input voltage, provided the amplitude of vibration is minute.

Where the amplitude of vibration is very small, these single-ended units serve well. Single-ended tweeters are still used as supertweeters.

The search for greater amplitudes, to extend the response downward, was on. The researchers, developing by analogy with the single-ended push-pull audio amplifier, came up with the push-pull "constant-voltage" electrostatic (Fig. 2). The charging system is connected to the center or moving diaphragm and the signal voltage fed, in push-pull, to the outer, perforated plates. Permissible amplitudes are much greater than those of single-ended operation.

But the drive is still linear only within narrow limits. The charge on the diaphragm would still change when the diaphragm moved, increasing, among other things, the risk of collapse of the diaphragm to the fixed electrode toward which it was attracted. The next step

The QUAD, a typical electrostatic speaker.



was an ingenious development, by Professors Hunt and Janszen.

Let us suppose that, after we charge the diaphragm, the source of polarizing potential is disconnected. The diaphragm now carries a constant charge, which remains independent of its position between the plates. The force acting on the diaphragm, rather than increasing as it approaches one plate (as in the "constant-voltage" illustration), is now proportional only to the field intensity and the charge. Since the charge is constant, the force and consequent movements are linear—a condition of low distortion. At the same time, the risk of collapse is greatly reduced (the force does not increase as the movement toward a plate results in a smaller gap).

Fig. 3 is a simplified version of this. Actually, the moving diaphragm is not uncoupled completely, but is connected through a charging circuit with time constants, as worked out by Professor Hunt, for dynamic stability. The diaphragm is connected to a power source through a high-value resistance to form a charging circuit that has a time constant that is large compared with ½ f, the half period of the lowest applied frequency.

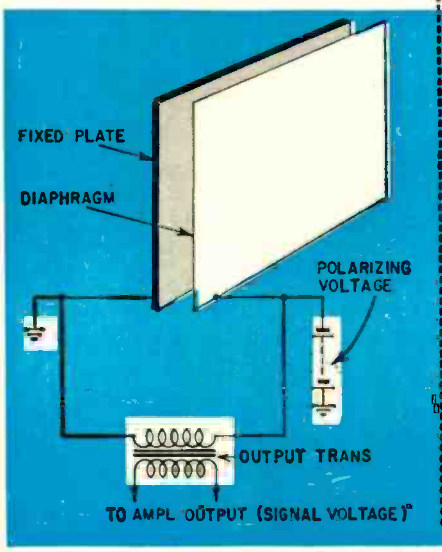


**Fig. 1—The single-ended electrostatic.**

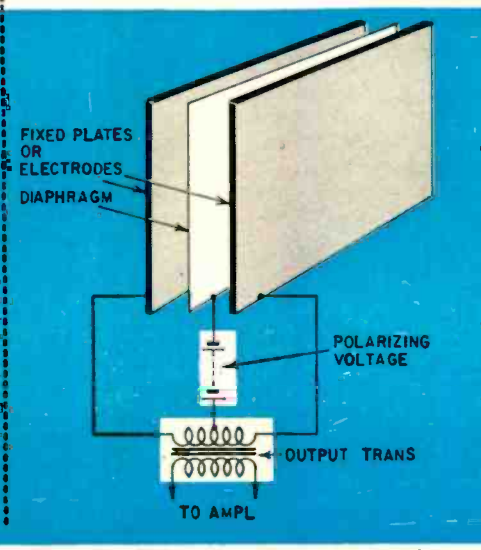


**Fig. 2—Principle of constant-voltage electrostatic.**

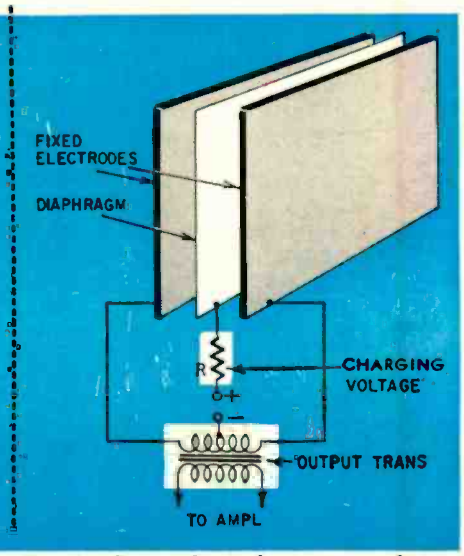


**Fig. 3—Principle of the constant-charge electrostatic.**

## Progress report

With this breakthrough, the pattern for the future was set. Several laboratories simultaneously and independently began to develop improved electrostatic systems. In this country, the principal work was done by Arthur Janszen and by Pickering & Co. In England, H. J. Leak began to work on electrostatic tweeters. The major and most significant work in England was a joint undertaking of P. J. Walker, of Acoustical Manufacturing, and D. T. N. Williamson, of Ferranti Wireless Works. Both had worked for some years on the problems of sound reproduction, including those of room presentation which are involved in the room itself, and how we perceive reproduced sound. (Their Acoustical Corner Ribbon Transducer was a marvel of another day.) Both had decided that the next great step was the development of a full-range electrostatic loudspeaker.

By 1955, Arthur Janszen's push-pull electrostatic high-frequency driver had been introduced publicly, followed soon thereafter by the Pickering. At about the same time, in May, 1955, Walker and Williamson presented publicly, for the first time, their full-range electrostatic loudspeaker—the first open demonstration of a push-pull, full-range unit.

We might compare the varying approaches of that day. In the United States, the tendency was to consider the electrostatic drive as ideally suited to mid- and high-frequency reproduction, while dynamic woofers were still superior. Several electrostatic–dynamic combinations, using high-quality woofers of that day, were developed.

In England, Walker and Williamson took this position: "The assumption that moving-coil units operate like distortion-free pistons at low frequencies is very far from the truth. It is obviously desirable to introduce the benefits of the electrostatic principle throughout the whole frequency range." What they meant, of course, was that the basic distortions they had been unable to eliminate in their previous design were principally the time delays caused by resonances. In suggesting that electrostatic drive was desirable, they were pointing out that a completely aperiodic system (one with uniform transmission times at all frequencies) had been found to be musically desirable, in fact essential.

The first publicly demonstrated electrostatic speaker was large, almost 6 feet high, and built into a wall. Its performance was excitingly good, essentially flat from 40 cycles to beyond audibility. The only criticism that could be made concerned its lack of intimacy—one critic feared that a 6-foot-high voice was a bit too much! Other than that, it was a remarkable loudspeaker, and everyone agreed that a tremendous step had been taken.

**Mr. Fried is one of the country's foremost proponents of the electrostatic speaker, and importer and distributor of Walker's *Quad* speaker. While his views probably do not represent those of the majority of the industry's sound engineers, they are worthy of very careful study.**

## Mounting arrangements

The next step was to devise a method by which electrostatic loudspeakers could be made practical for the home. Walker and Williamson went back into the laboratory to experiment with various configurations, sizes and baffling arrangements. Since electrostatics can be easily adapted to any desired combination of characteristics, they had a wide latitude of experimental types to investigate. They tried:

*Horns:* The increased efficiency and air-loading characteristics of horns can be used with electrostatic as well as dynamic drives. However, horns are normally used to match the high impedance of small dynamic drivers (small compared to the large cross-section pistons that are possible with electrostatic drive) to the low impedance of the surrounding air. Room-size horns present severe design problems in getting smooth response without delay times, but these are often overbalanced by their advantages in air matching. With electrostatics, this mismatch can be avoided in the driver design, and the disadvantages of horns need not be tolerated.

*Corner enclosures:* At low frequencies, corner mounting multiplies the air load by a factor of 8. In addition, optimum "high-note" dispersion (in the same pattern as the "lows") is easily attained. But the corners are also the very best position in a given room to excite every room mode or resonance (at the corner, the impedance of the room is at its highest). Since electrostatics are so smooth, it is foolish to prejudice that smoothness unnecessarily. Therefore, corner configurations were eliminated, though much research went into attempts to present an

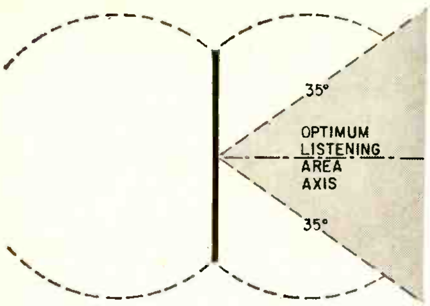



**Fig. 4—Cosine transmission characteristics.**

aperiodic reproduction from the otherwise desirable corner location.

*Wall mounting:* This presented an ideal loudspeaker–room relationship for the electrostatic, whose response patterns could be so well controlled. However, each unit had to be damped for the particular room, and the resulting cost, plus the size, made wall mounting out of the question for the typical home.

Since every conventional mounting arrangement presented serious objections to the final design objective—smooth sound in the home—the answer had to be a new approach. The year 1956 will be remembered in the art as the year of "Walker's Little Wonder," the first free-standing electrostatic, the first commercial speaker that had no cabinet.

Walker's QUAD speaker had no cabinet. Instead it was a "doublet"—a free-standing diaphragm that radiated from both sides, freely into the air. It was a multiple strip system, progressively increasing in plate spacing and area from the center strip. The center, very narrow strip was the very-high-frequency unit; on each side were wider, mid- and high-frequency strips, and the "woofer" diaphraghms formed the outer boundaries.

How did it produce bass without a baffle? Sad to say, many "experts" were confused, and still are. Let us try to help them.

The formulas for the performance of pistons are in all the texts: A piston of sufficient cross-section, providing a sufficient acoustic load against the air directly, can be made to operate predictably to any desired low frequency without a baffle. Therefore, if a piston can be constructed properly—which is very easy with electrostatic drive systems—the cabinet problem disappears. No longer need we struggle with the difficulties of panel vibrations, interior reflections, air-column resonances, time and phase delays, etc. What J. Somerset Murray calls the "double-image" response is, then, eliminated completely.

What other advantages in the doublet method?

▸ We regularize the air load, which is now predictable. This means that the performance is predictable.

▸ A doublet loudspeaker cannot radiate sound in the direction of its surface, since the equal and opposing waves cancel each other in that plane. Consequently, a doublet speaker, in a room, will not excite the room floor to ceiling, or side wall to side wall. Since it will not excite the room in these planes, it eliminates room modes, or resonances, in two of the three possible planes. Since it is also a low-impedance source (it must move very slightly, because of its size, as compared to a smaller dynamic piston, which must move far and rapidly, to move the same quantity of air), it can excite front and back room modes only if accidentally placed at a node for that room mode. In almost every room, then, the bass smoothness is fantastically increased.

▸ It is always desirable to have all frequencies—bass, mid-range and treble—propagated in the same pattern. This is one advantage of corner speakers. Other baffle speakers (other than corner) have ragged radiation patterns. Each driver starts off with a more or less omnidirectional pattern, which narrows with ascending frequency, until crossed over into the next driver, which repeats the pattern. The doublet has a "cosine" or "figure 8" radiation pattern at all frequencies, which eliminates the conventional steps in the energy response of baffle speakers. (Energy response is the total radiation at a given frequency, which is more important than the "on-axis" response.) The steps in response produce unnatural hardening of the sound. Since the doublet avoids these steps, it will sound much more natural.

▸ The cosine pattern also tends to reduce total "room color" effects at all frequencies, just as it does in the bass region. The effect is very much like that of the cardiod, figure-8 microphone, as used by recording engineers to minimize the color of unfavorable recording environments.

▸ The cosine radiation pattern reduces the "acoustic ratio" perceived by the listener—the ratio of reflected sound to sound direct from the speaker. The more the listener hears the speaker directly, the less he listens to room reflections, the replica of the sound pressures at the recording microphone.

Thus, the doublet speaker is a real tool for bringing laboratory advances in reproduction into the listening room. Wherever we insist on the final degree of listening transparency and cleanliness, unmarred by room effects, we must accept the doublet electrostatic.

The rest is modern history. The QUAD has been joined by the KLH free-standing unit of 1960, as designed by Arthur Janszen. These two, the QUAD and the KLH, are interesting contrasts in size, power-handling capacity, approach to homogeneity, and frequency parameters. As other full-range units are presented, they will undoubtedly have their individual variations, expressing the objectives, the knowledge and the solutions of their respective designers.

Electrostatics can be designed in any fashion, to produce any power level required, with negligible distortion, with uniform sound pressures over any desired listening area independent of frequency, and with aperiodic operation. These very desirable characteristics cannot be duplicated with dynamic speakers. The electrostatic principle has permitted the designer to overcome the dynamic woofer–tweeter concept to produce a closely coupled, integrated assembly which can be designed for any listening application. As we proceed into the exciting new art of stereo reproduction, and as we develop our knowledge of the specific requirements for proper loudspeakers for stereo, we will undoubtedly find that we will go toward completely predictable, low-distortion systems — the free-standing electrostatics! END

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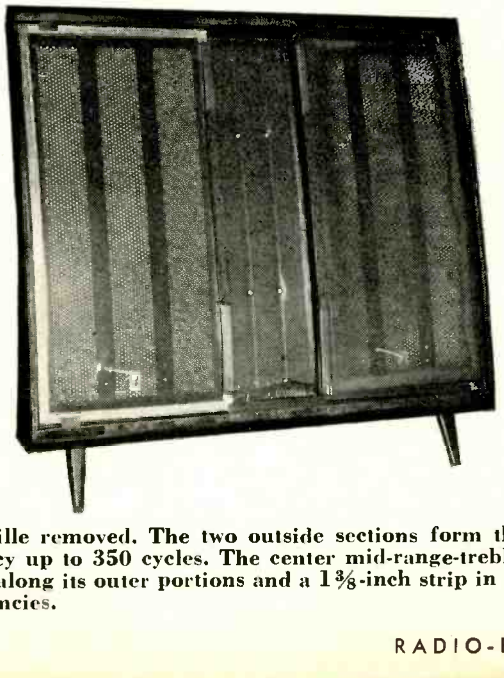


**The Quad with grille removed. The two outside sections form the bass unit, with maximum efficiency up to 350 cycles. The center mid-range-treble unit reproduces up to 6,000 cycles along its outer portions and a 1⅜-inch strip in the center handles the highest frequencies.**

# Handling Do-it-yourselfers

**By JACK DARR**

THE OLD-TIMER AND THE YOUNG HAM had just returned from a service call. As they were setting down their equipment, the door opened and a shock-headed man in a slightly grimy T-shirt rushed in. "Here," and he handed the Old-Timer a small tube. "You got one like it?"

"S'matter with this one?" asked the Old-Timer.

"It's dead. Doesn't light up at all. All the rest of 'em are lit, but that one's dead," replied the man.

"Well, there just might be something wrong with it." He picked up a tube from the shelf, tested it and handed it to the man. Then he checked the old tube. "You're just as right as a fox," he said. "She's dead, all right. Try that'n for size and see if it don't fix you up."

"How much?" asked the man.

"Lessee. Dollar ninety. Thank you, sir," he said, accepting the money, and throwing the old tube into the wastebasket. "How's the thing runnin'?"

"Fine, fine. Picture's just as clear as a bell. Didn't have a bit of sound, though."

"Well, that oughta fix it up. If it doesn't, holler," said the Old-Timer. The customer agreed, and left. The Young Ham glared after him.

"That's another kind of character I can't stand," he growled. "Darn do-it-yourselfer! Why don't they call us instead of messin' with their sets all the time?"

"Look who's talkin'!" The Old-Timer grinned as he started to check a TV set on his end of the bench. "Who was it took the head off that hot rod of yours and ground the valves last week? Th' Ford garage?"

"Well, that's different," said the Young Ham.

"How?" asked the Old-Timer innocently.

"Well, I—that is, I ought to—Aww, you know what I mean!"

"Makes a difference whose corn the shoe's pinchin', don't it?" quipped the Old-Timer. "No, sir, knucklehead, the sets these guys mess up are usually their very own, and they have the right to do anything whatever they want to them. Besides, we should be the last people in the world to gripe about 'em. Who was it got three alignment jobs last week on radios that had been tuned at home?"

"Me," admitted the Young Ham.

"And who was it," continued the Old-Timer, "that got to install a new flyback transformer, speaker and quite a bit of other stuff on old man Spritzer's set week before that, after he repaired it himself?"

"You," said the Young Ham.

"So, don't knock the do-it-yourselfers. If they want to tinker with their own sets, let 'em. Especially if they come in here and buy the tubes from us. I know this last guy has cabbaged a lot of free advice off me, but he buys all his tubes an' parts from me, which is just clear gravy, and I sold him a new picture tube only last month, too. They're customers, just like anybody else, and we want to treat 'em with the utmost of respect, just like all the rest."

"I guess you're right, there, at that," said the Young Ham. "I never thought of it that way. They were always just a nuisance to me."

"Junior, no customer is ever a nuisance!" said the Old-Timer severely. "They're our bread and butter and don't you ever forget it! Two very important things you gotta have to get along with people, and you'll find, if you check up, that a very large percentage of our customers *are* people. Two things: tolerance and friendliness! You gotta have tolerance. People bein' what they are, they've got their little quirks and idiosyncrasies, and you've got to learn to ignore the irritatin' ones. You've got to make allowances for people, just the same as they make allowances for you! If you treat 'em as just plain human bein's, and try to get along with 'em, you'll find almost all of 'em willin' to meet you more than halfway."

"I see," said the Young Ham.

"I sure hope you do," declared the Old-Timer seriously. "That's about the most valuable asset a man can have. Next, comes friendliness. I'll tell you a little secret. I really *try* to make friends with everybody that comes into this shop, customer or not. If there's a secret to success, that's it. Make a real sincere effort to make friends and the chances are you'll succeed! No phony stuff or puttin' on a big glad-hand act when you don't mean it. People can spot that high-pressure stuff a mile off! Take them two characters that was in here last week sellin' magazines. Why, they had a sales talk that just wouldn't quit! You'd have thought I was their long-lost brother or somethin', but it was just as phony as a three-dollar bill! And for that very reason, I didn't buy their dern magazines! I can't stand high-pressure salesmen!"

"That's the truth," agreed the Young Ham. "I've seen some of 'em workin' on you. I thought we were going to have to throw that pair out bodily, you kept saying no so much!"

"True, true," said the Old-Timer with a twinkle. "But, no kiddin', I'm serious about that makin' friends business. I'd like to see you practicin' on that. Learn to feel sorry for the customer when he comes in with troubles. Sympathize with him and let him see that all you want is to get him out of his trouble as quick and as cheap as possible. If you can get that message across to him, that you *really mean* it, half the battle's won and he's gonna feel a lot more kindly toward you. You've not only made a friend, but a faithful customer; one who'll recommend you to his neighbor when he's in trouble. And lemme tell you one thing, Buddy boy, that right there is the best and cheapest advertising that you can get and the kind you can't *pay for!*"

"Yes, sir," continued the Old-Timer, "you gotta remember those two ideas all the time. If you make a mistake, admit it. If you're right, be real quiet about it and let the customer find out about it himself. Of course, it helps if you kinda nudge him along the right track a little. But, in the long run, there's one rule that you gotta always follow, if you want to be a successful customer-relations man."

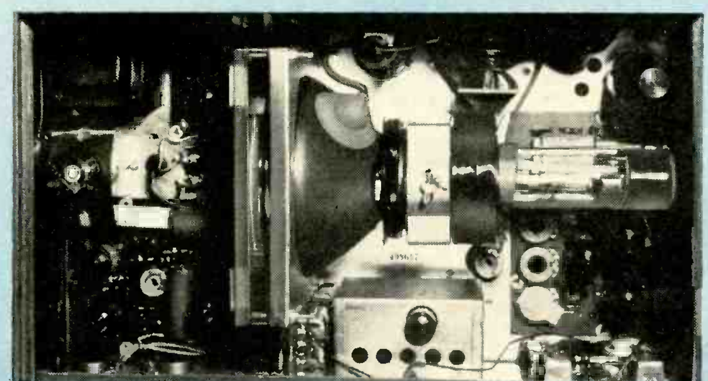
"What's that?" asked the Young Ham.

"The Golden Rule!" said the Old-Timer. "Do unto others as you'd have 'em do unto you! Let's go gitta 'nother cuppa cawfee." END

COVER STORY

# TV ANALYST SIMPLIFIES SERVICING

By WAYNE LEMONS



B&K Analyst with top cover removed.

*Unique test instrument substitutes whole sections of a TV receiver to pinpoint circuit faults*

THE B&K ANALYST IS BASICALLY A SMALL TV transmitter capable of injecting both video and FM modulated audio at their natural frequencies or superimposed upon an rf or if carrier (modulation). In addition, the instrument supplies dynamic signals for checking vertical and horizontal sweep, sync and agc circuits. Also provided is a shorted-turns indicator for checking flybacks and yokes and a continuity-leakage checker. A 3.563-mc crystal oscillator (15,750 cycles below color burst) produces a rainbow pattern for checking color sets.

This versatile instrument uses transparent slides and a flying-spot scanner to produce various test patterns on the TV screen. A standard test pattern, cross-hatch pattern, dot pattern, and a color-bar pattern are included with the instrument. A blank for making your own design or advertising message, etc. is also included.

For troubleshooting individual circuits and localizing troubles, the Analyst includes a variety of test functions which should provide the technician with almost unlimited test procedures for cornering a particular TV fault.

The Analyst delivers:

1. Video, audio, rf and if signals.
2. Test pattern signals for adjusting height, width, linearity and centering.
3. A 4.5-mc FM sound channel that can be modulated either with an internal 400-cycle tone or from an external sound source.
4. A 400-cycle tone for tracing audio amplifier circuits.
5. Separate horizontal and vertical oscillator driving pulses for substitution tests.
6. Horizontal and vertical "plate drive" for injection at the plate of either horizontal or vertical output stages.
7. Adjustable amplitude, positive or negative sync pulses for tracing sync circuits.
8. Leakage-continuity and shorted-turns indicator for checking flybacks and yokes.
9. Low-impedance vertical yoke driving signal.
10. Agc keying pulse.
11. Adjustable calibrated negative bias supply.
12. White-dot and cross-hatch pattern for converging color sets.
13. Color bar pattern for testing chroma circuits of color sets.
14. Complete audio–video modulated transmitter for demonstrating TV sets, using as an advertising medium or for checking community antenna systems, etc.
15. High-level video test signal for directly modulating a TV picture tube.

## How the Analyst works

The block diagram, Fig. 1, helps to explain its many functions. The scanner tube (5BKPV-1) is positioned so that light from it falls on the 931A photomultiplier tube. Since the scanner tube is deflected by the same horizontal and vertical signals used to sync the TV set being tested, at any given instant, the spot on the scanner tube is at exactly the same place as the spot on the TV tube. Now if we insert a transparency that, at any given instant, blocks the spot on the scanner tube from reaching the photomultiplier tube, this spot will also be missing (cut off) from the TV picture. Actually, this light variation is changed into a voltage variation by the photomultiplier since it doesn't conduct unless excited by light. This voltage (video) is amplified by the first video amplifier and fed into a video phase inverter so that either positive or negative signals are available at the VIDEO jack.

Horizontal and vertical sync signals from the Analyst's oscillators are fed into a sync mixer and phase inverter. The sync signals are mixed with the video in the plate circuits of the 1st video amplifier. They also go to the SYNC output jack through an amplitude control. Either positive or negative signals for tracing sync circuits are available, with a peak to peak voltage of 0–50.

The video and sync composite is also fed to the rf modulator which, in turn, amplitude-modulates the rf (or if) oscillator. Other signals that can modulate the rf–if oscillator are the sound and color oscillator.

An ingenious system of sound modulation is used so that two precisely controlled high-frequency rf carriers (such as used in a TV station) are not needed, and so that a frequency-modulated signal is available at the 4.5-MC output jack.

A 4.5-mc oscillator is first frequency-modulated. Then the composite is fed to the rf modulator which, in turn, amplitude-modulates the rf (or if) carrier with the already frequency-modulated sound. Seem complicated? The simplified schematic of the rf modulator should help to clear it up (Fig. 2).

The color oscillator signal (when on) is also fed into the rf modulator. This oscillator produces a rainbow pattern

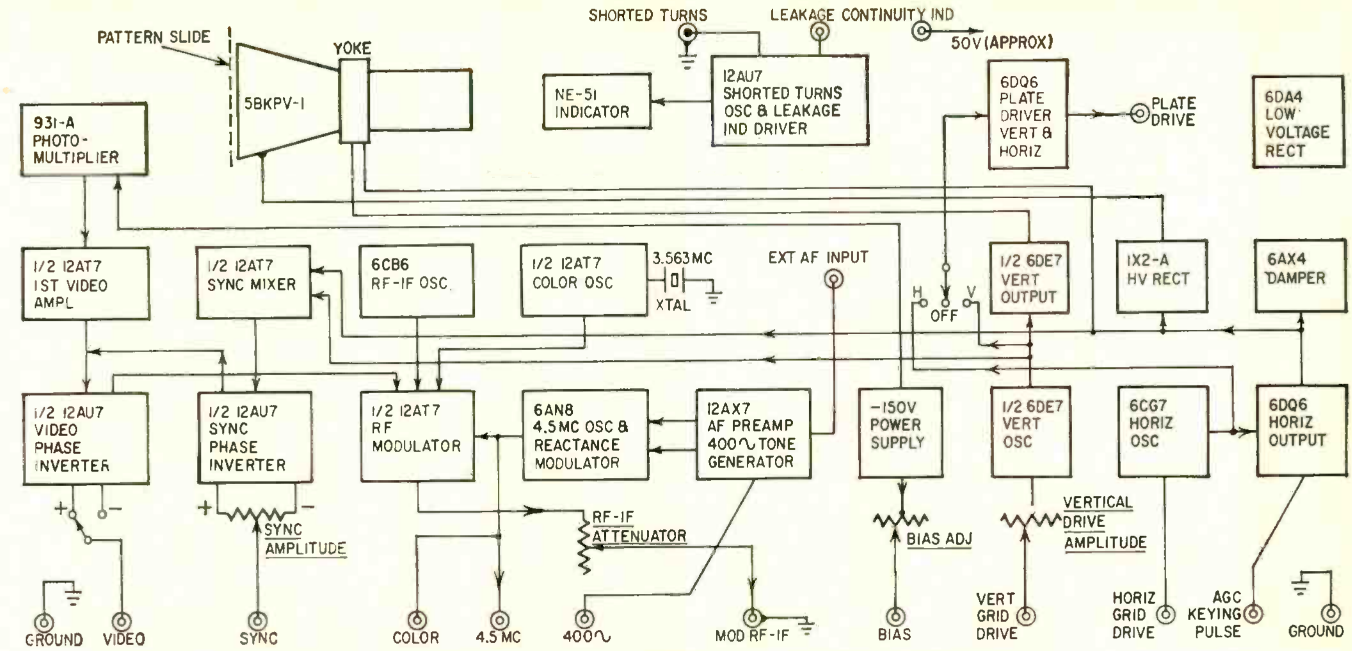



**Fig. 1—Block diagram of the B&K model 1076 Television Analyst.**

**Fig. 2—Rf modulator section of the model 1076.**

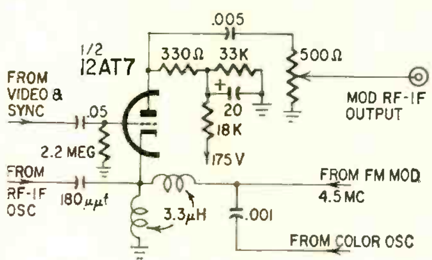



**Fig. 3—This color bar pattern is produced by mixing the output of a rainbow generator with that of a flying-spot scanner.**

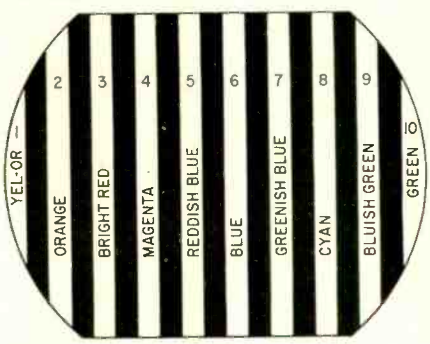
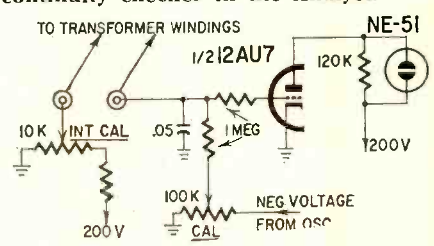



**Fig. 4—Basic circuit of the leakage-continuity checker in the Analyst.**




because it is exactly 15,750 cycles (horizontal scan frequency) below the color burst frequency. Color is produced since the color oscillator is exactly 1 cycle (for each horizontal scan line) removed from the color burst frequency. This represents phase excursion of 360° and, since color is produced by phase changes, a color rainbow pattern is produced on the TV screen. This rainbow is exhibited whether a color pattern slide is used or not. However, by using the color-pattern transparency, the colors appear in distinct bars and the proper color is identified by name and number (Fig. 3).

The Analyst is ideal for setting up color convergence since the cross-hatch or dot pattern is automatically locked in and stable. The cross-hatch pattern also has small dots near the center for setting dc convergence.

## Flyback–yoke checker

The Analyst will check flybacks and yokes for continuity or leakage between windings. It will also check them for shorted turns. Leakage is checked by applying approximately 50 volts between the windings. Any leakage (or continuity) puts a positive voltage on the grid of the 12AU7 (Fig. 4). The tube conducts and the voltage drop increases across the 120,000-ohm resistor, lighting the neon NE-51. The negative voltage used for calibrating this circuit is developed by the shorted-turns test oscillator. When checking for shorted turns (or leakage continuity), the CAL (calibration) control is set so the neon is just extinguished. If a transformer with a shorted turn is connected to the jack, a load is placed on the oscillator and it develops less negative voltage. The neon lights, indicating the defect (Fig. 5).

Other interesting circuits let you drive the horizontal or vertical output circuits by connecting the Analyst right to the plate cap of the horizontal or vertical output tubes in the TV receiver. Or you can drive the grid circuits of the output stages with the oscillator outputs. When driving the plate circuits, a neon BOOST INDICATOR lights up on the front panel if the circuit is working. A clip-on boost indicator is also furnished and is stored in a holder on the front panel.

The techniques of troubleshooting that could be evolved using this instrument would seem to be limited only by the ingenuity of the operator. Now let's look at some actual service problems and use the Analyst to find the trouble.

## Case histories

*Symptom:* Raster, No picture or sound.

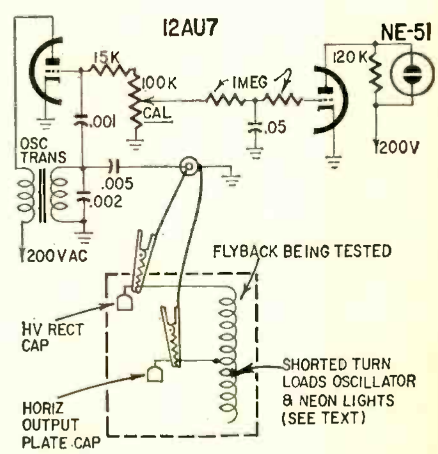



**Fig. 5—This circuit finds shorted turns in flybacks and yokes.**

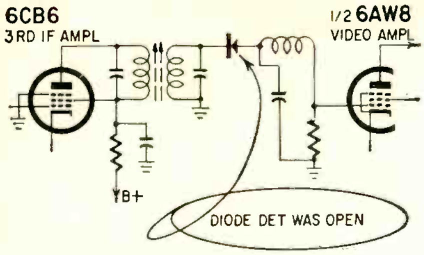



**Fig. 6—Open detector diode resulted in no picture or sound.**

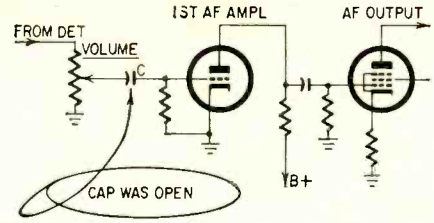



**Fig. 7—Here an open capacitor caused weak sound.**

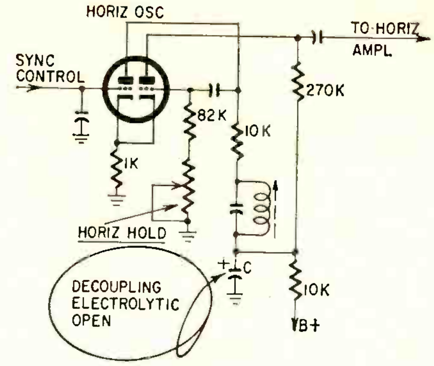



**Fig. 8—An open decoupling electrolytic killed the high voltage.**

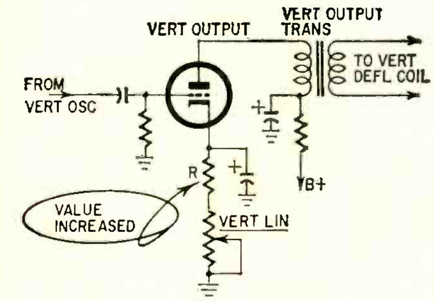



**Fig. 9—Insufficient vertical deflection was caused by a resistor increasing in value.**

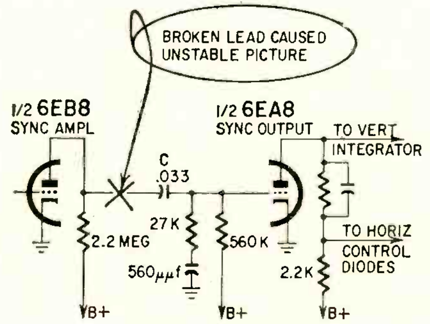



**Fig. 10—Poor sync was traced down to a broken capacitor lead.**

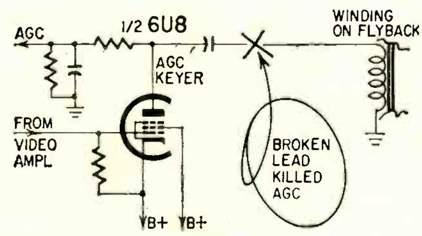



**Fig. 11—Negative picture was caused by a break in a flyback lead.**

*Service procedure:* Injected negative video signal into grid of 6AW8 video amplifier. A locked-in picture appeared. Injected if signal into grid of third if tube and swept if dial through its range. Got no picture or sound. Injected if at plate of third if and swept if dial through its range. Still no picture or sound.

*Conclusion:* Signal being lost between plate of third if and grid of video amplifier. Further checks revealed that diode detector was open. Replacing it cured the trouble (Fig. 6).

* * *

*Symptom:* Weak sound.

*Service procedure:* Injected 400-cycle tone at grid of audio output tube. Result: clear tone. Injected signal at grid of first audio. Large increase in tone volume meant first af stage was OK. Injected signal to "hot" side of volume control. Tone very much weaker than at the grid.

*Conclusion:* Signal being attenuated between volume control and first af grid. Further checks revealed that capacitor C (Fig. 7) was open.

* * *

*Symptom:* No high voltage—Singing in flyback.

*Service Procedure:* Removed plate cap from 6BQ6 horizontal amplifier and injected horizontal plate drive from Analyst into it. Boost indicator on Analyst lit, raster returned. Injected horizontal grid drive into grid (pin 5) of 6BQ6. Also had high voltage and raster.

*Conclusion:* Horizontal oscillator not functioning properly. Checked horizontal oscillator circuit and found open electrolytic decoupling capacitor (C in Fig. 8). Replaced it and set functioned properly.

*Symptom:* About 1-inch vertical deflection.

*Service Procedure:* Injected vertical plate drive signal at plate of vertical output tube. Vertical deflection normal. Injected vertical grid drive signal into grid of vertical output tube. Deflection still inadequate.

*Conclusion:* Trouble in vertical output stage. Checking proved that resistor R in series with the vertical linearity control in the cathode circuit had increased to a high value (Fig. 9). Replacement cured the trouble.

* * *

*Symptom:* Virtually no sync—vertical hold very critical, horizontal hold somewhat better.

*Service Procedure:* Injected rf signal into antenna terminals. Injected sync signal into plate circuit of sync output stage (positive polarity). Picture locked in with about 20 volts of sync. Injected sync signal into grid of sync output tube (reversed polarity using sync output control and reduced output). Picture still locked in. Injected same signal into plate of sync amplifier. No lock-in of picture except with sync output control turned to feed in about 30 volts of sync.

*Conclusion:* Sync signal being attenuated between plate of first sync amplifier and grid of sync output. Investigation disclosed that the wire lead of capacitor C had broken off (Fig. 10).

* * *

*Symptom:* Color programs could not be received in color. Black-and-white reception perfect.

*Service Procedure:* Inject color signal from Analyst to input screen of bandpass amplifier. Color pattern appeared on screen. No circuit faults in if strip.

*Conclusion:* Align if's. Color burst at 3.58 was suppressed because misalignment did not allow full if bandpass.

* * *

*Symptom:* Receiver produces color and black-and-white pictures but colors were wrong.

*Service Procedure:* Obviously, the if strip is OK or no color would appear at all. Hook up Analyst to feed color signal to receiver antenna terminals. Examine color bar pattern. No red in pattern. R − Y demodulator must be defective. Check R − Y demodulator. No plate voltage. Coil in plate circuit open.

*Conclusion:* Replace open coil with new unit. Replace demodulator tube.

* * *

*Symptom:* No color, picture or sound. Normal raster.

*Service Procedure:* Defect not isolated to color circuits as monochrome picture also missing. Use Analyst as if servicing monochrome set. Fault traced to defective if transformer.

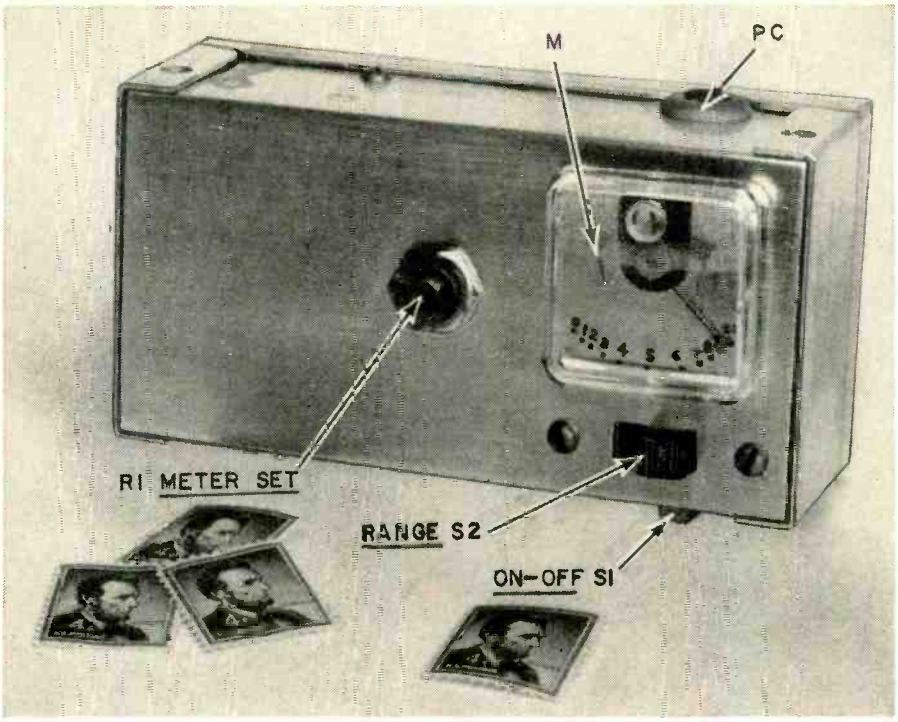
*Conclusion:* Replace transformer.

* * *

*Symptom:* Negative picture, no sync.

*Service Procedure:* Trouble in the agc was suspected. To confirm our suspicions, the adjustable negative bias available on the front panel of the Analyst was connected to the agc line, and adjusted. At about 5 or 6 volts negative, the picture locked in. Set had keyed agc. No negative voltage was being developed by the keyer even when zero biased. Keyer pulse from Analyst was injected at the keyer plate and the negative agc voltage returned.

*Conclusion:* No keyer pulse to plate of keyer tube. Investigation uncovered a broken lead wire on the flyback transformer (Fig. 11). END

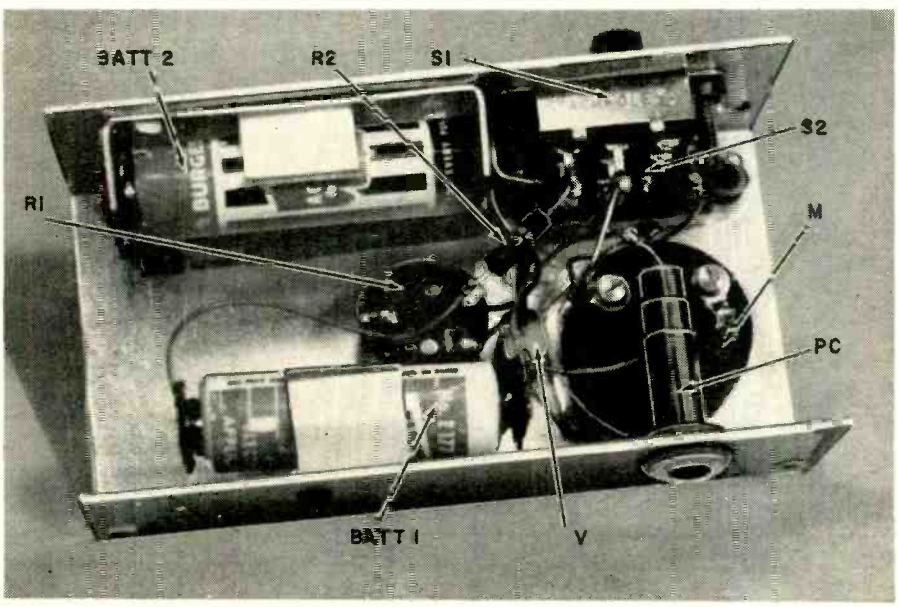



The completed instrument. When turned on, the meter pointer will move to its full-scale position.

# build a sensitive directional light meter

**By THOMAS R. TULLSEN**

## A simple but accurate amplified light meter that you can use indoors to measure available light




Inside the light meter. Obviously, the unit can be made still smaller.

NEARLY EVERYONE WHO HAS AN ADJUSTable camera owns a light meter. It is an invaluable aid to correct exposure. But most meters have shortcomings that hinder their use under low light conditions and their accuracy with scenes of high contrast.

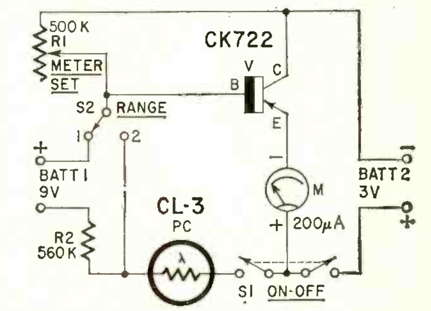
Using high-speed film, even an inexpensive camera can make perfect exposures where light levels are below the range of most light meters. Sensitive meters are nearly compatible with new film speeds, but their price may approach that of the camera used.

A more subtle fault of even the best meters is their poor directional characteristics. Light meters usually take in a very wide view angle compared with the angle seen by the camera. Suppose the subject seen through the viewfinder is dark and shaded while the surroundings are bright. Then the meter must be moved much closer to the subject. Otherwise, bright light from the surroundings enters the meter and causes a false reading.

In the meter to be described the view angle is tailored easily to match the camera used. Loss of sensitivity resulting from decreased view angle is more than made up for by the single stage of amplification that makes sensitivity about 20 times that of the average medium-priced meter. Therefore, the meter can be used indoors with normal room lighting, either day or night.

### Circuitry and construction

A CK722 emitter follower drives a miniature 200-$\mu$a meter (Fig. 1). Transistor base bias is adjusted for full meter deflection with METER SET potentiometer R1. Exposure to light causes




R1—pot, 500,000 ohms, linear
R2—560,000 ohms, 1/2 watt, 10%
BATT 1—9 volts, mercury, miniature
BATT 2—3 volts, 2 penlight cells in series
M—200 $\mu$a meter, miniature (Alco P-1000 series or equivalent)
PC—Clairex CL-3 photocell
S1—dpst slide switch
S2—spdt slide switch
V—CK722
Case, 4 1/4 x 2 1/4 x 1 1/2 inches
Miscellaneous hardware

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

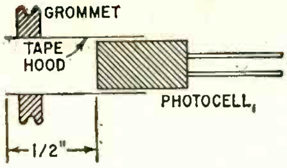



**Fig. 2—Details of the photocell assembly.**

the photocell to decrease in resistance. This biases the transistor toward cutoff. When S2 is in position 1, BATT 1 is added to provide a high-sensitivity range. R2 compresses the high end of the high-sensitivity scale to provide a small overlap between ranges. The CK722 may drift a little with temperature changes but this can easily be compensated for by resetting R1.

Layout, assembly and wiring are not critical and details are left to the builder. Any small box can be used as the chassis. I used a 4¼ x 2¼ x 1½-inch aluminum box. Make a hood for the tiny photocell by wrapping a few layers of black electrical tape around the sensitive end as in Fig. 2. A rubber grommet holds the assembly in place. Since the microammeter reads backwards, mount it upside down. Remove the meter face plate, turn the back side up and smooth the bare metal surface with steel wool. Then remount the face plate and calibrate it, by marking a scale with India ink on the prepared surface.

## Final adjustment

With your light meter operating, check the view angle by standing about 10 feet from a bright bulb in a dark room. Swing the meter slowly from side to side and note when the reading begins to drop rapidly. These points indicate the limits of your light meter's view angle. Keep them in mind by picking two objects in the room that lie in those directions. Remaining in the same spot, pick up your camera and center the bulb in the viewfinder. The two objects you have picked should lie at the extreme edges of the scene visible through the viewfinder. If the two objects lie outside the viewfinder, make the tape hood on the photocell shorter. If they are too close to the center, make the hood longer. Repeat this procedure until the meter and camera angles match.

Calibration is simple and accurate. Establish and mark points on your meter's scale by comparison with a borrowed or rented conventional meter. Be sure to hold both meters near an evenly lighted, colorless surface to eliminate directional effects. Since there are two sensitivity ranges, two sets of points should be marked.

Camera settings depend on film speed as well as light intensity, so make a small table to show typical aperture and shutter settings for various film speeds. The first column should show meter readings, and the remaining columns should represent particular film speeds and typical camera settings. Make the table compact enough so you can stick it right onto the back of the meter. END

# DX SHORT-WAVE FORECAST

**for July** **By STANLEY LEINWOLL**

IN A RECENT READER SURVEY WE DISCOVERED AN UNEXPECTED INTEREST IN SHORT-wave listening. Roughly 60% of you are tuning in the international broadcasts. In view of this interest, we have arranged with Stanley Leinwoll, radio-frequency and propagation manager of Radio Free Europe, to prepare monthly propagation forecasts for RADIO-ELECTRONICS readers.

The tables show the optimum short-wave broadcast band, in megacycles, for short-wave 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 own location, reads down the left side to the region he wishes to hear, then follows the line to the right till he is under the figure showing the nearest time. (Time is given at the tops of the columns in your local standard time, in 2-hour intervals from midnight to 10 pm.) The figure in the intersecting square is the short-wave band (in megacycles) nearest to the optimum working frequency.

For example, a listener in the Eastern USA would be most likely to receive broadcasts in the 9-mc broadcast band from Western Europe at midnight, while the 15-mc band would be best at noon, Eastern Standard Time.

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 is impossible or extremely difficult (for example from Eastern USA to Australia and New Zealand) with reception questionable. If an opening does occur, however, it is most likely to be in the bands shown.

Since this is a new feature, our readers are invited to participate in its formation by submitting comments, questions and suggestions.

| EASTERN US to: | Mid | 2 | 4 | 6 | 8 | 10 | Noon | 2 | 4 | 6 | 8 | 10 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| West Europe | 9 | 9 | 11 | 11 | 15 | 15 | 15 | 15 | 15 | 15 | 11 | 11 |
| East Europe | 9 | 9 | 9 | 11 | 11 | 15 | 15 | 15 | 15 | 11 | 11 | 9 |
| Northern Latin America | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 |
| Southern Latin America | 15 | 15 | 11 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 |
| Near East | 9 | 9 | 9 | 11 | 11 | 11 | 15 | 15 | 15 | 15 | 11 | 9 |
| North Africa | 11 | 11 | 11 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 11 |
| South & Cent. Africa | 9 | 11 | 11 | 15 | 17 | 17 | 17 | 17 | 17 | 15 | 11 | 9 |
| Far East | 11 | 11 | 11 | 11 | 11 | 15 | 15 | 15 | 15 | 15 | 15 | 11 |
| Australia & New Zealand | 11 | 11 | 11 | 11 | 9 | 9 | 9 | 21 | 21 | 21 | 21 | 15 |

| CENTRAL US to: | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| West Europe | 11 | 11 | 11 | 11 | 15 | 15 | 15 | 15 | 15 | 11 | 11 | 11 |
| East Europe | 9 | 9 | 11 | 11 | 11 | 15 | 15 | 15 | 11 | 11 | 11 | 11 |
| Northern Latin America | 11 | 11 | 11 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 |
| Southern Latin America | 15 | 11 | 11 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 |
| Near East | 11 | 11 | 11 | 11 | 15 | 15 | 15 | 15 | 15 | 11 | 11 | 11 |
| North Africa | 11 | 11 | 11 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 11 | 11 |
| South & Cent. Africa | 11 | 11 | 11 | 15 | 15 | 17 | 17 | 17 | 17 | 17 | 15 | 11 |
| Far East | 11 | 11 | 11 | 11 | 15 | 11 | 15 | 15 | 15 | 15 | 15 | 15 |
| Australia & New Zealand | 11 | 11 | 11 | 11 | 11 | 11 | 15 | 21 | 21 | 21 | 17 | 15 |

| WESTERN US to: | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| West Europe | 9 | 9 | 11 | 11 | 15 | 15 | 15 | 15 | 15 | 11 | 11 | 11 |
| East Europe | 11 | 9 | 9 | 11 | 11 | 15 | 15 | 11 | 11 | 11 | 11 | 11 |
| Northern Latin America | 11 | 11 | 11 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 11 |
| Southern Latin America | 15 | 9 | 11 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 |
| North Africa | 9 | 9 | 11 | 11 | 15 | 15 | 15 | 15 | 15 | 11 | 11 | 11 |
| South & Cent. Africa | 11 | 11 | 11 | 15 | 15 | 17 | 17 | 17 | 11 | 9 | 9 | 9 |
| Far East | 15 | 11 | 9 | 11 | 15 | 15 | 15 | 15 | 15 | 15 | 17 | 17 |
| South Asia | 15 | 11 | 9 | 11 | 15 | 15 | 15 | 15 | 15 | 15 | 15 | 15 |
| Australia & New Zealand | 15 | 15 | 11 | 11 | 11 | 15 | 21 | 21 | 21 | 21 | 21 | 17 |

# Troubleshooting the sweep generator

*Here's an easy way to localize the trouble*

**By DAVID R. ANDERSON**

**The sweep generator is an indispensable unit of test equipment when it comes to aligning TV and FM receivers. However, like any other unit of electronic equipment, it breaks down occasionally. When this happens, the owner can save time and inconvenience by servicing the instrument himself. All you need is a scope and a simple broadband detector made up of one diode, one resistor, and two capacitors.**

Although servicing the sweep generator is not the usual thing for the TV technician, it is not too difficult if a systematic approach to the problem is used. The first step in this approach is to divide the generator into sections. This simplifies the troubleshooting procedure by allowing the technician to trace the defect to one section. He may then concentrate on that section to find the defective component.

There are, of course, many models of sweep generators, and the design of their circuits varies. However, the same procedure may be used to trace the defect to a specific section for all models.

The sweep generator may be divided into five sections: rf oscillator, sweep circuit, agc section, blanking section and power supply. Some of the older models may not have all these sections, but the defective section is found in the same way for these units as for one using all five.

## Localizing defective section

Most sweep generators are designed with enough rf output to make the setup shown in Fig. 1 a very effective way of localizing the defective section. The detector circuit is made of readily available components, and can be put together in a few minutes.

Fig. 2 shows various traces that appear on the screen of the scope when using the setup of Fig. 1. The form the trace takes immediately indicates which section is defective. The waveforms shown assume a zero-level reference line which appears only if the sweep generator has blanking and zero-baseline inserter.

Fig. 2-a shows a trace produced by a normally operating generator. The markers are produced by either the sweep generator's built-in marker oscillator or an external one.

Fig. 2-b gives an example of what no rf output would look like. Since the rf oscillator produces the rf output, a trace such as the one shown immediately localizes the defect to this section. However, this section, in addition to the rf oscillator, usually contains a cathode follower used to isolate the oscillator from the load.

Either the oscillator or cathode follower may be at fault. To localize the defect to one or the other, a quick voltage measurement at the grid of the oscillator will tell whether or not it is working. If negative bias is present, the oscillator is working and the cathode follower is at fault. If there is no bias, the trouble is in the oscillator.

## Sweep circuits

If, with the sweep width control set at maximum and a marker frequency applied, the trace appears as in Fig. 2-c, there is no sweep (we're not talking about deflection). A trace such as this localizes the trouble to the sweep circuits, since it is their duty to vary or *sweep* the rf oscillator frequency.

As you can see, there is rf amplitude so the rf oscillator is working. However, instead of making a pip on a small part of the trace, the marker frequency is beating with the entire trace. This shows the rf oscillator is operating at a single frequency instead of producing a swept band.

There are many ways of varying the frequency of the rf oscillator to produce a band of frequencies. For instance, it may be done electronically with a unit known as an Increductor or by mechanically varying an inductor or capacitor.

In most cases, when an electronic sweep circuit is used, it can be checked quickly with an ohmmeter by looking for shorts and opens. If the sweep is mechanical, the electronic portion may be checked with an ohmmeter while the mechanical portion is checked visually.

If the generator has automatic gain control and the trace appears as in Fig. 2-d, the defect is localized to the agc section. The purpose of the agc is to control the output of the rf oscillator so the rf amplitude is the same for all frequencies. If the trace has a dip such as the one shown, all frequencies do not have the same amplitude.

A control usually sets the operating point of the agc action. This control should be adjusted before any troubleshooting is done. If this adjustment does not clear up the trouble, voltage and resistance measurements will quickly show which component is at fault.

To avoid the confusion of a double trace, many sweep generators are equipped with retrace blanking. This section, as the name implies, blanks out the retrace portion of the sweep signal. For instance, if it is desired to view the portion of the sweep cycle when the frequency is moving from the low- to the high-frequency end of the band, the rf oscillator will be cut off or blanked when the frequency is moving from the high- to the low-frequency end. This eliminates the retrace line and forms the zero reference line shown in Fig. 2.

Fig. 2-e shows an example of an unblanked trace. As can be seen, the zero reference line is missing, and the mirror image of the trace appears. Such a trace, of course, localizes the trouble to the blanking section. Here, as with the other sections, a few voltage and resistance measurements will reveal the defective component.

The sweep generator power supply will offer no problem to the technician. It usually consists of a full-wave rectifier with a pi filter. This, of course, is a very familiar circuit.

The main problem when troubleshooting sweep generators is to localize the defective section. Using the arrangement in Fig. 1 greatly simplifies this problem. Once the defective section is located, a few voltage and resistance measurements pinpoint the defective component. This procedure enables the owner to service his generator in a minimum of time. END

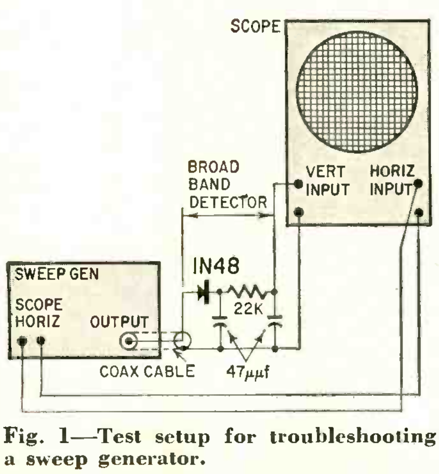



**Fig. 1—Test setup for troubleshooting a sweep generator.**

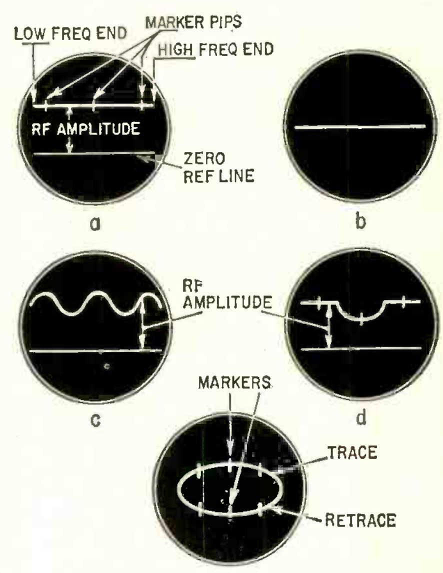
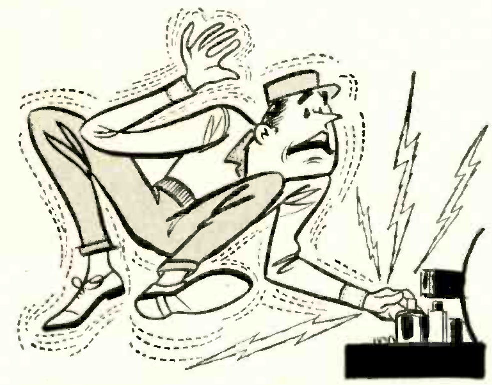



**Fig. 2—Patterns and what they mean: a—normally operating sweep generator; b—no rf output. c—no sweep; d—poor agc; e—no retrace blanking.**

# DON'T DO HALF A JOB



By HAROLD DAVIS

**The service technician who walks in, crams a few tubes into his customer's television set, collects his $15 and walks off without thoroughly adjusting the receiver isn't getting the job done.**

The starting place with adjustments is the picture tube. I never make a call without bringing my pix-tube rejuvenator along. There is no way of getting a good picture on a washed-out picture tube and, if one has the equipment (and he should have), rejuvenating is a small effort.

Before rejuvenating the picture tube, discharge the high-voltage at the anode connection. And, if you don't want to burn a brown spot on the face of somebody's picture tube, don't ever forget it. Also adjust the focus and ion-trap magnets after rejuvenating. I have seen picture tubes refuse to light up after rejuvenation because of the ion-trap magnet adjustment.

This is a good place to point out that every time a damper, horizontal output or high-voltage rectifier is changed, check the focus and ion-trap magnet. Anything that varies the voltage in the horizontal circuit can necessitate such adjusting. Installing new rectifiers increases the overall voltage and makes these adjustments necessary. In fact, so does normal deterioration of the tube itself. An old picture tube can often be brightened simply by adjusting the ion-trap magnet.

The ion-trap magnet should be adjusted only after the set has been operating long enough to be hot. If the gadgets that position the picture are moved, then the ion-trap magnet must be readjusted. Never try to remove dark corners with the trap. The positioners are there for that purpose. Operate the ion-trap magnet as far back on the neck of the tube as possible. Sometimes good brightness can be obtained at two spots, one far in on the neck and another closer to the base of the tube. Use the one furthest from the bell of the tube.

Do not leave the ion-trap magnet out of adjustment with the set on. The trap directs the electron stream through a tiny hole in the electron gun assembly. When the picture tube is not lighting up, (everything else being normal), the electron stream is beating against the metal around the hole, and can knock off enough of it to cause a gassy condition. For safety, keep the brightness control setting low during ion-trap magnet adjustment.

There is little one can do externally with the new tubes without ion-trap magnets. When these new tubes get weak, they go out of focus—and many of them do not have a focus adjustment either. I have found feeding them a good load of electrons in the form of rejuvenation the only cure.

## Making it wider

On the old sets, if you watch closely, you will notice that the width control pushes the raster out on one side and the horizontal linearity on the other. You'll also notice that the adjustments tune. That is, maximum width is not always all the way in or out, but somewhere in between. On many of the newer sets, width is adjusted by pulling a piece of thin brass out from under the yoke.

If the brass has been pulled out and the raster is still narrow, there is nothing more that can be done with adjustments and a weak horizontal output tube or low B-supply voltage should be suspected.

On sets that have one, the horizontal drive control can be used to widen the picture. However, there is a limit and that limit is just before that little white vertical line appears on the left side of the screen.

## Up and down with the vertical

The controls requiring the most attention are usually the vertical linearity and height, sometimes called size. A simple job on most sets, but you'll occasionally run into one where the controls do not respond normally. Ordinarily, the height or size control spreads the picture at the bottom and the vertical linearity control spreads it at the top. This condition is sometimes reversed, and occasionally neither seems to do either.

If the picture is distorted vertically, turn both controls until the raster fills only about 3 or 4 inches in the center of the screen. Then work first one and then the other until the picture is spread normally.

You have a normal picture when the screen is filled and all raster lines are the same width. This can be double-checked by rolling the blanking bar up and down to see if its size remains constant as it crosses the screen. If it stays the same width, the controls have been adjusted properly. If it starts off an inch wide and ends up 2 inches wide, better try again.

If you can't find the vertical size and linearity controls, pull the vertical hold knob. If the shaft is hollow, stick a small screwdriver into it and see if you can't feel another control. Find another front-panel knob that is mounted on a hollow shaft and you'll have the other. Some Philcos and Emersons use this system, and on some Raytheon Airline and Truetone sets you have to take a plate off around the channel-selector shaft.

On a few sets the technician has more trouble finding the controls than

*The road to satisfied customers and a prosperous TV service business is paved with properly adjusted TV sets*


using them. On some of the first vertical chassis, the controls straddled the vertical output tube. And, on that line of Crosley Super V's, watch out for the open connection on the transformer that sits within an inch or so of the controls. It carries B-boost and, even if it doesn't hurt you, it can make you hurt yourself!

Later the manufacturers wanted to save the small amount of metal required for a shaft so they just put holes in the board and one can get to the controls by sticking a screwdriver in them. The only catch is—which hole is which. For all you know, you may be playing with an if transformer. So, don't go turning anything 'till you're sure you know what you're turning. And above all, if something doesn't give, **don't turn!**

The next development was to stick one of the vertical controls onto the back of the vertical hold control and the other onto the back of one of the other front-panel controls. This really is an improvement for the technician—if he knows about it. If he doesn't, he may have to walk off leaving a blank space at the top or bottom of the screen, thoroughly convinced that the manufacturer just didn't put vertical controls on the set.

By the time this gets into print they'll probably be hidden in a new place, so, if the controls are not where you expect them, start looking under everything you can get loose. Sets are on the market on which it is necessary to take off a panel on the front around the other controls.

The manufacturers explain this by saying that the position of the controls is shown in the service data. That's nice. The only rub is that you may not have a data sheet on that particular set on the job with you.

### Don't take the lines out

Nearly all older sets have some way of focusing the raster, and that is what you focus, not the picture. There are two general types of focus adjustments—mechanical with a magnet, and electrostatic with a control. The mechanical arrangement is critical, and all the things that can throw the ion-trap adjustment off can throw it out of focus. On some older sets it is difficult, if not impossible, to get the raster in focus over the entire surface of the tube. In this case the compromise should be around the edges. Get the raster in focus in the center of the screen. A raster is in focus when its lines are clear and distinct.

If you adjust focus with the set off-channel, check it with a properly adjusted picture on the screen. The raster may pull slightly out of focus when the station selector is turned to a station.

On some recent sets there is no focus control, and poor focus is caused by low voltage (if the picture tube itself is OK).

The control that contributes as much as any to getting a good picture is the fine tuning. This is one of the customer's controls, but it won't do him much good unless he knows how to use it, and the tuner oscillator slug is adjusted so he can. If the fine tuning is proper, you can rotate the control until sound bars appear in the picture. The proper setting is then to roll it back until they just disappear.

### Getting the wiggle out

Adjusting the horizontal oscillator phase control is usually considered a shop job. There is no need, however, to go to the trouble of hauling a set in just because it needs a phasing adjustment. Like some of the other operations, finding and getting to the phase adjustment is often a bigger job than adjusting it. To begin with, not all sets have a phase adjustment. Some that do are RCA, Admiral, Emerson and Crosley. One that doesn't is Westinghouse, and another is G-E.

On the older sets, getting at the phase adjustment usually requires pulling the chassis. Old Admirals had a hardware screen that could be cut to reach the phasing. RCA, on some later models, put a hole in the bottom of the cabinet through which the phasing could be adjusted.

Later, on vertical chassis, the phase adjustment on RCA sets became accessible through a hole in the board, the question being again, "which hole?" It is one of two or three around the horizontal oscillator tube, so check diagrams and spot the location before you run into any of these.

Emerson put the phasing adjustment on the apron on some of its early sets, then moved it up beside the horizontal output tube. Keep your hand off the top cap during the operation. Even if you don't get shocked, you can still be burned by the hot envelope.

The worst thing about it is that half the time you can't turn the slug at all, especially with a plastic hex wrench. Resorting to a metal device, if you can find anything to fit it, will demolish the coil. Heating the barrel with a soldering iron has been known to release the slug, and sometimes a drop of oil or the stuff used to quiet controls is helpful.

Phasing usually has to be adjusted when the vertical lines in a picture bend at the top. Otherwise the condition tends to get worse until the picture falls out of sync when the set warms up. The drop out of sync is usually accompanied by white flashes.

When properly adjusted, the lines are straight and the picture can be made to fall out of horizontal sync without the flashing.

### Sound circuits

Good sound adds to the enjoyment of television, but you don't get it when people sound as though they were talking through their noses, or lisping, or when so much picture information is getting in the sound that it sounds as if a filter capacitor is open.

Before attempting to adjust sound, two things should be checked: the fine tuning must be properly set—rolled over until sound bars appear in the picture, rolled back until they don't—and all audio tubes should be good.

The adjustment on the secondary of the ratio detector or the discriminator clears the sound. It requires only a slight turn. Hum and distortion will appear on either side of the clear spot within a single turn. If turning doesn't have an immediate effect, there are other troubles and the coil had best be left as it was. The discriminator or the ratio detector transformer is almost always sitting immediately in front of the tube that performs that function, a 6AL5, 6AV6, or 6T8 in most sets. The top of the transformer is usually the secondary; however, there are exceptions.

Adjusting the primary slug has little effect and mostly on the volume, as do sound if transformer adjustments. These, if one can get to them can be peaked to increase the volume, but the ratio detector or discriminator should be the final check.

Remove the antenna if the set is operating on a strong signal. False peaks can be set up when the signal is excessive, but check the ratio detector once more after the antenna is reconnected.

Sound systems using gated-beam tubes such as the 6BN6 and the 6BK5 are less critical on adjustments. The quadrature coil used in this system requires only peaking. However, several peaks can be found, and the one closest to the present setting is normally the right one. When these sets start getting video information in the sound, one had

# WHAT'S YOUR EQ?

The first of these is a problem rather than a puzzle, since the author shows you how it's done. No. 2 is a Black Box that some readers will solve without trouble, and No. 3 is a service sticker that may possibly have only one solution.

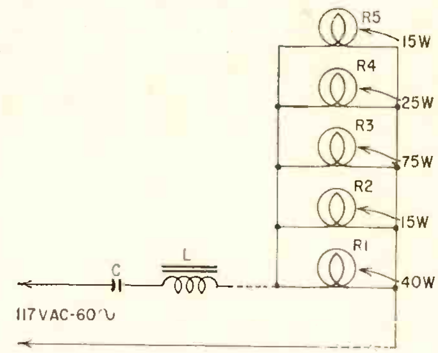
Answers to last month's puzzles, with comments on the May quiz, are on page 72.

We can still use brain-teasers on the engineering level—are swamped with simple ones and TV problems. $10 will be paid for each one accepted. Address Puzzle Editor, RADIO-ELECTRONICS, 154 W. 14 St., New York 11, N.Y.

## Parallel Bulb Puzzler

THIS is a game. It is intended, not only to mystify those of your friends familiar with straightforward parallel circuitry, but to confound them to a point of sheer frustration. They have before them five ordinary light bulbs of varying wattages connected in parallel. Merely by turning each bulb into its socket, one at a time, they are to light all four bulbs but the middle one—the 75-watter. According to all laws this should be easy; but they find that by turning in the first bulb nothing happens. Turn in the second bulb, all others turned out, and it glows. Now turn in the first bulb again, and the second one goes out. Or, turn in bulbs two and five, and both glow. Now turn in any remaining bulb and they will all go out. This mystification will prevail until the bewildered one discovers that bulb three responds rather peculiarly in respect to the others. Presto—with a little logic he has it and all the bulbs but the middle one are glowing with about the same intensity. What adds to the confusion is that the first bulb, a 40-watter, will not glow when turned in, and this discourages the puzzler from trying the larger 75-watter which, after all, is not to be lit. But turn it in, and there it is glowing. This, only if all the others are turned out.

The circuitry is very simple (see figure) and need not be concealed from




your victim. It is better, in fact, to build it in a plastic box, and wire the sockets so he can see the parallel connections.

Two questions:

1. Why does the circuit act as it does?

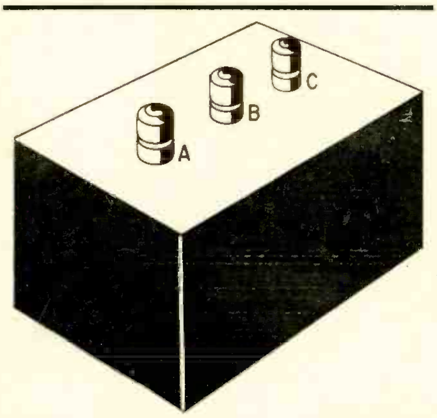
2. What are the values of C and L? (We can tell you that is a filter choke and that C should be nonelectrolytic.)

C—?

L—?

R1, 2, 3, 4, 5—Ordinary 120-volt electric light bulbs. Suggested values: R1—40 watts; R2—15 watts; R3—75 watts; R4—25 watts; R5—15 watts.—*Martin H. Patrick*

## Black-box Puzzler

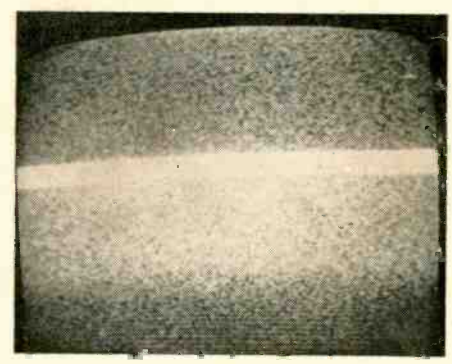



THE ingenious little brain twister below is reprinted from the April 1961, issue of *Electron Bulletin*, Cleveland Institute of Electronics:

Three leads, marked A, B and C, feed into a box containing three resistors. Measuring with an ohmmeter, the resistance between A and B is 30 ohms, between B and C 40 ohms, and between A and C 50 ohms. Draw a diagram showing how the resistors are connected, and the resistance of each of them.

There are at least two solutions for this problem. You will find the easy one fairly soon. Now find another hookup that will give you the same ohmages between terminals.

## What's the Trouble?



THIS Westinghouse V2411 chassis was lugged into the shop by the outside technician for the condition shown in the picture: a bright horizontal bar about an inch wide across the upper center of the raster. The technician had changed the 6EM7 vertical oscillator output tube in the home but it had no effect. Moving the height and linearity controls widened or narrowed the bar but did not remove it. The shop technician made a couple of exploratory checks and announced that the trouble was a fairly simple, though unusual, one that could have been repaired by the technician in the home. What's the trouble?—*Wayne Lemons*

### *Don't Do Half a Job*

*(Continued)*

best take a look elsewhere. Quadrature coils sometimes open. When this happens there is still plenty of sound but accompanied by excessive hum, which of course is picture information.

This type of circuit has what Zenith calls a buzz control and Westinghouse a quieting control. It is a button affair sitting close to the sound output or on the apron of the chassis and should be set for maximum sound without hum.

An effective agc control will permit the set to overload when turned to one extreme, and will cut the rf amplifier and if tubes off with excessive bias when turned to the other end. The correct setting is for good contrast on a strong signal, with the contrast control slightly retarded.

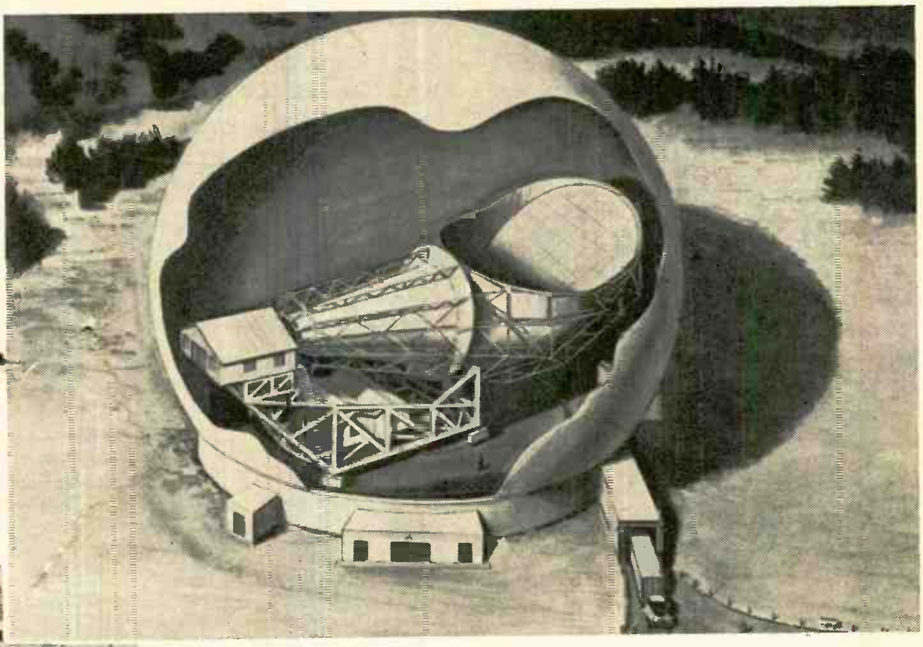
The control on an RCA has always been on the back apron except on vertical chassis, where it will be found alongside the vertical controls (height and vertical linearity).

Zenith installed it in the front with the others until the vertical chassis came along. Then it too went to the back but usually plainly marked.

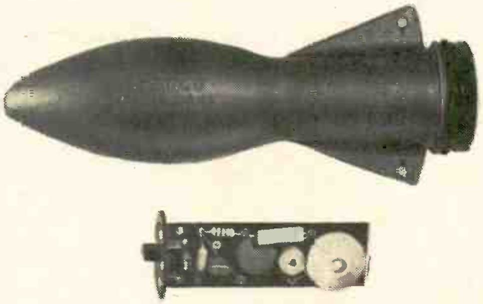
Some others, Stromberg Carlson, Dumont, etc., have the control on top of the chassis and not marked. It is less effective on these sets. Philco does not use an agc control. END

# What's New

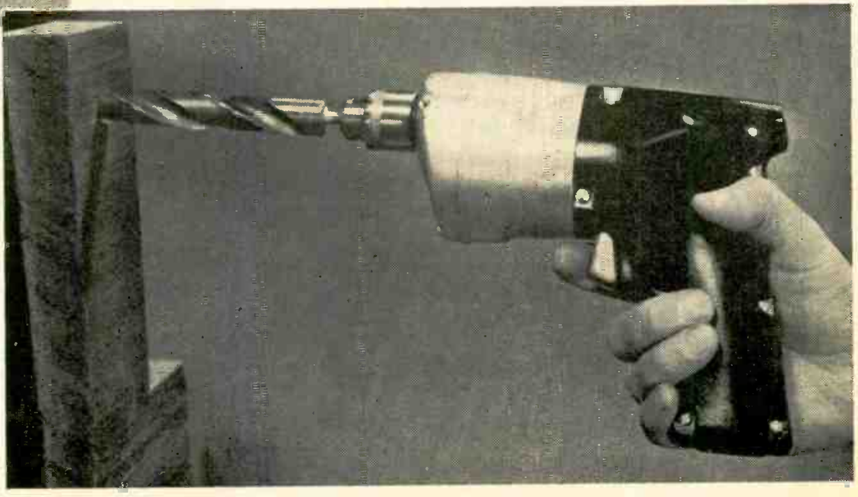
**SATELLITE COMMUNICATIONS** station is being built near Rumford, Maine by AT&T. Overseas telephone calls will be transmitted via satellite rebroadcast and stations like this one. The antenna is said to be the world's biggest horn.



**ELECTRONIC COACH** sets the pace at Tokyo's national athletic stadium. Athletes match their pace to the device during training sessions. The unit is equipped with a radio receiver and speaker which broadcasts instructions from the coach. It's made by Toshiba, and can be controlled remotely or by magnetic tape.



**FISH CALLER** is simple transistor oscillator in a waterproof case. Dangle it in the water and its chirping tone is said to attract fish, bringing them within range of your tackle. It's manufactured by Semco, Dallas, Texas.



**CORDLESS DRILL** is powered by self-contained rechargeable batteries. Now you can do that antenna installation and leave the star drill and long extension cords at the shop. Black & Decker makes this unit. It will be available around the end of the year.

Fisher FM-200 stereo FM tuner.

# UNIQUE CIRCUITS IN FM TUNERS

The 202-R FM-AM tuner.

*Automatic afc defeat, interstation noise suppressor and antenna selector and attenuator circuits in the new Fisher FM tuners are well worth looking at—twice*

By **ROBERT F. SCOTT**
TECHNICAL EDITOR

**During the past few months we have seen a number of new circuit features in high-fidelity radio and audio equipment. Perhaps the most interesting tuner developments are in the new Fisher 202-R and FM-200 FM–AM and FM tuners, respectively. Among these are the MicroTune afc circuit, the if type interstation noise suppressor and the antenna selector and attenuator circuits.**

The MicroTune is an automatic afc defeat system. Touch the FM tuning knob and the afc automatically cuts out, permitting you to tune for maximum signal on the tuning meter. Lift your hand off the control and the afc cuts in to correct any possible tuning errors and to hold the temperature-compensated oscillator at the point that gives maximum noise suppression and minimum distortion.

The MicroTune circuit is shown in Fig. 1. It is operated by the stray 60-cycle hum fields present in any location wired for ac. The FM tuning knob is the hum-sensing element. Touching the knob greatly increases the amount of hum voltage fed to the grid of V10-a—a high-gain amplifier stage.

V10-b is normally biased to cutoff by returning its cathode to a B-plus voltage divider consisting of R34, R30 and R31. The relay is de-energized and the circuit to the afc indicator lamp completed through the normally closed contacts. When you touch the tuning knob, V10-a amplifies the stray 60-cycle signal and feeds it to the grid circuit of V10-b. This signal is rectified by a miniature silicon diode (2E4) to develop a positive voltage on V10-b's grid. Then this triode conducts and the relay pulls in, grounding the afc line and turning off the afc indicator lamp. The MICROTUNE LEVEL control adjusts the back bias on the rectifier diode to set the relay pull-in point.

## Attenuator and antenna switching

Other noteworthy features of the FM-200 and 202-R are provisions for 300- or 72-ohm antennas and 20-db antenna pads that reduce the signal applied to the rf amplifier, when desired, to prevent overloading in the front end. The 202-R has a single FM antenna terminal strip with slide switches on the back of the chassis for matching the antenna to the receiver's rf circuits and for cutting in the attenuator pad when needed. The FM-200 has separate 300- and 72-ohm antenna input terminals and combines the antenna selector and sensitivity control in one front-panel control.

The FM-200's antenna input circuit is shown in Fig. 2. The antenna transformer in the grid circuit of the rf amplifier presents a 300-ohm unbalanced load to input. The attenuator is a bridged-T type (R2, R4 and R5) designed for a 72-ohm impedance.

When the 300-ohm input is used, the input balun (L3) transforms the 300-ohm balanced input to 72 ohms unbalanced. The signal then goes to the attenuator (or around it, depending on whether the switch is in a LOCAL or DISTANT position). The second balun (L1) transforms the impedance of the circuit to 300 ohms unbalanced to match the antenna transformer. With the switch set for 72 ohms, the signal goes through or around the attenuator to the second balun and the antenna transformer.

## The squelch circuit

The muting circuit is shown in Fig. 3. Its operation is based on muting oscillator V9, which acts as an electronic switch. The oscillator's grid resistor (R45) returns to ground through R47,

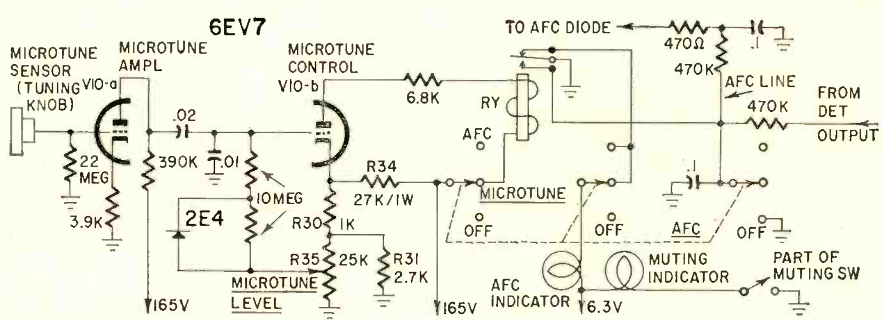



Fig. 1—This circuit grounds out afc when you touch tuning knob.

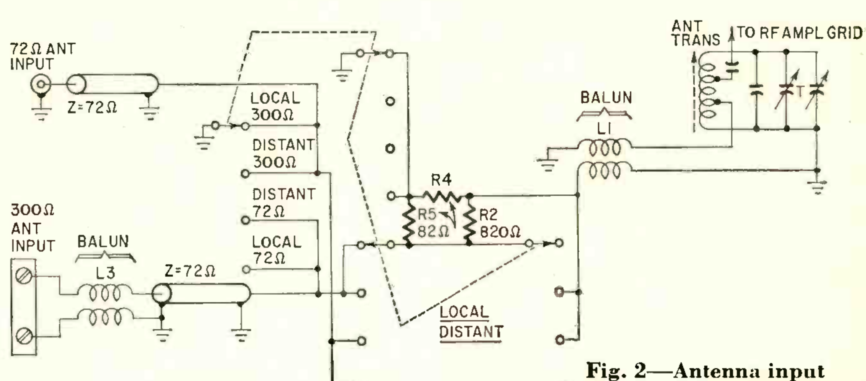



Fig. 2—Antenna input circuit of the FM-200.

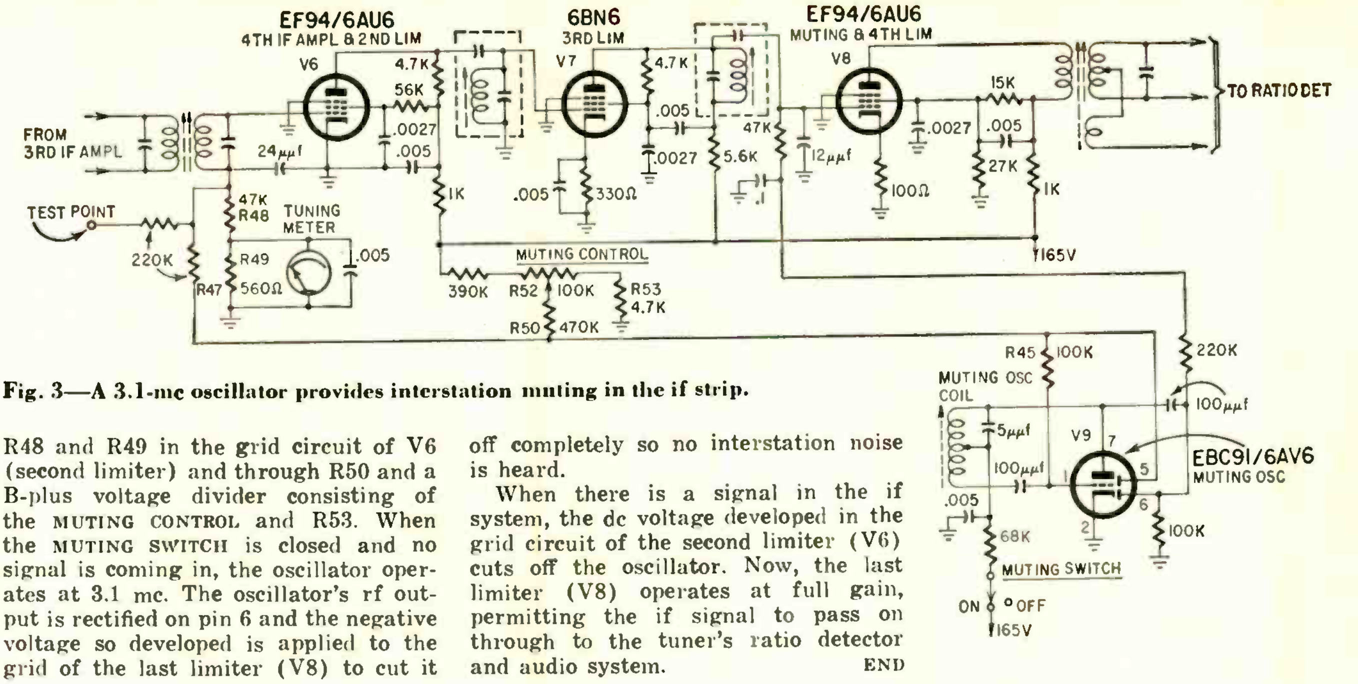



**Fig. 3—A 3.1-mc oscillator provides interstation muting in the if strip.**

R48 and R49 in the grid circuit of V6 (second limiter) and through R50 and a B-plus voltage divider consisting of the MUTING CONTROL and R53. When the MUTING SWITCH is closed and no signal is coming in, the oscillator operates at 3.1 mc. The oscillator's rf output is rectified on pin 6 and the negative voltage so developed is applied to the grid of the last limiter (V8) to cut it off completely so no interstation noise is heard.

When there is a signal in the if system, the dc voltage developed in the grid circuit of the second limiter (V6) cuts off the oscillator. Now, the last limiter (V8) operates at full gain, permitting the if signal to pass on through to the tuner's ratio detector and audio system. END

# Credit to wartime inventors

*The following letter was received from Benjamin F. Miessner, veteran inventor and author of books and articles in this and other magazines:*

DEAR MR. GERNSBACK:

Provocative, as usual, the May RADIO-ELECTRONICS' editorial, with its list of Armed Services "Inventions Wanted," spurs me on to air a subject in which all inventors should be interested.

I feel capable and justified in dealing with this subject because I have, for over 30 years, been an independent researcher and inventor, operating entirely on my own inventions-earned financial resources, running to over 130 US patents, over 100 foreign patents, and nearly $2,000,000 in royalty and sales from those patents through these 30 years.

To explain my subject, some of my experiences must be recounted:

On the day the US declared war, Dec. 7, 1941, I dropped all of my own developmental and research work, and offered my services and laboratory facilities, gratis, for work on such defense problems as my experiences and training best fitted me. Any inventions growing out of this work, it was made clear, would be assigned, also gratis, to our Government, should it wish to patent them.

I also gave, again royalty free, a license under all patents still under my own control (some 50) to the Secretaries of the Navy and War.

I went to work in my laboratory near Morristown, N.J., first on problems suggested by the Bureau of Ships, involving radar display systems for surveillance and range of aircraft and surface vessels and terrestial objects. Several lengthy technical reports were soon made to the Bureau of Ships and the Inventors Council on several scanning and display techniques. On two or three occasions I was called to Washington for consultations on these and other of my inventions.

I went on to develop submarine-detection concepts, FM radar, FM aircraft altimeters, miniature 1-tube Walkie-Talkie transmitters of extraordinary acoustic sensitivity for acoustic surveillance and paratroop use; submarine detection and precisely locating self-powered radio sonobuoys, and other needed apparatus, all of the correspondence being "Confidential."

During this year of continuous work and reporting, I realized that security restrictions would prevent the Washington authorities from disclosing, even to me, what, if anything, was being done with my inventions. So I was not then disturbed by an entire absence of return reports.

But, when World War II finally ended, and when many of the largest corporate laboratory war contractors began, in full-page advertisements in many US publications, to brag about their great technical and inventive contributions to the winning of that war, several of which were the very concepts I myself had contributed, I began to make inquiries about what had happened to those reports of mine and *who* was given credit for them. But I got nowhere. I did get letters of commendation and thanks in very general terms from the Secretaries of the Navy and War, but nothing definite as to *particular* contributions. The Inventors Council likewise was silent on this, to me, importatnt question, for I felt that if credit was due me, that, at least, I should have, if only for my grand children. To an inventor, credit for his creative work is one of the most enduring rewards.

Pursuing this matter further, I wrote unofficially to various Government and civilian experts in the effort to unravel this tangle of credits. No definite answer has ever come from these various inquiries.

Finally, in frustration I wrote the Inventors Council, suggesting that this agency of the Government operated what might be termed a big grab-bag of inventions for the benefit, in part, of the Government contractors who had access to the inventive material patriotically deposited there by inventors from all over the country. I admitted, the council had some experts in some fields of technology. But if the invention information was considered meritorious, *some one or several government contractors* eventually were given it for further evaluation, test, development, and processing into war-useful hardware.

It is still the practice, in its dealings with such contractors, for many of the governmental departments and agencies to allow the contractors to patent *for their own commercial uses*, such inventions as they may get from their own inventors, or otherwise, even though their contracts are drawn on a cost-plus basis to the Government.

By the very nature of an all-out war effort, useful ideas and inventive concepts are where one finds them, and credits for the creative solutions to pressing problems are the least of the worries of those who so earnestly request them. But, in justice to their creative contributors, the Government should, either through the patent office or otherwise, protect those contributors as to the credit for their creations. It should never permit cost-plus contractors to grab credits which rightfully belong to others, and which is the only possible reward for their untiring zealous work.

BENJAMIN F. MIESSNER
*Miami Shores, Fla.*

# ULTRASONICS CONTROLS AIR CONDITIONER

By HENRY O. MAXWELL

TV remote control is modified to handle air conditioners too

WIRELESS REMOTE CONTROLS FOR TV have been with us in ever-increasing numbers for the last 5 years or so. Now it appears that wireless remote controls may be outstanding features in 1961 air conditioners.

Admiral Corp. has adapted its transistorized Super-Son-R ultrasonic remote control to turn one of its 2-hp air conditioners on and off, adjust fan speed in three steps and to operate fan only, cool only, cool and ventilate, and ventilate only. This feature is extremely useful in hospitals and for bed-ridden persons at home. It also makes it practical to install air conditioners in transoms and other out-of-reach places in hotels and small business establishments.

The Super-Son-R remote controls used in air conditioners are adaptations of the S121C transmitter and 7E2A transistorized receiver used in the 20B7 and 20C7 TV chassis. Operating frequencies have been shifted to 36.5 and 40.0 kc to eliminate the possibility of interference with remote-controlled TV sets.

The hand-held Son-R tuner (transmitter) is entirely mechanical. It contains two metal rods, one resonant at 36.5 kc and the other at 40.0 kc. The rods are struck individually by two

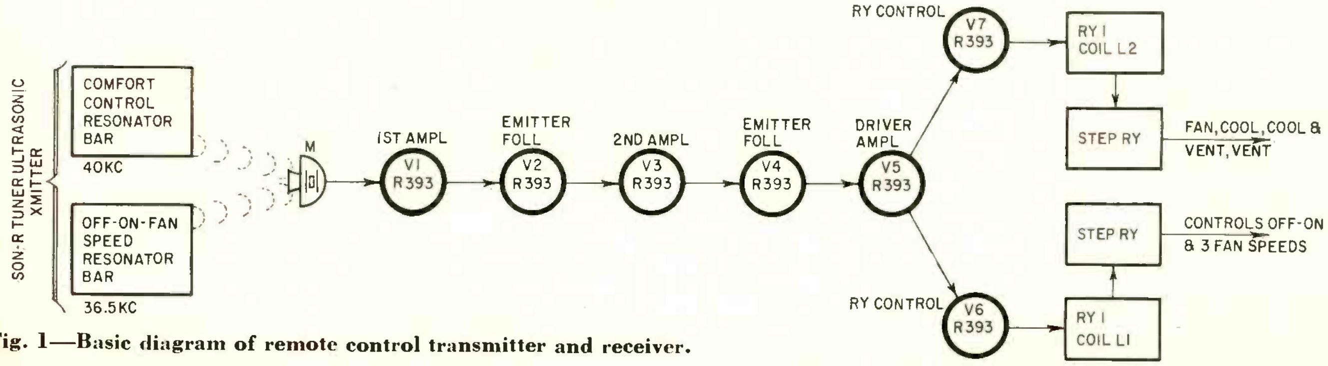



**Fig. 1—Basic diagram of remote control transmitter and receiver.**

pushbuttons on the tuner. As each rod is struck, it generates ultrasonic signals. These are picked up by a microphone built into the front of the air conditioner and converted into 36.5- and 40.0-kc electrical signals that control the air conditioner. The 36.5-kc signal turns the unit on and off and controls fan speed. The 40.0-kc signal operates the COMFORT control to select either cooling, ventilating or both.

Fig. 1 is a block diagram of the Super-Son-R wireless remote control. A schematic of the model 7E2A receiver with a basic diagram of the control elements in the air conditioner is shown in Fig. 2.

Incoming signals from the ultrasonic transmitter are picked up by the microphone and amplified by transistors V1 through V5. V2 and V4 are connected as emitter followers to isolate the alternate stages to provide high gain with good stability. The driver–amplifier is a common-emitter circuit with 36.5- and 40.0-kc tuned coupling transformers in its collector circuit. A 36.5-kc signal drives V7 and a 40.0-kc signal drives V6. Relay control stages V6 and V7 are normally cut off and conduct only when a signal is developed in the secondary of the transformer in the circuit.

The collectors of V6 and V7 are fed through dual coils (L1 and L2) on a special relay (RY1) that acts as a mechanical discriminator to prevent false triggering by jingling keys, coins and other spurious ultrasonic noises. The relay is constructed somewhat like a polar relay with two fulcrums ⅝ inch apart supporting the armature. Current through one coil tips the armature in one direction and closes one set of normally open contacts. Current through the other coil tips the armature in the other direction and closes the other set of contacts. Spurious broad-band noise produces current in both relay coils. The magnetic forces on the ends of the armature effectively buck each other. The double fulcrum adds further stability.

When the ON–OFF–SPEED button is pressed on the tuner, a 36.5-kc note is emitted and is picked up by the mike. After amplification, this signal drives V7 to conduction, operating the relay and closing contacts A-B. This momentarily energizes the coil of stepping relay RY2 to apply power to the air conditioner and start the fan at high speed. Pressing the button twice sets the fan speed at medium, and three times drops it to low speed.

Pressing the COMFORT (40.0-kc) button causes V6 to conduct and send a pulse of current through contacts A–C of RY1 to the coil of RY3. Additional 40-kc pulses are sent to step RY3 around from FAN to COOL, COOL-VENT or VENT. Indicator lights show whether the air conditioner is on or off, and the setting of the COMFORT control.

The remote-control receiver operates from a 12-volt dc power supply and draws only 0.8 watt. With this low power drain, the receiver can remain on standby indefinitely with negligible operating cost.

The seven transistors in the receiver have been selected and coded according to beta. Beta characteristic is indicated by a number or colored dot on the top. Transistors with a red dot should be used only in V1 through V4. Transistors with blue dots can be used as universal replacements in all stages.

**Transistorized remote control amplifier draws only 0.8 watt and can be left on standby indefinitely at negligible cost.**

Transistors coded number 135 (2N481's) should be used for V1, V3 and V5. Units marked 24 (2N363's) should be used for V2 and V4. Transistors coded 67 (2N632's) may be used as replacements for V6 and V7. END

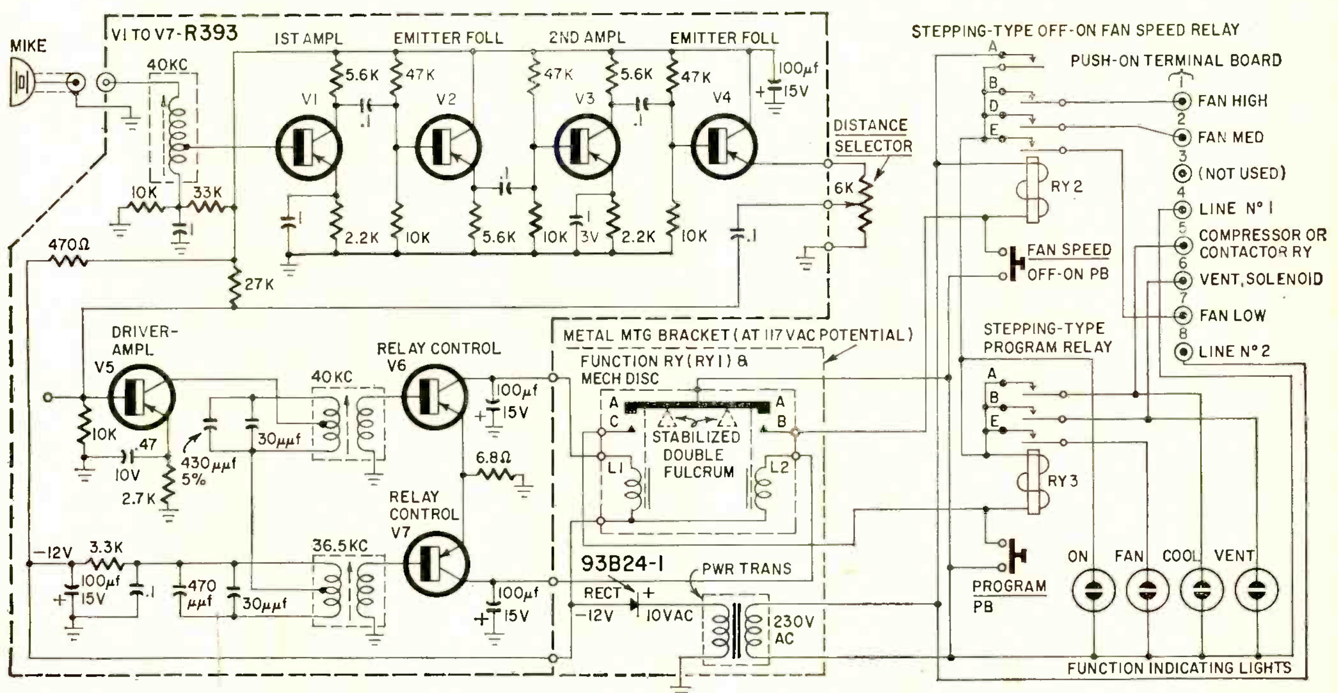



**Fig. 2—Circuit of the receiver built into the air conditioner.**

# CB TRANSCEIVER from car radio

*A simple converter and printed-circuit transmitter turn auto radio into CB transceiver at the flick of a switch*

**By J. H. THOMAS**

WANT Citizens-band radio in your car? Well, you can have it on a minimum budget if your car radio operates from a vibrator type power supply and has an audio output of around 2.5 watts. (A single 6AQ5 or equivalent power amplifier tube is generally adequate.) All you need to add is a simple CB converter, a transmitter rf section and a control relay. With the relay doing the switching, you can make the auto radio serve as the speech amplifier and modulator, transmitter power supply and if amplifier and audio sections for the CB receiver. And you can still use the set as a normal broadcast receiver.

Fig. 1 shows the changes made in a Motorola CTM3 auto radio with a five-pole double-throw relay connected to perform the following functions when energized through the push-to-talk button on the microphone.

- Disconnect the high end of the volume control from the detector output and connect it to the microphone.
- Break the B-plus line from the receiver's rf circuits and connect it to the transmitter's oscillator.
- Open the voice-coil circuit to mute the speaker.
- Switch the antenna from the converter input to the transmitter's rf output.
- Connect the transmitter's final amplifier B-plus line to the plate of the af amplifier (modulator).

(Instead of switching the B-plus leads to the transmitter's oscillator and amplifier, you can connect these leads permanently to their respective B-plus points and turn the transmitter on and off by closing and opening the common cathode return.)

Generally, the power supply in a quality auto radio is adequate for the whole job. If it isn't, then a vibrator or transistor power supply can be added to run the transmitter's oscillator. The rf amplifier draws about 18 ma from the set's power supply.

Fig. 2 is the circuit of a highly sensitive and selective inexpensive crystal-controlled dual converter for 26.965 to 27.255 mc. The first stage converts the incoming signal to the range of 5.182 to 5.472 mc, and the second stage heterodynes these signals down to the broadcast band between 1164 and 1454 kc. Crystal control makes the converter extremely stable and the high first if (5.182 to 5.472 mc) minimizes image interference. Selectivity is provided by the receiver's antenna and if circuits.

The if transformer is a 4.5-mc TV sound if unit. The converter oscillators are Pierce types with crystals connected between screen and oscillator grids. I used a surplus 7.261-mc crystal in the first converter, but you can use any 7-mc crystal whose third harmonic beats with the incoming signals (26.965 to 27.255 ma) to produce a difference frequency falling within the tuning range of the 4.5-mc transformer. A 7.538-mc crystal will center channel 13 in the transformer's passband.

The crystal for the second converter is selected so it beats with the first if to produce difference frequencies falling within any desired 290-kc segment of the broadcast band. I use a 4.018-mc crystal and tune in the CB channels between 1164 and 1454 kc on the broadcast band. You can shift the tuning range down toward the low-frequency end of the band where tuning occupies more dial space by using a crystal of slightly lower frequency in the second converter.

Resistors R1 and R7 are connected across the primaries of the antenna and if transformers to broaden these tuned circuits. Values are optional. Decrease the resistor values to broaden tuning. Increase or omit the resistors to sharpen tuning. If your auto radio has push-button tuning, you can set one of the buttons to your base-station frequency.

## Building the converter

I built the converter on a printed-circuit board as shown in Fig. 3-a. Fig. 3-b shows the layout of parts. My converter is used in a car with a 6-volt electrical system, and the circuit board was made accordingly with the tube heaters in parallel. Connect the heaters

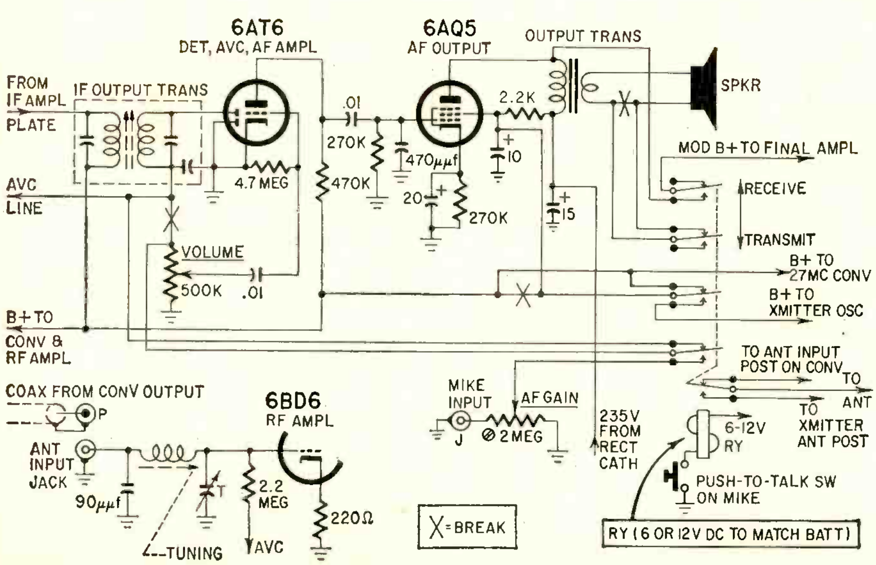



**Fig. 1—Partial schematic of Motorola CTM3 auto radio showing changes made to convert it to part of a CB transceiver. Similar modifications can be made in other sets with vibrator-type power supplies.**

RY—5-pole double-throw relay with 6- or 12-volt dc coil to match car's electrical system
J—microphone jack or connector to match mike
High-output crystal mike with push-to-talk button
Hookup wire, terminal strips, miscellaneous hardware

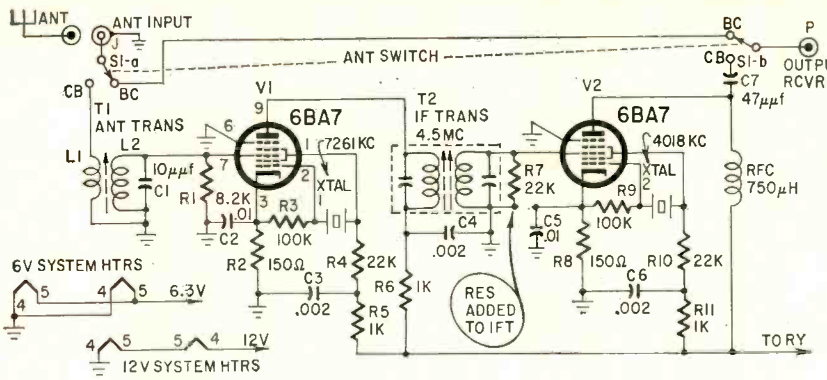



**Fig. 2—Diagram of the broad-band crystal-controlled CB converter**

R1—8,200 ohms, ¼ watt
R2, R8—150 ohms
R3, R9—100,000 ohms, ¼ watt
R4, R7, R10—22,000 ohms
R5, R6, R11—1,000 ohms
*All resistors 10%, ½ watt unless noted*
C1—10 μμf
C2, C5—.01 μf
C3, C4, C6—.002 μf
C7—47 μμf
*Capacitors 500-volt or higher disc ceramics*
RFC—750-μh rf choke or single coil from 455-kc if transformer
T1—antenna transformer (L2—15 turns No. 34 single cotton enameled wire on CTC type LSM 30-mc coil form. L1—3 turns No. 24 hookup wire wound over L2).
T2—4.5-mc TV sound if transformer with capacitors
S1—dpdt slide switch
V1, V2—6BA7
XTAL 1—7261-kc crystal (see text)
XTAL 2—4018-kc crystal (see text)
J—Jack to match auto antenna plug
P—Plug for auto antenna
Copper-clad board for printed circuit
Crystal and tube sockets
Utility box (see text)
Miscellaneous hardware

in series for 12-volt operation. To do so, isolate pin 4 of V2 from ground and connect it to the 12-volt source.

## The transmitter

FCC regulations now require that the frequency-determining circuits in home-built CB transmitters shall be commercial units provided preassembled and pretuned to a specific frequency and sealed by the manufacturer. The model D-11 printed-circuit transmitter (Fig. 4) unit for the transceiver is available for $14.50 from International Crystal Manufacturing Co. Inc., 18 N. Lee St., Oklahoma City, Okla.

The transmitter circuit is shown in Fig. 5. It consists of a 6AU8 with the triode section connected as a third-overtone crystal oscillator and the pentode section as the rf amplifier. The transmitter requires a 250-volt power supply. The oscillator supply voltage is taken directly from the receiver's B-plus (225 to 275 volts) line. The modulated supply for the amplifier is taken directly from the plate of the set's audio output stage.

The cathode return (terminal 4) may be grounded permanently if the transmitter's B-plus leads are switched as in Fig. 1, or it may be grounded through a relay in the transmit position if the B-plus terminals are permanently connected to their respective voltage sources.

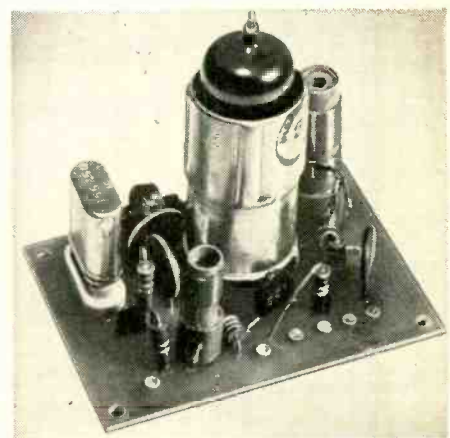


**Fig. 4—Photo of the transmitter**

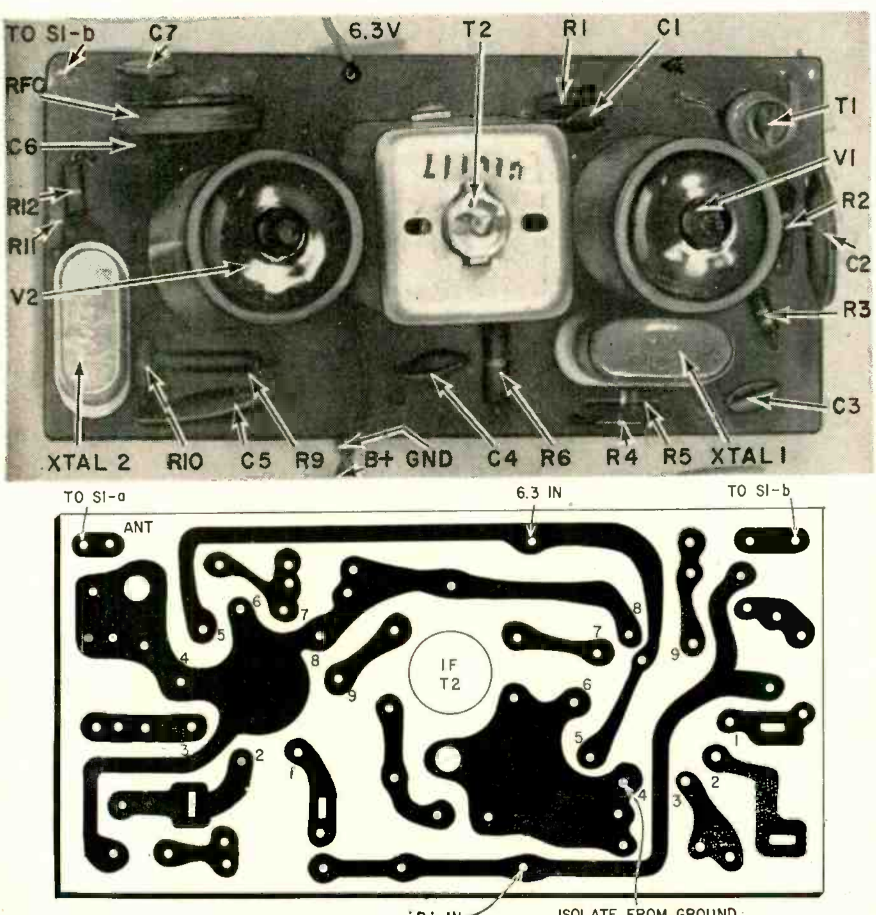



**Fig. 3—(a) Under side of the converter's 1⅞ x 3⅞ inch printed-circuit board. (b)—top view photo shows placement of converter's components.**

The transmitter's ouput link operates into a 50-ohm antenna or transmission line. The dashed lines show how an NE-2 neon lamp may be added as a tuning indicator. (The oscillator and amplifier plate coils have been tuned for maximum output at the factory but may be repeaked in the field without affecting frequency.) In 12-volt installations, a suitable dropping resistor must be used in series with the 6AU8 heater. You can use small pilot lamps to save space (see diagram).

I mounted the transmitter and converter sections in separate 4 x 4 x 2-inch utility boxes but you can mount them in one larger box. Be sure to provide some ventilation because the transmitting tube develops a lot of heat.

## The antenna

A number of types of CB antennas are available but, if you are on a budget and have access to surplus radio stores, a surplus job will do the trick. The surplus 9-foot whips that break down into 10 sections are fine for the job. But, if you want a shorter whip to avoid tangling with low underpasses, traffic lights, trees, etc., use the arrangement in Fig. 6. Here, the two bottom sections are removed and a loading coil inserted in the center. The coil is wound with 5½ turns of ¼-inch-OD (⅛-inch-ID) copper tubing wound around a 1¼-inch-OD pipe of dowel used as a temporary form and spaced ⅛ inch between turns.

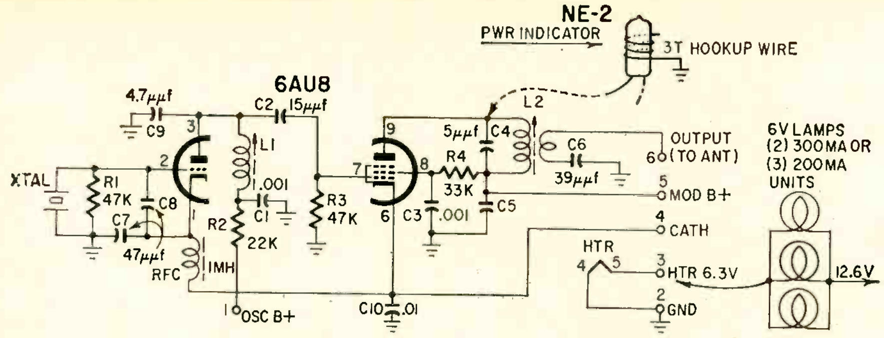



Fig. 5—Diagram of International Crystal's printed-circuit Citizens band transmitter.

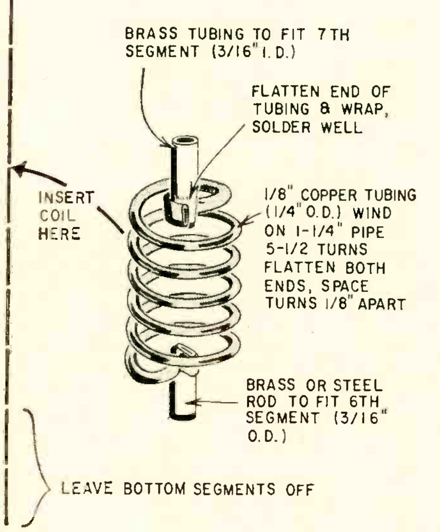



Fig. 6—Center-loaded antenna made from surplus unit. Tubing and rod for ends came from hobby shop.

The coil is made from a length of tubing about 36 inches long. The overall length of the antenna and coil is about 88 inches.

## Adjustments

Use a field-strength meter when tuning the transmitter final tank for maximum output. Watch the input to the final plate circuit and make sure that it does not exceed 5 watts. This means that with a 250-volt supply the plate current must be just under 20 ma. Check modulation by connecting a scope's vertical amplifier input to a pickup coil near the final tank and the horizontal amplifier to the audio output (modulation) transformer. With 100% modulation a trapezoidal pattern will appear on the screen. (See the section on "Modulation Monitoring" in *The Radio Amateur's Handbook.*)

Use a signal generator to tune the converter. If you want to cover the whole band, set the signal generator to the center of the band (between channels 12 and 13) and peak T1 and T2 for maximum signal—either by ear or on a vtvm connected across the speaker voice coil. If you are interested in only one channel, adjust the converter for maximum output at that frequency. You probably won't be able to read your signal generator accurately enough to tune it to any given channel, but you can calibrate it with a beat from the transmitter if you use the transmitter without an antenna. With the antenna there is too much power and it is impossible to get a good beat. (The Seco model 500 test set is a handy device that combines a crystal checker, field-strength meter, rf signal generator and beat detector and indicator. It can replace the conventional signal generator and beat detector when aligning the converter, and a field-strength meter in tuning the transmitter for maximum output.—*Editor*)

This transceiver is indeed an economical setup, but don't underestimate it. We have covered a distance of 23 miles under average conditions in fairly open country. The receiver is far more sensitive than the ordinary superregenerator. In fact, you have a triple-conversion superhet that is a high-class bargain for very little money.

The transmitter is as good as you can use under FCC rules. To avoid temperature effects on the crystals, I made small Styrofoam hoods for them. The stuff can be formed easily with a soldering iron. I heated an old crystal case and shoved it right into the Styrofoam to get a cavity of the right size. END

# Phono-Plug Adapter

With this easily made adapter, you can quickly connect two phono plugs to one phono jack. The adapter is completely shielded and cannot introduce hum into your equipment. To make the adapter you will need a 1-inch diameter round tin can with a friction lid (I have used cans which contained band-aids, bouillon cubes, etc.), two single-hole-mounting phono jacks and one phono plug.

Using a fine-tooth hacksaw, cut the can to a length of about ¾ inch and smooth the rough edge with a file. If desired, scrape the paint off the can or dissolve it with paint remover. Punch a small hole in the center of the bottom of the can and use a small rat-tail file to make the hole large enough for the back end of the phono plug. Then solder the plug into the hole securely. In the lid of the can, make two ¼-inch holes about ½ inch apart. Fasten the two phono pin jacks in the holes with the hexagon nuts and washers supplied. Then take a short length of flexible insulated wire, solder one end into the pin of the plug, and the other end to both lugs in the centers of the jacks. This connects both jacks in parallel to the plug. When the lid is put back on the can, both jacks have their "ground side" connected to the ground side of the plug. Solder the lid to the can in one or two spots to hold it securely and to insure a good connection.

Fig. 1 shows the construction and wiring; Fig. 2 the completed adapter, and Fig. 3 the adapter in use.—*Art Trauffer*

Fig. 1

Fig. 2

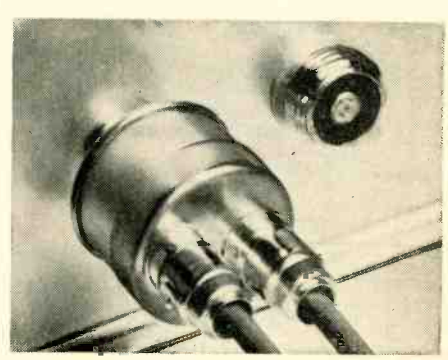


Fig. 3

# TV TUNER care and repair

## Don't be scared of tuners, many repairs can be made in your shop

By CHARLES B. RANDALL

THE most critical and exacting section of the TV chassis, the tuner, is also expected to be the most rugged. Its circuitry is jarred hundreds of times a week as the selector is twisted from station to station, and is expected, not only to withstand this punishment, but also not to drift out of its precise alignment. Keeping this unit in good working order is a most important segment of a technician's service.

Bugs that plagued the early front ends have been virtually eliminated by advances in design and construction. Trying to eliminate microphonic squeals, swapping a half dozen 6J6's to find one that works properly, and monthly "slugging" of front ends are tasks that are being forgotten as older sets are scrapped. Nevertheless, the modern technician should know certain basic techniques for working on tuners.

### Cleaning tuners

Servicing tuners in the home is generally limited to replacing tubes and to cleaning contacts when they are accessible. I have found that a thorough cleaning restores most noisy and erratic selectors to normal operation. A proper diagnosis of trouble in the tuner can be made only after this is done.

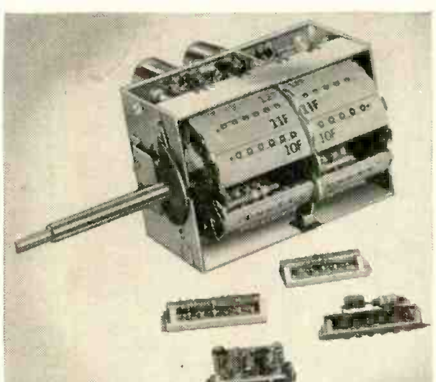
My cleaning kit contains a contact cleaner, a tube of white lubricant, a piece of clean cloth, a small artist's brush and a toothbrush. To assure the best and most permanent results, each kind of tuner should be cleaned in the appropriate manner. Tuners divide into two general categories, wafer-tier or switch types, and those that employ a turret or drum.

The wafer switch generally requires the most attention. Wet the bristles of the small brush with contact cleaner, hold the brush against each moving contact in turn and swab the entire surface by rotating the selector knob a few times (Fig. 1). This procedure also carries cleaner to each of the stationary contacts. (I bend my brushes at the tip about 20°, to facilitate reaching between wafers that are very close together.)

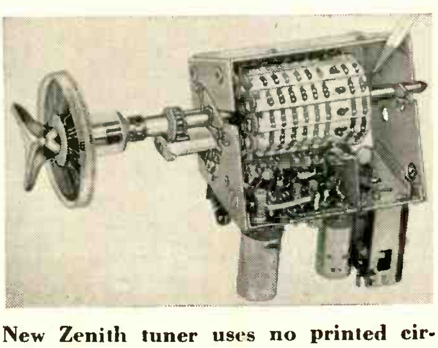
Next, wrap a small piece of cloth on the end of the brush handle and carefully wipe each contact in the same manner. On particularly dirty units it may be necessary to reapply the contact cleaner and wipe again, repeating until proper operation is restored. Finally, apply a thin coating of lubricant with the same brush to each contact and also to the detent bearing and its notched track.

Most wafers can be exposed by removing a cover plate. Some, as in the older RCA sets, require a little more effort; parts and leads have to be unsoldered and a number of screws removed.

The old Zenith turret front end with its porcupine projections is most effectively cleaned with a toothbrush. Moistened with contact cleaner, the brush is rubbed briskly up and down over the contacts, cleaning three or four channel strips each time the drum is rotated.



**Standard Coil tuner with some of the channel strips removed.**



**New Zenith tuner uses no printed circuits.**

Lubricant is applied with the same brush, but with a light sidewise motion to catch a little on each contact.

The Standard Coil types of contacts can be cleaned simply by rubbing across each channel strip with a cloth dampened with cleaner. Lubricant can be applied with a fingertip, dabbing lightly across each row of contacts. The stationary springs can be cleaned with the small brush after removing three or four of the strips.

On the new types of tuners where contacts are arranged on a thick disk, the dampened cloth can be wrapped around the brush handle and held against the contacts while the knob is turned. Wipe with a dry piece of cloth on the handle and apply lubricant to each contact with light dabs of the brush.

### Electronic defects

A defect in tuner circuitry will usually manifest itself in one of two ways. A snowy condition probably means trouble in the rf stage, while the reception of a rushing noise with no sound or video indicates oscillator or mixer trouble. In some cases, a defect in the first stage of the video if strip will also result in a snowy picture. However, if the trouble is in the tuner, grasping the mixer or rf amplifier tube will cause a notable improvement in the picture.

The most common troublemaker in tuners is the rf cascode circuit in which dual triodes are operated in series, putting the cathode and grid of one section at a high potential. This invites arcover and shorting between the closely spaced elements of these high-gain tubes. Some of the more recent front ends, such as the RCA KRK 72 or 73, are using this type circuit in the mixer–oscillator stage too, and the frequency of breakdowns is accordingly high. Whether or not trouble is indicated, I check the B-plus resistors in such tuners when they are being cleaned or a defective tube is replaced. I often find that the resistors have been damaged in the past by a shorted tube, and even though they are not apparently affecting tuner operation, they may cause trouble later on.

A tuner can be fused to provide complete protection against the damaging

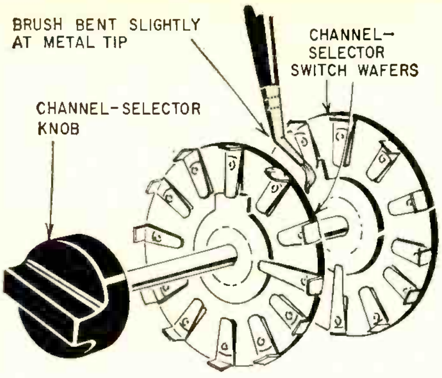



**Fig. 1—Use an artist's brush to apply contact cleaner to wafer switch in tuner. Rotate the knob while brush is held against moving contact.**

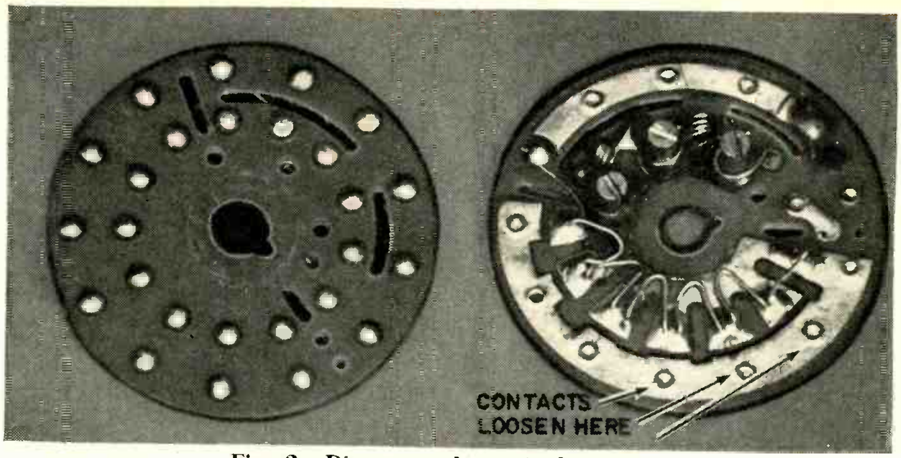



**Fig. 2—Disc tuner has raised contacts that sometimes come loose from printed circuit.**

results of tube shorts. I have worked on a number of sets where a defective 6BQ7 caused the B-plus resistors in the tuner to burn and short out, popping the 5U4 and ruining the power transformer. RCA gives the tuner some protection by incorporating a spring-loaded resistor in the B-plus feed of their newer front ends. If overloaded, this resistor snaps apart, breaking the circuit before other parts inside the tuner are damaged. In most other sets a fuse holder can be placed on or near the tuner and spliced into the B-plus. A 1/32 amp slow-blow fuse will protect parts in the tuner against a bad short.

Aside from damaged B-plus resistors, component breakdown in the tuner is rare. The next most vulnerable parts are bypass and coupling capacitors which separate large differences of voltage. Parts in grid circuits and other areas where voltages are low and current flow light are sometimes affected by humidity and heat, which changes their values or causes mechanical defects to show up.

When parts are replaced in a critical circuit, use exact values and be careful to recognize special units, such as capacitors with particular thermal characteristics. Proper schematics and parts lists are essential as many burned resistors cannot be identified and capacitor codes are often undecipherable. Never use two or more resistors or capacitors to obtain a desired value and stick as close to the physical size of the original as possible. Using a 1- or 2-watt resistor to replace a ½-watter, for example, will not protect against future burnout, and the increased capacitance of the larger capacitor may adversely affect a critically tuned circuit.

When soldering in the new component, use a heat sink (long-nose pliers or even an alligator clip) to avoid damage by overheating. Place the new part in exactly the same position as the old, and avoid disturbing other wires and parts. Slight changes in their position can have serious detuning effects. Coupling between circuits is often dependent on the proximity of two capacitors or the position of a gimmick (small piece of wire connected only on one end.) Headaches rather than a satisfactory repair will result from haphazard and incautious attempts to fix a tuner.

## Tame those intermittents

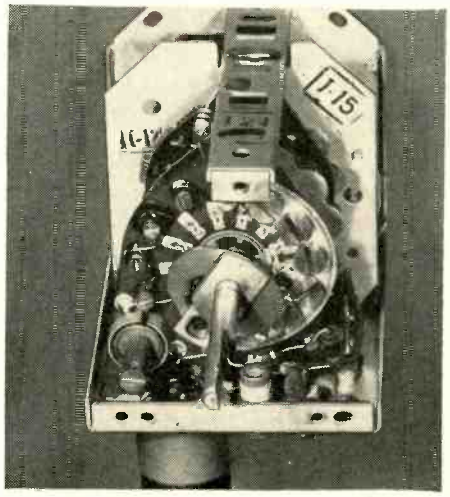
A frequent tuner trouble is the intermittent connection. The shock and jar of turning the selector will eventually loosen any poorly soldered connection and break down physically defective parts. Patience is the most useful tool for finding such defects. The slightest movement of any part of the tuner will sometimes cause the trouble, but locating the bad connection can be very tedious and time-consuming. Use an insulated rod to poke carefully, and tug until the trouble is found. Give particular attention to tube-socket pins and to parts which bridge from the chassis to the bandswitch.

Some tuners have persistent weak points, and experience will help the technician to identify and repair those defects. For instance, I have found specific bad solder connections in so many of the Philcos using the disk type turret that it has become a practice to check each set thoroughly. In this tuner rows of raised contacts on a thick disk press against stationary kidney springs as the selector is turned (Fig. 2). These contacts pass rivetlike through the disk and are soldered to printed circuitry on the opposite side. As stations are changed, pressure from the springs eventually cause the contacts to work loose from the printed area. Heat each contact thoroughly and resolder carefully to insure a lasting repair. Some of the other early disc type turrets have the same fault.

## Mechanical breakdowns

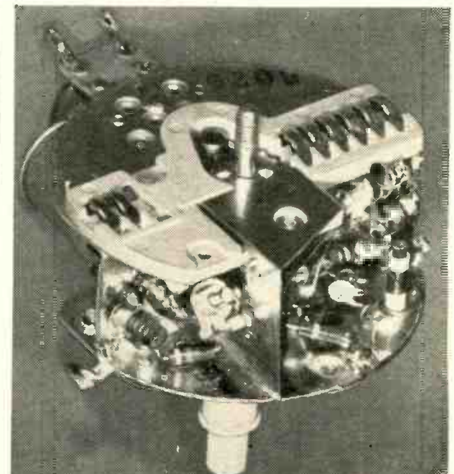
Because of the great amount of physical punishment the average tuner takes in its lifetime, there are a large number of mechanical failures. Most frequent is the breaking or loosening of detents, fine-tuning mechanisms and selector shafts. Usually the individual parts, such as selector shafts or detent assemblies, can be obtained from local distributors, and a complete tuner need be replaced only where damage is extensive.

A very common mechanical defect occurs in the new Admiral disk type tuner. The two disks in the turret are mounted on a metal tube crimped over at each end to hold them in place. The selector shaft fits inside one end of this tube, insulated from it by a thin piece of plastic. The coupling between the larger top disk and tube invariably loosens, resulting in excessive play and difficulty in switching stations. Less frequently the selector shaft slips, mak-



*Sylvania*

**Early switch-type tuner.**



*Sylvania*

**Inside one of the modern flat turret tuners.**

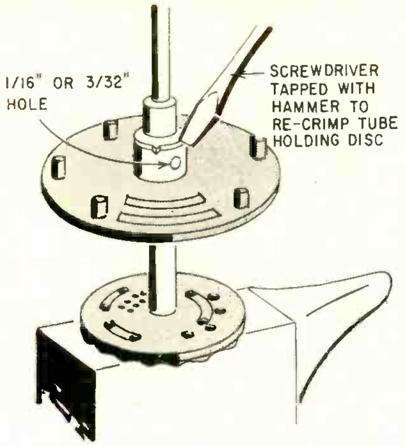



**Fig. 3—Tightening top disc of Admiral tuner. Also shown is hole in hub for strengthening pin.**

ing it impossible to move the turret.

To repair, remove the turret by releasing the two spring-steel clips and taking off the fine-tuning shaft. Rest the unit on a vise or other hard surface and, with a screwdriver and hammer, tap sharply in each of the four notches on the crimped edge, tightening the tube against the disk hub (Fig. 3). If the bottom disk is loose, tighten it in the same manner. To insure a lasting repair or to tighten a slipping shaft, drill a small hole through the hub of the top disk, through the tube, insulation and steel selector shaft (be sure the shaft is in its original position before drilling). For a pin use nylon, fiber or any strong nonconductive material, fitting it tightly in the hole.

### Alignment

Tuner alignment in the average repair shop is limited to oscillator range adjustment, as only this can be done efficiently without using expensive equipment. When there is an individual set of coils for each channel, "slugging" each one is all that is necessary to center the stations. On other sets, there may be as few as two adjustments, one for the higher channels (13–7) and one for the lower ones (6–2). Some of these sets may have an adjustment for each station. Since the circuitry is series-connected, altering one station's setting affects the others.

The arrangements of the oscillator adjustments on a typical tuner appear in Fig. 4. First center the fine tuning. Then adjust the high-band screw (sometimes marked as 13) for proper reception of the highest channel used. Continue with the other stations down to 7. Next center channel 6 (or the next lowest channel used) with the low-band screw (or marked as 6) and finish up with the lowest channel. If there are no individual adjustments for each station and some remain misadjusted, spread or squeeze the oscillator coils for those stations until they center.

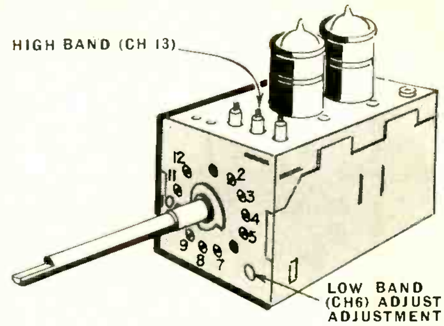



**Fig. 4—Oscillator adjustments as they might appear on some older tuners.**

If tuner misalignment is very serious—due either to tampering by unqualified persons or severe circuit changes—correction can be attempted only with proper service instruments. The percentage of tuners in this condition will be very low, and the small shop may find it practical to "farm out" those few to shops specializing in such work.

Many service technicians are easily dismayed by tuner troubles and too often avoid repairs by replacing the entire unit. The answer is to stop saying, "It needs a new tuner." Only a very few front ends are so badly damaged that replacement is necessary. With a little caution tackle that next tuner job—it can be repaired. END

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## World's smallest electric motor

*It fits into a 1/16-inch cube*

A MOTOR SO SMALL AS TO BE BARELY VISIBLE to the naked eye was awarded a Certificate of Excellence by the annual Miniaturization Awards sponsored by Miniature Precision Bearings of Keene, N.H. The awards were given for ingenuity in solving basic miniaturization problems of broad interest to industry; for new design concepts with wide possibilities, and for developing or manufacturing equipment that extends the frontiers of miniaturization.

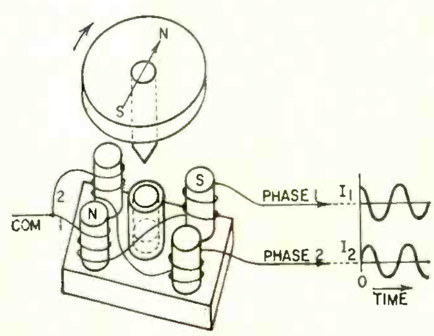
The micromotor—built by William McLellan of Electro-Optical Systems Inc. in response to a $1,000 challenge by Dr. Richard Feynman of Caltech—is built in a cube 1/64 inch on each side. That is roughly the diameter of the period at the end of this sentence. The motor itself is practically unphotographable under its protective cover of thin plastic, and is hardly noticeable at first glance. When put into action by spinning a small ac generator mounted with it, it can clearly be seen to be rotating with the help of a small microscope. Rotation is not visible to the naked eye.

Since the motor is so difficult to photograph, a scale model 100 times as large was constructed and is pictured here. The drawing is a partly exploded view. The parts and dimensions (in inches) are:

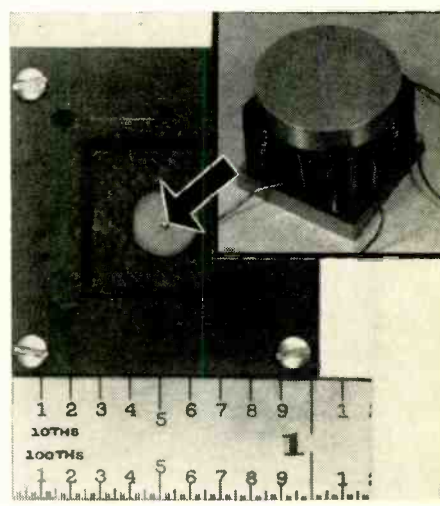
| | |
|---|---|
| 4 coils | .0005 enameled copper, 21 turns |
| 4 poles | iron pins; diam. .0035, length .010 |
| 1 base | steel shim stock .003 x .004 square |
| 1 sleeve bearing | quartz ID .002, OD .003, length .007 |
| 1 thrust bearing | quartz rod, diam. .0018, length .005 |
| 1 shaft | molybdenum, diam. .0016, length .009 |
| 1 rotor | permanent magnet (Vicalloy) diam .014, thickness .003 |

Each of the 21-turn coils has two layers, 11 and 10 turns. Inside diameter of each coil is .0042 inch, outside diameter .0065 inch, and the resistance of each coil is 1.25 ohms. The motor weighs 250 micrograms, and delivers about one-millionth horsepower.

Mr. McLellan and two assistants took two months of spare-time work to construct the motor. Their most important tool, they reported, was a microscope, all work being done under one, and often two, of these unusual assembly tools. The second microscope—at right angles to the first—was especially useful when drilling holes and laying out centerlines.




**Partially exploded view.**



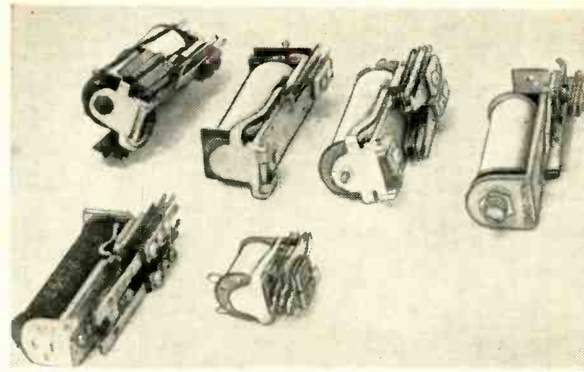

**Micromotor is tiny speck in middle of light-colored circle. Inset shows large-scale model of motor.**

There are said to be no commercial plans for the motor at this time, but all commercial rights in it are assigned to Electro-Optical Systems, Pasadena, Calif.

While considered extremely ingenious, the micromotor was runner-up in the competition for the Annual Miniaturization Award. That honor was won by Bulova with its electronic watch, Accutron (RADIO-ELECTRONICS May, 1961, page 42). Nine other Certificates of Merit were also awarded, for accomplishments ranging from ceramic micromodules containing electron tubes and circuitry to a surgical needle .008 inch in diameter. END

By TOM JASKI

# How relays work



Group of telephone relays. Each has a different contact arrangement.

*Part II—How and why of relay characteristics, contacts and coils*

**Last time we were introduced to a wide variety of relays. This month we'll see how their characteristics can be adjusted to suit the application. We will also examine relay contact and coil design.**

Many relay characteristics can be controlled—current and voltage requirements, for example. These are determined by the coil design. Most relays can be equipped with various coils to accommodate different voltages, without changing the magnetic structure. For a particular structure and armature spring, the number of ampere-turns is the design factor.

Another characteristic often controlled is the operating time of the relay. This can be done in several ways. One — dashpots — was mentioned last month. Mechanical escapements can be used in their place. A nonmechanical method of controlling the time characteristic of a relay is with copper slugs (Fig. 1). A copper slug at the heel end of the coil makes the relay slow-closing. A slug at the armature end makes the relay slow-opening (analogous to the shading coil in ac). A copper slug at both ends makes the relay slow-operating. Delays up to ½ second can be obtained. The size of the slug controls the time delay.

When the current in a relay coil is started or interrupted, the relay with the slug acts like a transformer while the current is still building up or decaying. The slug acts like a shorted secondary and prevents either the buildup or the decay of the magnetic field for some short time after the current in the coil has become stable (or zero).

The vibrating-reed *time-delay* relay used in telephone work has a weighted reed instead of a clapper for its armature. When the relay releases, the springy armature closes the controlled contact a number of times. It can be used to maintain a slow-release relay for time delays of 1 to 15 seconds. Using a slow-acting relay, the same kind of delay in operation can be obtained. Then a number of the short pulses will be given, but the slow-acting relay will not pull in until the reed comes to rest and finally closes the circuit completely. In a self-cycling circuit, the vibrating reed relay (Fig. 2) can be used to generate slow pulses.

Another controllable relay characteristic is sensitivity to polarity. Polarized relays are usually dual-coil clapper types with some remanent magnetism built into the core or armature. When the coils are properly connected, a voltage of one polarity aids the magnetism in one coil and opposes it in the other, closing that side of the relay. A reverse polarity voltage closes the other side.

Characteristics such as time, polarization and voltage and current required to operate relays can also be controlled with auxiliary electronic equipment.

## Contacts

Relay contacts have always been a problem. Early relays had brass contacts which did not last very long. To prevent excessive corrosion, the relays were sometimes built with little cups of mercury for contacts. A wire is dipped into the cup to complete the circuit. These too suffered from excessive oxidation under arcing conditions.

Arcing is most severe when the contacts control an inductive load. Sometimes it can be reduced materially by adding a capacitor across the contacts. The capacitor value must be determined in each individual instance, according to the nature of the switched load. Incorrect capacitors can actually increase arcing.

Silver has been used to a large extent for contacts, and now contacts of many materials are available. Palladium and tungsten are best where heavy arcing occurs. Silver is found where contact resistance must be low. In extreme cases, gold contacts are used, but they are obviously too expensive for all-around use.

Led by the telephone companies, industry now has adopted standard contact configurations. They are shown in Fig. 3. On some relays, such as telephone and aircraft types, large stacks of contact springs can be used. The circuit designer can select any combination of contact configurations up to the maximum number of "springs". Contact size, determined by the current-carrying capacity needed, is a limiting factor.

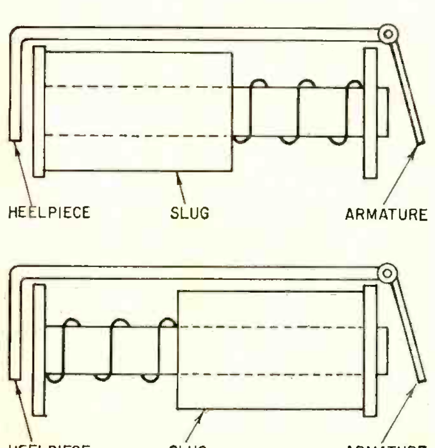
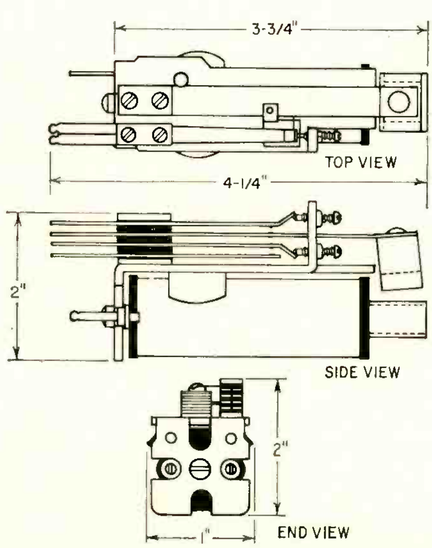



Fig. 1—Copper slugs can slow down the operating time of a dc relay.



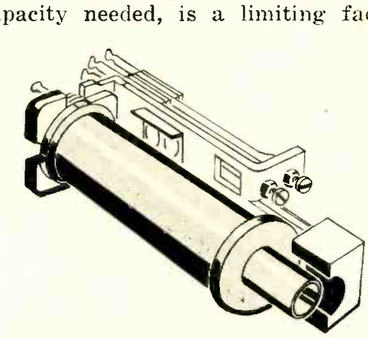



Fig. 2—Typical vibrating-reed relay.

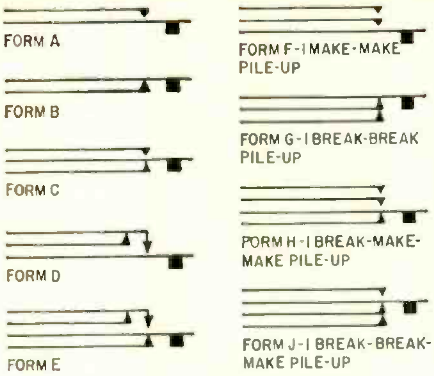



**Fig. 3—Some possible relay contact arrangements.**

Extra-heavy contacts must be carried on extra-heavy springs, to avoid heating (and consequent softening) of the springs by the current.

Lately, control problems requiring more than the normal number of springs have led to the development of a number of "wire-contact" relays, carrying as many as 51 springs. These are used for special jobs not often encountered in industry.

### Coil problems

Relay coils are not extremely difficult to design, once the magnetic structure has been determined. However, we need not get into coil design data here. What is of more interest is the behavior of coils in service. Dc relay coils have a problem of electrolysis. There is a small potential difference between turns of the coil. With moisture present, even this small difference can cause electrolysis unless the coil connections are periodically reversed.

Electrolysis usually leads to shorted turns, which in a dc relay act like copper slugs and slow the relay down. If enough turns are shorted, the problem becomes serious. Moreover, shorted turns cause additional heat when the relay is operated, and this aggravates the electrolysis situation. Keeping coils dry and clean is the first commandment of relay care.

In ac coils the electrolysis problem is rare, since the current reverses continuously. But here another problem is more serious. While shorted turns may slow down the action of a dc relay, in an ac relay the same damage can cause failure because of extreme heating. The relay acts as a transformer with the shorted turns as its secondary. But the turns are not designed for the resultant heavy current (as is the shading coil) and they heat rapidly, leading to complete breakdown. Furthermore, while in dc relays the initial current is less than the final holding current, in ac relays there is a strong in-rush current, as much as 10 times the normal holding current, because the open relay has a large air gap, reducing the impedance of the coil.

The ac relay coil must be designed to withstand this much greater current for the time it takes the relay to close. With a relay which is operated frequently, more attention must be given this factor. Although most relays close faster than this, a three-cycle period is often taken as the design point for in-rush current. The problem is serious enough to cause designers to include ac-to-dc conversion and use dc relays when they are operated frequently. A typical example of this is in elevator control, where the relays are operated rapidly all day. As an alternative, specially designed rugged ac relays must be used in elevator control.

Coils have been standardized, and industrial relay coil replacement is usually not a major operation, but one must always consider the delay such a repair can cause in the production line.

In the next articles in this series, we will look at relay applications, selection, circuits and the various special forms of induction relays prevalent in industry, and how they are used. Finally electronic aids and controls for relays will be discussed. TO BE CONTINUED

# TECHNICIAN OF THE MONTH

*Waldo D. Ludwick—he made it the hard way—by himself*

**In the studio corner, Waldo and his wife put on a disc-jockey show.**

**By GUY S. CORNISH**

**When a boy becomes a successful businessman in a line unlike that of his father and without special training, other than that acquired by his own efforts, he deserves much credit. This can be considered the success story of such a man who became the leading technician in his community.**

In the early Thirties, while furnishing public-address equipment for the American Legion football games at Mariemont Field just outside of Cincinnati, my attention was attracted to a boy by the name of Waldo Ludwick. He hung around my sound car and, from the questions he asked, it was plain to see he had been bitten by the radio bug. He told me he had picked up the local radio station on a crystal set he had made and was now trying out some different crystals to see if he could get more volume.

Waldo became a weekly visitor to my sound car and kept me posted on the success he was having. It wasn't long before he had acquired enough parts to build a one-tube receiver and, with the knowledge gained from reading the radio magazines, he began experimenting with more elaborate circuits. He soon started building receivers for friends and neighbors and it wasn't long before he decided to enter the radio service business in earnest. He fitted out a small shop in one corner of his father's grocery store and, when he was not waiting on customers, he was busy at his bench. In those days, the service business was not crowded and a little advertising brought in more work than he expected.

About this time the football games were discontinued at Mariemont and I lost track of him. After retiring in 1952, I purchased a small farm about 7 miles from Lynchburg, Ohio. On my first trip to town, I was surprised to find that the boy I had known back in the early Thirties was now a successful business man, operating the Ludwick Radio & TV Service Center. His shop is well equipped with tools and test equipment, some of which he made himself.

One corner of Waldo's shop is fitted out as a disc-jockey studio from where he sends a weekly program, "Lynchburg on the Air," to radio station WPFB in Middletown, Ohio. He also has a studio in the office of the Chamber of Commerce in Blanchester, Ohio, where he sends out another weekly program to the same station in Middletown. The advertising he receives from these programs and the fact that he is active in civic and business groups in Lynchburg have made him popular with the townsfolk. With him, radio is a business and not a sideline.

Waldo told me that he has followed radio ever since I first met him and the only time his radio career was interrupted was when he was in the army. In addition to his service work, he finds time to operate a ham station, K8NLG. He is married, has two children and owns his own home and insists his wife deserves some credit for his success. END

# taking the MYSTICISM OUT of MATCHING

By HERBERT A. RAVENSWOOD

## If we know what to match, and why, most of the confusion disappears

MOST discussions of matching start with a mathematical formula showing that a certain relationship will result in maximum power transfer, efficiency of operation or what-have-you. One learns this in high school (or is it college these days?). Often it is much later that—more or less accidentally—we learn that the mathematically ideal relationship is seldom used, for reasons which remain obscure. The only way to remove the general obscurity that surrounds this subject is to deal with each case specifically.

At the input end *maximum power transfer has no significance*. A tube needs an input grid *voltage* and a transistor needs *current*. Where the level is low, it is particularly important to get the maximum voltage or current input to achieve the best possible margin above noise level. Even where noise is not a problem, the same choice will minimize the amplifier gain needed, and possibly save a whole stage.

But achieving a satisfactory frequency response, or keeping distortion down, usually sets opposing limitations. To be specific:

A magnetic pickup cartridge, microphone or tape playback head has a resistance of about 1,000 ohms with some inductance. It consists of a magnetic circuit on which a coil is wound to provide the electrical output. The coil has fixed physical dimensions set by the design. The number of turns that can be squeezed into the space depends on the wire gauge. The more turns, the higher the voltage output and also the higher the resistance and inductance of the winding. To "match" a grid input, an impedance of several thousand ohms at least would be needed, but the limit is usually set by the finest wire gauge that can be wound into the space.

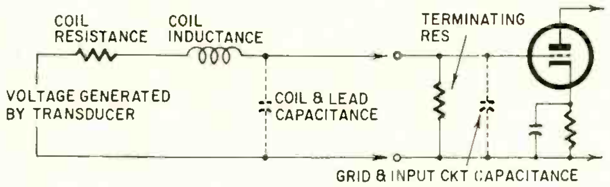



**Fig. 1 — Factors in matching magnetic transducer to tube input.**

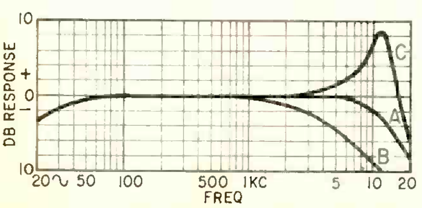



**Fig. 2 — Effect of loading on typical magnetic pickup: (A), equalized response, R = 25,000 ohms; (B), R = 10,000 ohms; (C), R = 100,000. (Pickup resistance, 1,250 ohms; inductance, 250 mh; total shunt capacitance of pickup, input lead and grid, 450 μμf.)**

So we have a coil with a resistance of about 1,000 ohms and an inductance of about ½ henry—this will vary in individual cases. Voltage output would be maximum by working open-circuit —no terminating resistor. In this case, the terminating resistor is needed to optimize frequency response. Without any terminating resistor, the inductance of the coil resonates with the combined capacitance of the input lead and the grid of the input tube, to produce a high peak in response at the top end (Figs. 1 and 2).

An ideal resistance termination gives the closest possible to flat response, by holding down this resonance—shunt damping. Make the resistance too low, and the high-frequency response droops down: all the output voltage gets lost (at higher frequencies) in the series inductance of the coil.

Moving-coil types have much smaller coils, with much lower resistance and usually almost negligible inductance. This means they also have much fewer turns, hence much lower voltage output. Moving-coil microphones *must* use some input transformer arrangement to get enough input voltage (above noise). The coil resistance is usually about 50 ohms. The transformer should step this up to an impedance value between 50,000 and 250,000 ohms. The higher impedance, because of the greater step-up it gives would help gain or sensitivity, thus defeating noise better. But input capacitance across the high impedance results in loss of extreme high frequencies. So for best high-frequency response, the lower impedance (in the region of 50,000 ohms) is better.

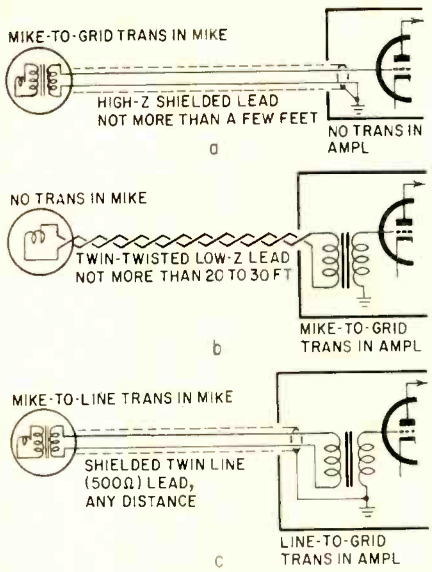



**Fig. 3—Three methods of coupling moving-coil microphones.**

This stepup from 50 ohms can be made in one of three ways: for quite short shielded-lead input, a transformer on the microphone steps up directly to 50,000 ohms or so (Fig. 3-a). Any moving-coil microphone rated high impedance has such a transformer built in. But a shielded lead of more than a few feet increases the input capacitance, loading the high frequencies down so that even 50,000 ohms is too high.

For medium-length leads, the transformer can be on the amplifier chassis instead (Fig. 3-b). Now the impedance of the connecting lead is 50 instead of 50,000 ohms. This avoids high-frequency loss, but is more susceptible to stray inductive pickup, resistance losses in the line and grounding problems.

So, for more than 20 or 30 feet (100 feet at the outside), line impedance is best. The microphone transformer steps up the coil impedance to line impedance (250 or 500 ohms) and the amplifier transformer steps up from line to grid (between 50,000 and 250,000 ohms as in Fig. 3-c). Use of line impedance is more costly because it requires two high-quality transformers for one connection. It is used only where distances are long, or where standardization is more important than cost.

## High-impedance devices

Crystal and ceramic microphones and pickups are called "high impedance," from which information one might believe they are like a magnetic or moving-coil type, with matching transformer. Actually they are quite different. The impedance of a magnetic or moving-coil type always consists of resistance and inductance in various proportions. The transformer does not alter these proportions, merely their magnitude and the voltage they put out. But the impedance of a crystal or ceramic element is basically that of a small capacitor.

Applying the classic matching principle, maximum volt–amp transfer would require the load to be an equal capacitance (Fig. 4-a). Maximum voltage (which is what we want for a grid input) requires the load to have the smallest possible capacitance. So a shielded lead, with its capacitance effect, will modify the transfer, not just at high frequencies as with other types, but throughout the range. Putting any resistance—such as the usually needed grid leak — results in low-frequency loss, the same as a coupling capacitor feeding into a grid resistor does.

But you can always make the coupling capacitor bigger to get the required low frequencies. With crystal or ceramic transducers, the capacitor is fixed for you. The only way to improve low-frequency response is to use a bigger *resistor*—usually several megohms (Fig. 4-b). You can also add external capacitance (Fig. 4-c), so the resistance may be smaller, but this "improves" bass response by pulling

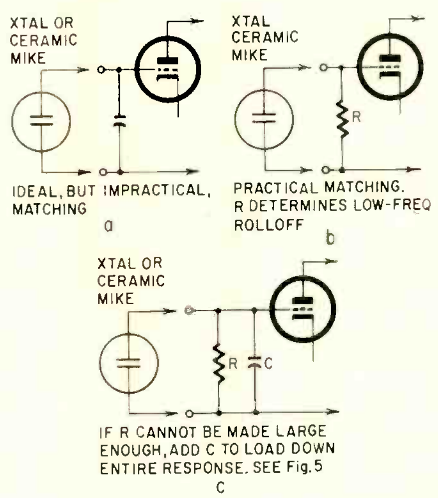



**Fig. 4—Considerations in matching a crystal or ceramic transducer.**

all the rest down to correspond (Fig. 5).

An interesting matching trick with ceramic or crystal elements is loading them to make their output correspond with that from a magnetic type (Fig. 6). The output voltage of magnetic and moving-coil types is proportional to the *velocity* at which the stylus or diaphragm moves. A ceramic's output is proportional to *distance of movement*. If the stylus moves the same *distance* at different frequencies, it will have to move *faster* when frequency is higher. So a velocity pickup has a response, compared to ceramic types, that rises with frequency.

To make a ceramic "look like" a magnetic, its response must be made to rise with frequency too. Viewed the other way, it must be given a "bass cut" until the top end is left standing high. The whole equalization curve tilts the other way. Appropriate choice of values to suit the ceramic element will give precisely the right response. These have to be chosen by the manufacturer, because he doesn't tell you the capacitance of his element.

## Transistors

So far we've talked about tubes,

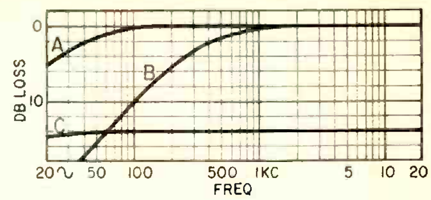



**Fig. 5—Curve A, no capacitance, 10-megohm load; B, 1-megohm load; C, input capacitance 2,000 μμf, 10-megohm load. (Microphone capacitance 500 μμf.)**

where the important input quantity is volts. Transistors will change all that. The basic input quantity of a transistor is current. But it does possess an input resistance or impedance. So *basically* the maximum power transfer rule will now apply. But there are different ways of meeting it.

The transistor input impedance depends largely on the emitter resistor (Fig. 7). Suppose the transistor has a current gain of 100. If the emitter resistor is 10 ohms, the input impedance (the product of current gain and emitter resistor) will be 1,000 ohms; if it is 50 ohms, the input impedance becomes 5,000 ohms. Now suppose a magnetic or moving-coil transducer (microphone or pickup) can be wound to any desired impedance. Let's take three possibilities: an output impedance of 1,000 ohms, with open circuit voltage of 10 mv; an impedance of 5,000 ohms, voltage 23 mv; an impedance of 16,000 ohms, voltage 40 mv.

First use the 10-ohm emitter resistance: The 10 mv from the 1,000-ohm version has to drive current through a total of 2,000 ohms, 1,000 ohms of its own and 1,000 the input impedance of the transistor. So the input current is 5 microamps. A gain of 100 brings this up to 500 μa. The 5,000-ohm version produces 23 mv, and has to feed a total resistance of 6,000 ohms, giving a cur-

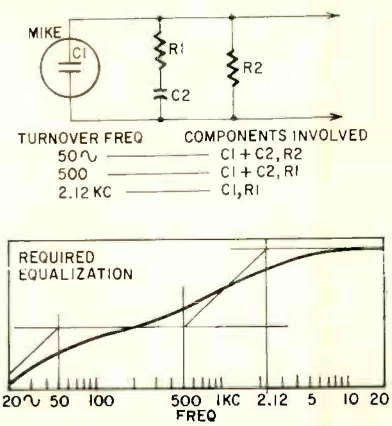



**Fig. 6—Network to obtain RIAA equalization with crystal or ceramic pickup.**

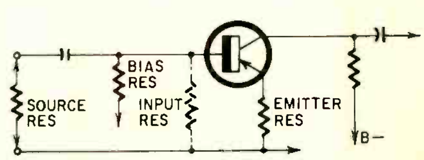



**Fig. 7—Emitter resistor helps match and linearize input impedance.**

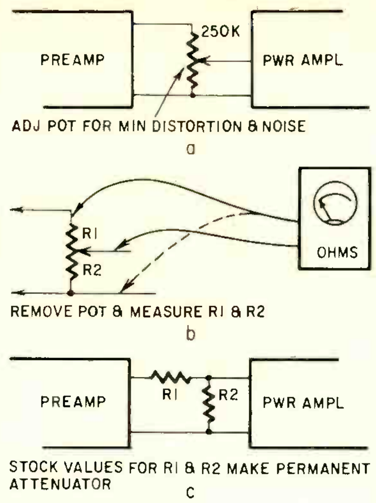



**Fig. 8—How to install an attenuator between preamp and power amplifier.**

rent of 3.8 μa. The transistor amplifies this to 380 μa. The 16,000-ohm version produces 40 mv, feeding a resistance of 17,000 ohms, giving 2.3 μa, which gets amplified to 230. The 1,000-ohm version, giving proper matching, is best.

Now try the 50-ohm emitter resistance: The 10 mv from the 1,000-ohm version now has to feed 6,000 ohms, resulting in 1.6 μa, amplified to 160. The 23 mv from the 5,000-ohm version has to feed 10,000 ohms, resulting in 2.3 μa, amplified to 230. The 40 mv from the 16,000-ohm version has to feed 21,000 ohms, resulting in 1.9 μa, amplified to 190 microamps. Here again, the best output is obtained by matching—using the 5,000-ohm version.

But this is assuming we fix the emitter resistor first. The highest output of all was from the 1,000-ohm version feeding the 1,000-ohm input (10-ohm emitter resistor). But notice that all the outputs using a 10-ohm emitter resistor are greater than the corresponding ones with the 50-ohm emitter resistor.

Then it seems we should use the lowest emitter resistor possible (why use any at all?) and then match the transducer impedance to the transistor input impedance. But, if you do that, you'll run into severe distortion. The transistor's amplification characteristic may be linear enough, but its input impedance is extremely nonlinear. If the transducer generates a linear voltage, the current will be nonlinear because the input resistance is. Using a high emitter resistance linearizes the input impedance.

So solving the matching question in transistor input circuits depends on what you have control over. The best thing is to set the emitter resistance to the best compromise between the gain finally achieved and the distortion, and then design the transducer to match the input impedance that results. But, if your input source is already fixed for you (say it's a crystal or ceramic pickup), the maximum gain will be obtained by making the emitter resistor as low as possible. This will produce less distortion than the matched condition because the internal resistance or impedance of the source itself will linearize input current.

On the other hand, if the input impedance is low—say a moving coil, without any matching transformer—distortion would probably be much too high if you use the emitter resistor to match input source because the transistor input impedance is nonlinear at such low values. In this case, a higher-value emitter resistor should be used, resulting in mismatch with resulting loss of gain, but linearizing the input impedance of the transistor.

Those are the main cases of input matching. Sometimes a problem may arise where more than one source is connected to the same input, but that can get into a big subject and is really beyond the simple subject of matching.

## Preamp to power amplifier

Impedance matching between preamp and power amplifier is not too often a problem. More often, there is a question of level to consider. But the use of a cathode follower (or not) has raised questions related to impedance.

A cathode follower provides a low-impedance source, around 500 ohms. But the output still comes from what is really the plate circuit of a tube. The voltage and current fluctuations in the output are provided by the plate-voltage drop and plate-current variation in the tube. The fact that the 100% feedback due to cathode-follower connection makes the source impedance about 600 ohms does *not* mean it will work satisfactorily into a load of 500 or 600 ohms, or anywhere near this value.

The normal optimum load for the tube is probably at least 20,000 ohms. The plate-circuit impedance is the parallel combination of the plate coupling resistor (even though this is cathode-connected) and the ac resistance of the tube. This is probably 7,000 or 8,000 ohms. Cathode connection produces something over 20-db feedback; its effect is to reduce the *effective* plate circuit impedance to around 500 ohms.

But if you connect this to an actual 500- or 600-ohm load, such as a line input transformer on the basic amplifier, the plate circuit of the tube is coupled to a 500- or 600-ohm load. The distortion will be about 20% and the feedback has almost disappeared. This was fully explained in RADIO-ELECTRONICS, December 1954, page 50, and May 1958, page 50.

Summarizing the value of a cathode-follower preamp output, for matching purposes: It minimizes the tendency to hum pickup that occurs in a high-impedance connection and also loss of high frequencies due to cable capacitance. It also enables one preamp to be connected to several power amplifier inputs—provided they are all high-impedance—without interaction. But it does not permit the preamp to be connected to a 500- or 600-ohm input—unless you want lashings of distortion.

## Level matching

This aspect of matching is often overlooked, both at the input and between amplifiers. If the impedance is right, it should work! Not infrequently it doesn't because the level is not right too.

If the output level from the preamp is much too low to drive the power amp, the result is obvious—there just isn't enough gain. But sometimes the output level may be too low when it needn't be, and when cause and effect are not obvious.

This is the case where the basic amplifier is driven to full output with a level much lower than the preamp is designed to work at. True, it will work there, by turning the gain or volume down. But this results in unnecessarily high noise. What is needed is either to turn back the preset control on the power amplifier or, if there isn't one, insert an attenuator to serve the same purpose (Fig. 8).

To set up your attenuator, insert a pot between preamp and amplifier (Fig. 8-a) and adjust it till volume is correct. Then remove the pot without disturbing the adjustment and measure the resistance of the two portions (Fig. 8-b). Then insert resistors of equivalent value, as in Fig. 8-c. (A good place to put the attenuator is just inside the power amplifier input connection.)

The opposite can happen, usually when the power amp does have a preset control. This control is set too far down, so a high level is needed from the preamp. The preamp will supply it, but only by producing some distortion. The preset control on the power amp should be set to avoid causing distortion because the transfer level is too high, or increased noise or hum level because it's too low.

If the power amplifier just doesn't have enough gain, and therefore requires too high an input level, the preamp distorts to get full output. There are two answers to this problem: buy a new amplifier or preamp, so the transfer level is satisfactory; or add an extra stage between them to make good the gain deficiency, so the preamp can work without distorting.

Well, that's about half the matching story. We still haven't touched the output end, where the traditional power-transfer objective is at least more nearly encountered. That will be the subject of another article. END

## PROGRESS NEEDS RELIABILITY

The reason for many of the recent rocket failures may just be the problem of the startling amount of reliability required, according to *Miniaturesque*, a publication of Miniature Precision Bearings.

The average guided missile has 37,000 parts (and many of these are made from several pieces). If each of these items can be made so reliable that it would fail only once in 100,000 times, the mathematical chances are that one missile in three would misfire.

The goal the industry is striving to reach is for each item to be so reliable that it would not fail in 300,000 times. That's reliability!

# 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 was an extremely old joke, back in the early days of radio, about "Them things are no dern good; I can't hardly git enough light out of them little lamps to read by at all!" While the joke may not be any better now than it was then, it would do us some good to give just a little more attention to filaments and heaters. I'm afraid that some of us tend to regard them as something that's just "there to read by," instead of a very important part of a vacuum tube.**

Tube heaters are rather accommodating as far as voltage goes. They will work with quite a bit of difference between their rated voltage and what they actually have, but even these comparatively wide limits may be exceeded. So if you run into a mysterious trouble in a TV receiver, after everything else has been exhausted, check the heater voltage!

I remember one case in particular. I was faced with some very unusual symptoms which seemed to be centered around the video amplifier stage. Everything there checked out fine. Did I say everything? All but one thing! The tube was shielded and pretty dusty, and I was in a hurry. Finally, I took the shield off and wiped the dust away, and lo and behold, that tube was lit up like a Christmas tree! You could have read by it, almost. So, out and into the tube checker. (Should have done this first, as I keep telling everyone else!) However, this time the trouble was obvious. It was a 6AW8, and it required an abnormally low 350 ma to allow 6 volts to develop across it. Being in a 600-ma series string, it naturally lit up pretty bright. This boiled out the gas, raised the cathode temperature away above normal and played heck with the whole stage in general!

I spotted this one as soon as I put it in the tube tester, although I had my suspicions of it at the time. For just this reason, I have added a heater current meter to my tube tester, along with a voltmeter (Fig. 1). This is extremely handy in cases like this, although I will admit they are not too common. But, when you do run up against something like this, they're awfully handy! (You just put the ammeter in series with your common lead from the tube-tester filament transformer. Notice that I used two ranges: 0–1 and 0–5 amperes, although I didn't mark the 0–5 range as such—the shunt switch just says "High". The shunt's a piece of solid wire, cut and try. Put a 2-ampere tube like a 5U4 in the socket, and adjust the shunt until the meter reads 2 amps. Simple, huh?)

This is extremely handy for spotting series-string tubes that are just a wee bit off. Not ones that are completely out, like my 6AW8, but the type with only a single fold in the heater shorted, so the cathode runs colder than it should. When testing, set the current meter to what it should read, then read the voltage. This will tell you exactly what the tube is doing in the circuit!

I might add that this is also handy while checking a whole set of tubes, if you are unfortunate enough to have to do so. Watch the ammeter when the tube is inserted in the socket. If it doesn't jump immediately, the tube is dead! (Or you haven't got the tube tester set up right!)

I might also recommend checking the heater voltages in mysterious cases of fading out in parallel-wired filament strings. Any tube in the set can cause trouble, especially the picture tube, if the heater has a cold-solder joint at its ground lead, the most common location for such troubles.

In this case, of course, the test should be made, not at the tube socket, but on the ends of the heater pins. This will catch the rare case where a socket contact is intermittently open or dirty. Rectifier tubes, horizontal and vertical output tubes, picture tubes and all octal-based types (with hollow pins, I should have said) are prone to this trouble.

Watch out for tubes in this same category which run very hot! In many cases, you'll find that the solder on the ends of the heater pins has crystallized and become intermittent. This can be spotted by the peculiar rough appearance of the ends of the pins. Some of them get so bad that a distinct crack can be seen all the way around. Resolder them, and you may cure the trouble.

## Horizontal wiggling

*I have horizontal wiggles on the*

(*Continued on page* 62)

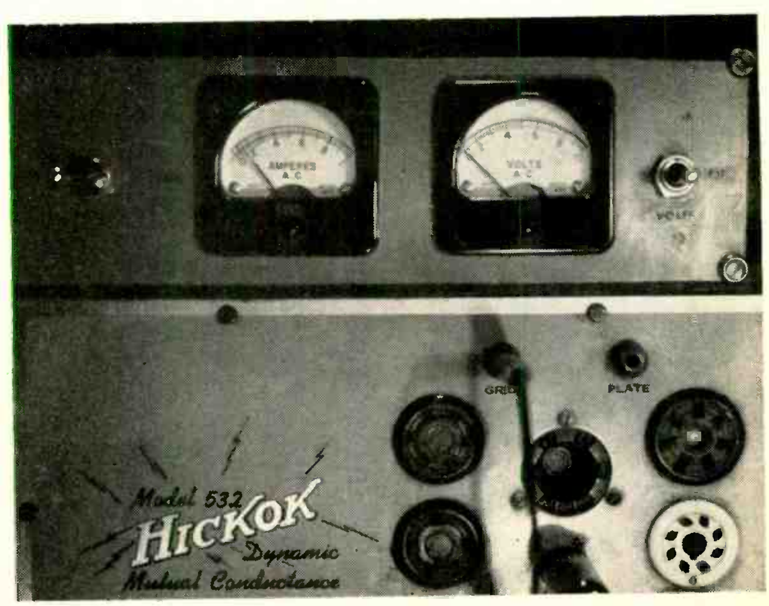



**Fig. 1—0-1 ac ammeter added to tube tester. Unit is connected in series with the common heater transformer winding.**

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Heath exclusive; 20 watt *hi-fi rated* PA amp. Two inputs; equalization switches; electrical mixing; sealed "pads"; tape recorder, line, and voice coil output. Plug-in, low-Z mic. Xformers separate. 24 lbs.

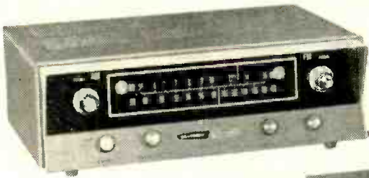
**Kit AA-31**... $6 dn., $6 mo........ **$59.95**
Mic. Xformers, AN-11 **$11.95**

**"LEGATO-COMPACT"**

All Altec Lansing speakers! 2-12″ hi-compliance woofers; exponential horn and driver; range 30-22,000 cps; assembled. 800 cps network. 30 watts program; 16 ohm Z. Assembled, finished cabinets; 32″l x 19″d x 32⅜″ h 132 lbs.

**Kit AS-21U**, unfin.. **$224.95**
**Kit AS-21W**, wal... **$229.95**
**Kit AS-21M**, mahog **$229.95**

**HEATH COMPANY** Benton Harbor, Michigan / a subsidiary of **DAYSTROM**, INCORPORATED



***Introducing a new styling concept in two popular Heathkit Stereo Units***

Here's a handsome matching pair for your new Heathkit stereo system! Both have new louvered wrap-arounds of luggage-tan vinyl-clad steel with contrasting charcoal-grey front panels framed with polished aluminum bezels . . . a regal new look to Heath's medium-price stereo line.

**HEATHKIT AJ-11 AM/FM TUNER**

Successor to the popular AJ-10, this new version features fly-wheel tuning, two "magic-eye" tuning indicators, adjustable FM automatic frequency control, AM "fidelity" switch for max. selectivity or fidelity, dependable 12 tube circuit, built-in power supply. 21 lbs.

**Kit AJ-11**...$7 dn., $7 mo. .............................. **$69.95**
**Assembled AJW-11**...$13 dn., $11 mo. ............... **$129.95**

**HEATHKIT AA-151 28-WATT STEREO AMPLIFIER**

Here's the popular SA-2 model all dressed up in brand-new styling. Delivers 28 hi-fi rated watts (14 per channel) for plenty of power. Has clutched volume controls, ganged tone controls, 4 dual inputs. 28 lbs.

**Kit AA-151**...$6 dn., $6 mo. ........................... **$59.95**
**Assembled AAW-151**...$12dn.,$11mo. ............... **$119.95**

# *can build any Heathkit®!*

**IGNITION ANALYZER**

Switch to primary, secondary, parade or superimposed patterns. See condition of plugs, points, wiring, coil & condenser. Plug-in ID-11 Timing Light available. 15 lbs.

**Kit IO-20**...$9 dn...... **$89.95**
**Assembled IOW-20**. **$169.95**

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Hands-free phone chats! Ideal for conferences, dictation, etc. Place handset on cradle, unit turns on, instantly ready! All-transistor; long-lasting battery power. Easy to build. Ivory color.

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Best value in marine electronics. Detects fish, submerged objects, and bottom depth. Big 4¾" dial calibrated from 0-100'. 6-transistor circuit, battery powered. Corrosion & splash-resistant aluminum cab. Transducer included. 9 lbs.

**Kit MI-10** $7 dn., $7 mo. **$69.95**

**LOW COST 3-BAND MARINE RDF**

Deluxe features at minimum cost. Covers 200-400kc beacons, 550-1600 kc broadcast, 1700-3400 kc marine band. Loop and "sense" antennas eliminate double null. 9-transistor circuit, battery powered. Preassembled tuning unit.

**Kit DF-3** 12 lbs. $10 dn. **$99.95**

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*(Continued from page 59)*

*screen of an RCA KCS-34C. The scope doesn't show anything wrong in any part of the circuit that might be causing it.—A. F. M., Buffalo, N. Y.*

This chassis has a rather unusual dc voltage distribution system, as you have no doubt discovered by now. Many cathode circuits are returned to negative bias lines as shown in the basic dc distribution circuit in Fig. 2. The horizontal oscillator circuit is a Synchroguide, pretty well immune to pulling or wiggling, if properly adjusted.

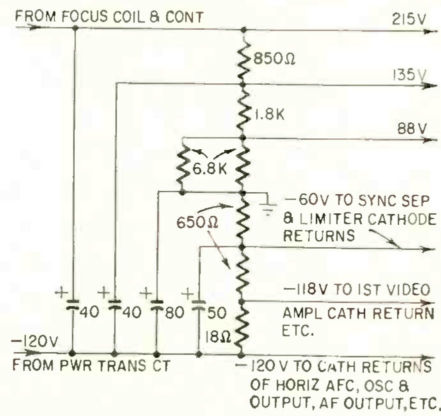



**Fig. 2—Dc distribution circuit of RCA KCS-34 chassis.**

As a first step, make a complete readjustment of the Synchroguide, as per the instructions. After that, check all the electrolytic capacitors along that tremendous voltage divider! It would also be wise to check the 10-μf unit connected to the vertical height control. The basic cause of such troubles is leakage of pulse or sine-wave voltages from power supply or sweep circuits into sync or control circuits. Therefore, use the scope to check the dc supply lines for the presence of ripple of any frequency. The −120-volt line would be the most likely suspect.

## Loss of height

*A Motorola TS-60 has a momentary loss of height when switching channels. The vertical hold control works OK, but somewhere in its range the picture collapses.—J. P., Bronx, N. Y.*

This is one of two things or possibly both at once! You've either a bad spot on the vertical hold control, which opens the circuit when the slider passes it, or the vertical oscillator is operating in a marginal condition—that is, right on the edge of its holding range, ready to fall out at the slightest disturbance.

Check all your vertical circuit adjustments—height, linearity, hold—and reset them to get the oscillator back to center. Clean the controls with spray cleaner, and replace any that are worn. In a chassis this old, this is a distinct possibility!

## Bad brightness control

*I have two RCA KCS-82 chassis with identical troubles. The brightness control won't black out the raster. All parts in the brightness control circuits are OK. The voltages read with brightness*

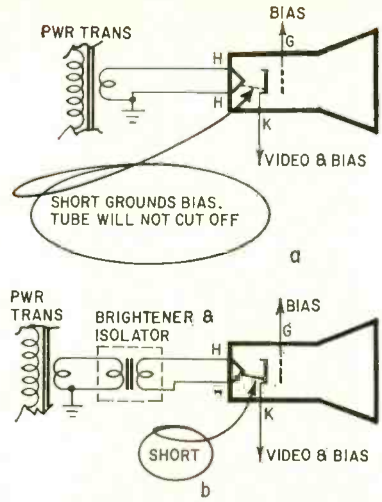



**Fig. 3—Heater–cathode shorts in CRT can result in fixed brightness.**

*control at full off and full on are as follows: grid, 8 to 120; cathode, 90 to 180.—J. F. N., Carlton Hill, N.J.*

Sounds as if you have the same trouble in both sets: a shorted picture tube! If the cathode shorts to the heater, all bias control is lost, as the brightness control will not reduce the bias enough to cut off the electron stream. So, the screen stays lit all the time. Check both tubes with a good CRT checker. Sometimes this is due to small flakes of matter falling between cathode and heater, pieces of the cathode coating, etc. In a few cases, these can be flashed off by the short-check voltage.

You might install an isolating type brightener. It will open the ground on the heater circuit, and allow the tubes to work again (Fig. 3). Most of these have a tap which allows use as an isolator and doesn't raise the heater voltage.

## Interference

*We're located about 9 air-miles from a 316-kw channel 10 station. In a few weeks there will be a channel 9 station, about 250 kw, 60 miles east. We expect a lot of interference problems! I don't believe there is any kind of magic antenna that will solve this one! Is there a practical and not-too-complicated method of sharpening the video if and improving the selectivity? I'd like one that could be switched in and out at will.—G.C., Breaux Bridge, La.*

This *is* a toughie! Because of the extreme bandwidth required in a TV set, selectivity in the average front end is practically nonexistent, and the video if isn't much better! However, all is not lost. By using a combination of methods, I think you'll be able to alleviate if not cure completely most interference troubles.

The first thing, on *all* sets, would be a thorough video if realignment, mostly for the purpose of setting the adjacent-channel and co-channel traps *exactly*. Then do the same thing to the tuner. The use of an antenna cut for the distant station, with an extremely long, narrow frontal lobe and very small side lobes would be of some help. Watch out for some of the all-channel types. There are a few which have extremely large side lobes, especially on the high band! Possibly one of the screen-reflector types would help.

Probably the handiest and most efficient aid here, and certainly the only one which would meet your spec's on switching in and out, would be a tunable trap in the lead-in. Jerrold makes one under the name Trap-Ease. It is simply a very sharp notch filter with tuning and fine tuning, and is quite effective. Be sure to get the high-band model.

## Unstable horizontal hold

*I have a problem with a Magnavox TV chassis U24-04AA. The horizontal hold control is not stable. I can lock a picture in, but just a little turn of the control and it drops out of sync. I have checked all capacitors and resistors in the horizontal circuit. The customer says the hold control has always been sensitive. Can I make it more stable by changing some of the parts in the circuit?—C. S., California*

You should be able to get better horizontal hold action in this chassis. The first step would be a complete readjustment of the horizontal oscillator (Fig. 4).

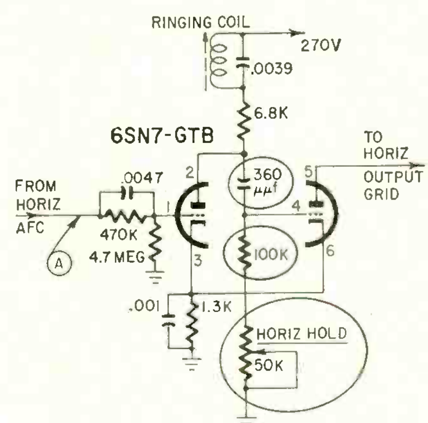
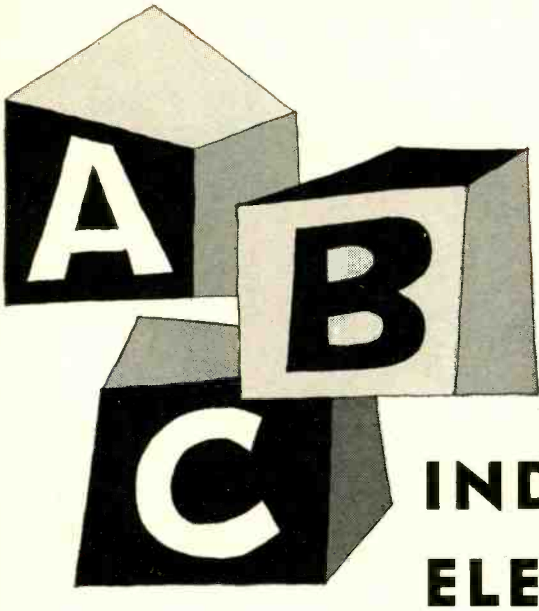



**Fig. 4—Unstable horizontal hold was traced to this section of a Magnavox U24-04AA.**

Short out the ringing coil and ground point A. You'll probably have to increase the 6,800-ohm plate resistor to about 15,000 temporarily, to keep the oscillator running. Now see if you can get a picture to stand nearly still by adjusting the hold control.

If you can't, check the value of the 100,000-ohm resistor and the hold control. If the hold control winds up jammed against the stop at either end, there's something wrong there. Also check the 360-μμf coupling capacitor in the grid circuit.

You can probably get more hold range by changing the hold control to a 100,000 ohms and the 100,000-ohm series resistor to 47,000. Check the voltage on the first grid (take the short off point A first) to see if it is nearly zero with a picture locked in. If not, check the 4.7-megohm grid resistor and the R-C network between the grid and the horizontal afc. END




# INDUSTRIAL ELECTRONIC DICTIONARY

By ED BUKSTEIN*

MUCH OF THE TERMINOLOGY USED BY the industrial electronics technician is the same as that of the communications man, TV service technician and other workers in the electronics field. But many terms apply strictly to the industrial field. The following definitions have been selected as those most likely to be of interest to technicians already in industrial electronics and to those wishing to enter this field.

### A

**Amplitude-controlled rectifier:** A rectifier circuit employing a thyratron as the rectifying element. In addition to the usual advantage of a gas-filled rectifier—lower and more constant voltage drop—the thyratron offers another important advantage: dc rectifier output can be controlled by varying the bias. As shown in Fig. 1, increased bias causes the tube to ionize later in the plate-voltage cycle. This *delayed firing* of the thyratron occurs because the plate voltage must reach a higher value before the gas can ionize. At a lower bias, the thyratron ionizes at a lower plate voltage and the tube fires earlier in the cycle. Variation of bias voltage can be used to control the conduction time per cycle of the thyratron, and therefore the average current through the load.

The load is represented by a resistor in Fig. 1, but in practice may be the armature of a dc motor (for speed control), the heating element of a furnace (for temperature control), etc. A half-wave circuit is shown in Fig. 1, but it can be extended for full-wave operation by using an additional thyratron and a transformer with a center-tapped secondary.

In the amplitude-controlled rectifier, half-wave or full-wave, thyratron firing can be delayed through an angle up to but not beyond 90°. If the thyratron has not fired by the time the plate supply has reached its peak value (90°), it will not fire at all. So load current (and voltage) can be varied from its maximum value to about half of maximum. This limitation is overcome in the *phase-controlled rectifier* in which thyratron firing can be delayed up to nearly 180°.

**Angstrom:** A unit of measurement commonly used to specify the wavelength of visible light, ultraviolet, infrared and X-rays. The Angstrom unit is equal to one ten-billionth ($10^{-10}$) of a meter.

**Anti-hunt circuit:** A circuit for preventing excessive correction in a control system. In automatic control systems designed to hold some quantity (temperature, pressure, mechanical position, etc.) at a constant value, the anti-hunt circuit prevents the controlled quantity from rapidly and alternately increasing and decreasing around the desired value. In a temperature-control system for example, a decrease of temperature will unbalance the system and initiate a corrective action. If the correction is excessive, the temperature will rise above the desired value. This will cause the system to initiate an opposite correction, and the temperature may now fall below the desired value. The anti-hunt circuit, which may be nothing more than an R-C network, prevents such oscillation of the temperature above and below the desired value.

### B

**Back-to-back circuit:** Two tubes connected in parallel but in opposite directions. Two ignitrons (Fig. 2) are often so connected to control the current through a welding transformer. The back-to-back circuit, also known as an inverse-parallel connection, permits control of the current *without* introducing rectification.

The ignitron is a liquid cathode (mercury) type tube. Because the liquid cathode is not damaged by ion bombardment, the ignitron can safely carry hundreds of amperes of current flow. The ignitor, a pointed rod extending down into the liquid mercury, is the tube's starting electrode. When current is passed through the ignitor circuit, an arc forms at the junction of the ignitor and the mercury pool. This arc vaporizes and ionizes some of the mercury, initiating a flow of current to the anode.

As shown in Fig. 2, the ignitors are controlled by thyratrons connected as an amplitude-controlled or phase-controlled rectifier. Since the ignitron cannot conduct until the associated thyratron has fired, delayed thyratron firing permits delayed ignitron firing. Such delayed firing reduces the conduction time per cycle of the ignitrons and, therefore, reduces the amount of heat developed in the metals to be welded. Thus welding current can be controlled accurately, simply by varying thyratron bias.

TO BE CONTINUED

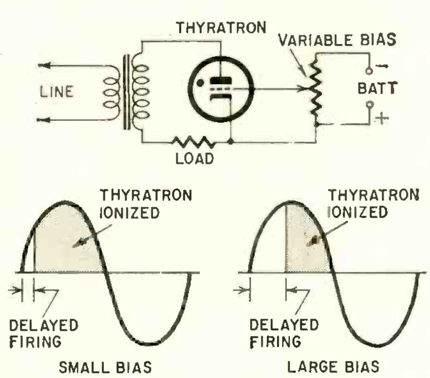



**Fig. 1—Increasing bias on amplitude-controlled rectifier causes tube to ionize later in cycle, reducing average load current.**

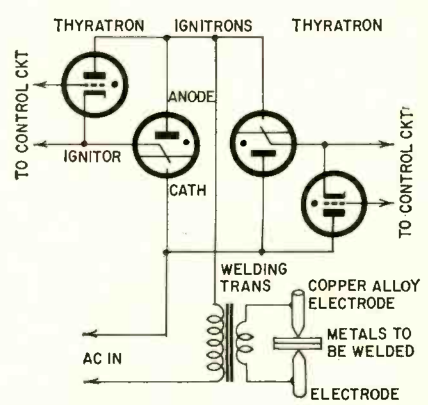



**Fig. 2—Back-to-back circuit controls welding current without rectifying it. Thyratrons permit delayed firing of ignitrons.**

*Northwestern TV & Electronics Institute, Minneapolis, Minn.

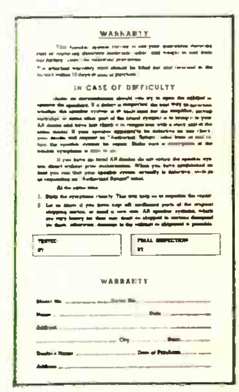
# *Quality Control at AR*

*The frequency response of every AR speaker is checked in an anechoic chamber before it is shipped. (Many other tests, of course, are also made.) Acoustic Research is one of the very few companies in the history of loudspeaker manufacturing, so far as we know, that have followed this rigorous practice.*

Silvano Cannavacciuolo, AR inspector, checks a speaker response curve at one of AR's anechoic chambers. The response curves of the individual drivers in the system he is testing have already been recorded and found acceptable at the main anechoic chamber.

*The purpose of such careful quality control is to make sure, as far as is possible, that AR speakers provide natural reproduction of music, without rattles, buzzes, distortion, or pseudo-hi-fi exaggerations.*

*Prices are from $89. to $225.*




Until now, AR speakers have been sold under a one-year guarantee covering materials, labor, and freight to and from the factory.

On the basis of our field experience we are now able to extend this guarantee to five years. The extension is retroactive, and applies to any AR speakers bought since 1956.

**AR speakers are on demonstration at AR Music Rooms, on the west balcony of Grand Central Terminal in New York City, and at 52 Brattle Street in Cambridge, Massachusetts. No sales are made or initiated at these showrooms.**

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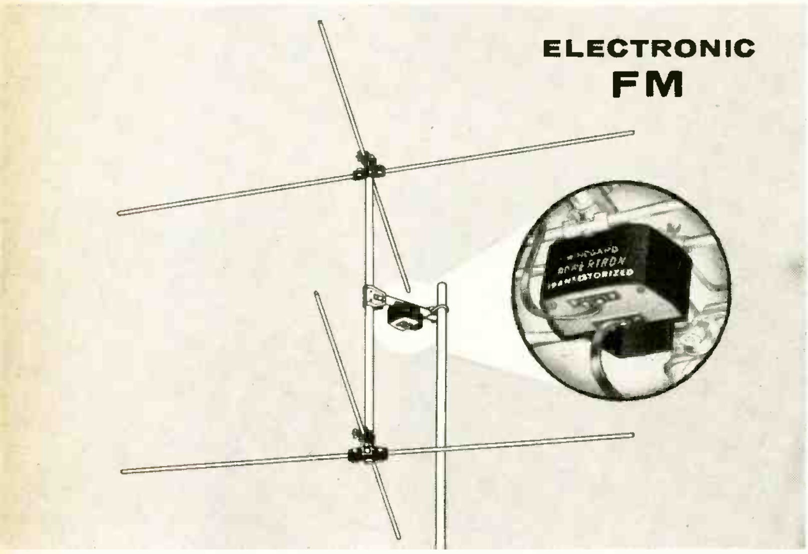
# NOW...A Complete Line of

## Built-in Amplifier clears up snow, improves

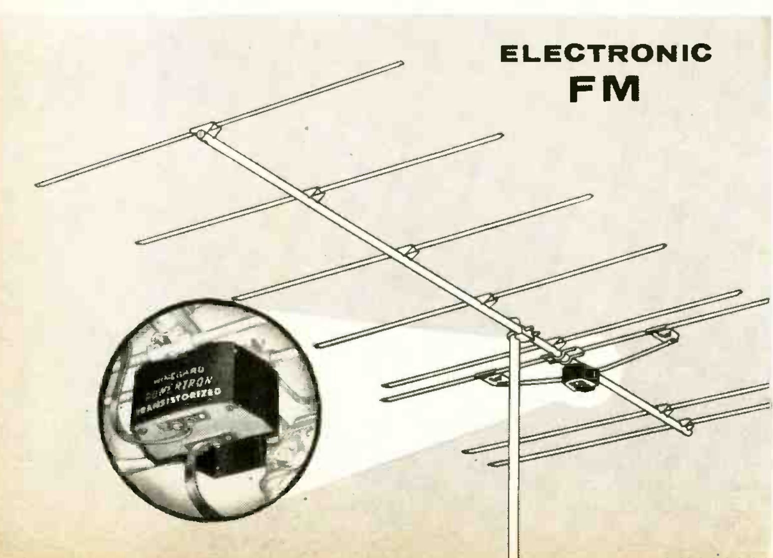



**MODEL PF-T FM POWERTRON TURNSTILE** Non-directional FM antenna with 16 DB gain in all directions over a folded dipole. Has unique offset mount and comes complete with built-in transistorized amplifier and TV-FM coupler.

## NEW, POWERFUL TRANSISTORIZED FM POWERTRONS WITH FM-TV COUPLERS

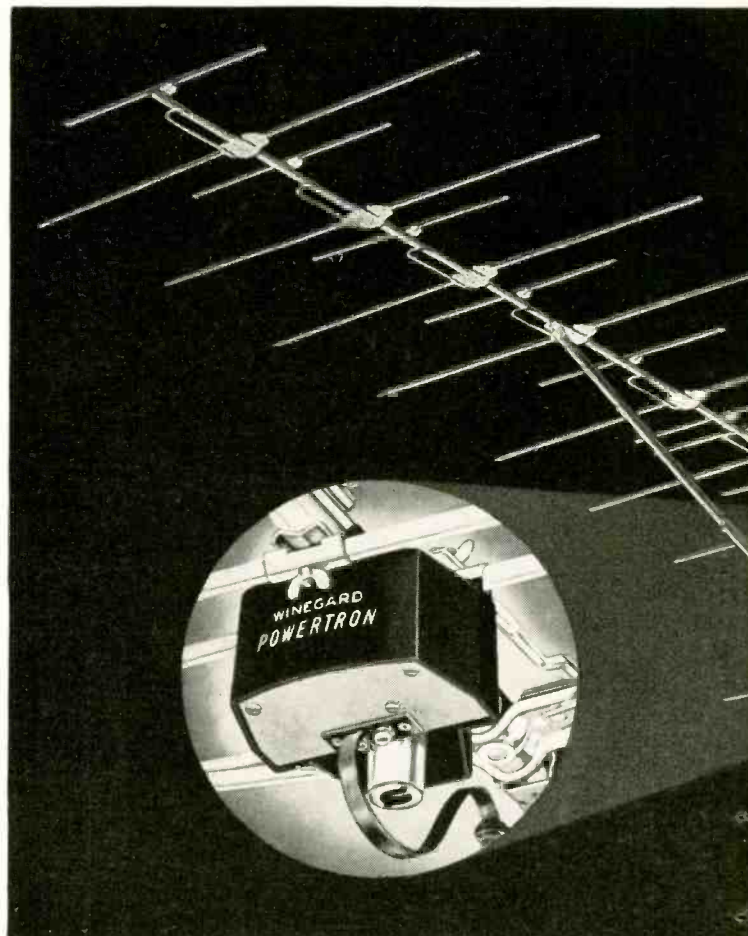
For the first time, FM antennas with built-in transistorized amplifiers are available for long range FM reception. Winegard offers two models — FM Powertron Turnstile (omnidirectional) and the FM Powertron Yagi (directional). Both models have two 300 ohm terminals on the amplifier: one for down-lead connection to the set and one for connection to a TV Powertron antenna.

**MODEL PF-8 FM POWERTRON YAGI** This is the world's most powerful FM antenna. Makes weak signals come in like "locals". Has 25 DB gain over folded dipole. Eight elements with exclusive Winegard "tapered T" driven element. Built-in TV-FM coupler allows you to couple into TV Powertron with only one power supply. Complete with built-in transistorized amplifier.



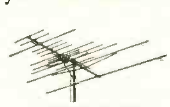

In addition to three all-channel (VHF) Powertron antennas, Winegard now offers you 14 cut-channel and broad band Powertron yagis and two FM Powertrons. Each of these high gain antennas has the following important features:

1. Electronic amplifier for unprecedented antenna gain.
2. Amplifier connected *directly* to the yagi "Tapered-T" driven elements for best possible signal-to-noise ratio.
3. Linear frequency response for crisp, clear black and white and brilliant, true color reception.



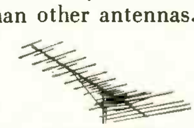

## ELECTRONIC ALL-CHANNEL YAGIS

. . . will greatly improve every channel. Weak, faded pictures become crisp and clear. "Good" channels will be even better. In many areas you'll watch channels you couldn't possibly see before. Because Powertrons are powerful enough to drive up to 10 TV sets, you can have plug-in outlets in every room . . . and in many locations you can install a Powertron lower than other antennas.



**POWERTRON MODEL P-44**
**14-Elements**

**POWERTRON MODEL P-44X**
**21-Elements**



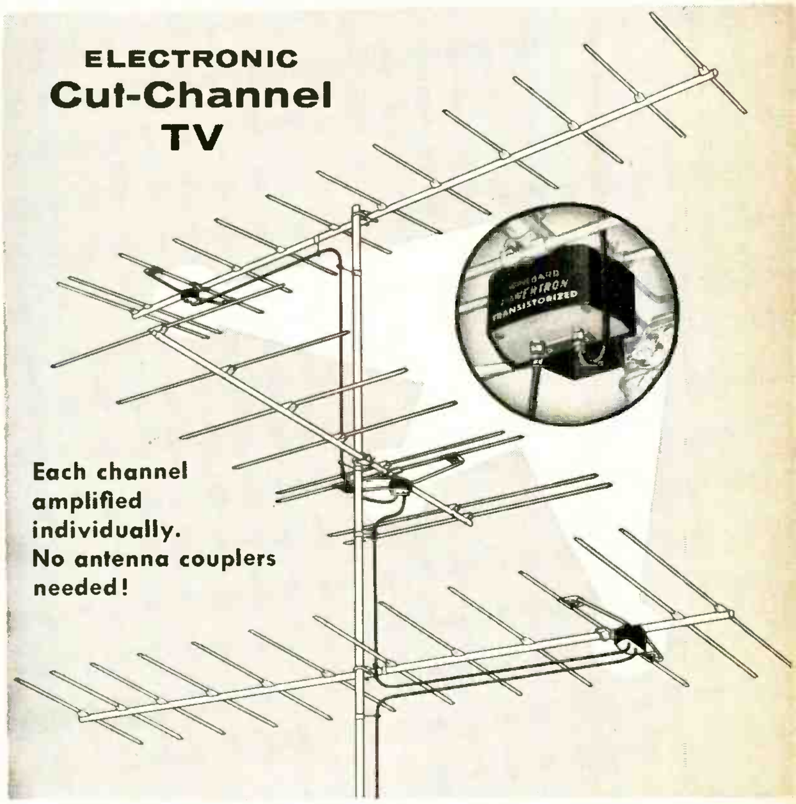
**POWERTRON MODEL SP-44X**
**30-Elements**

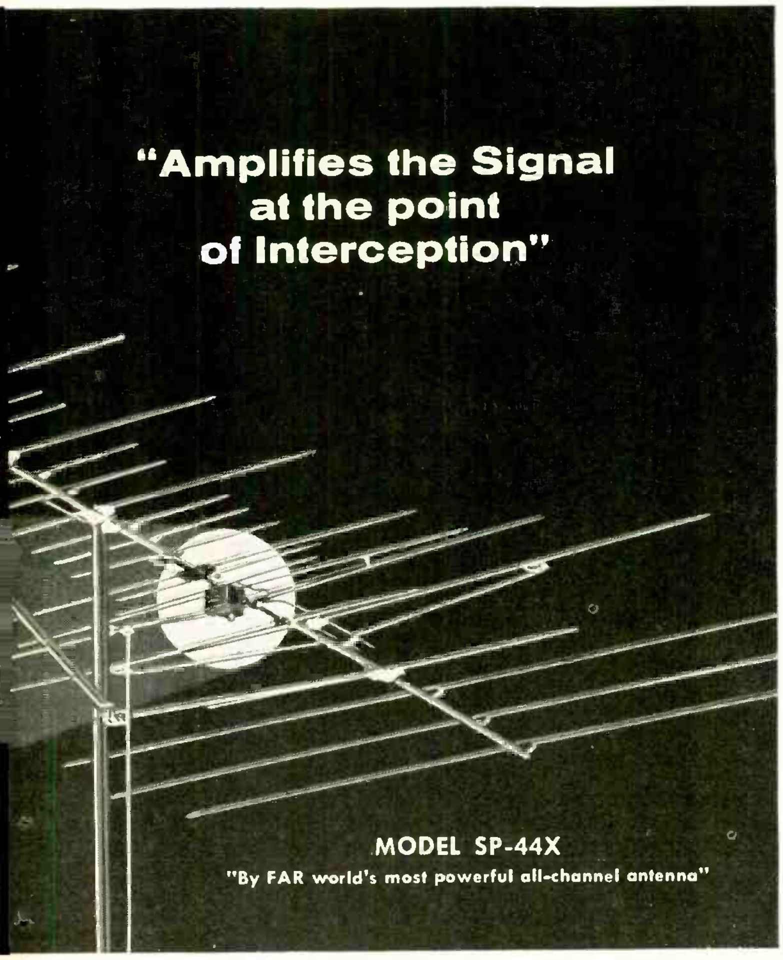
# Winegard Electronic Antennas

## contrast...gives you greater reception distance!

4. Gold Anodized finish for permanent corrosion protection and fine appearance.
5. Deluxe quality materials and workmanship.

Try a Powertron and see for yourself. Take a field strength meter reading with your present antenna and then take a Powertron reading. When you see the meter jump 5 to 10 times . . . and see the sharp, contrasty reception you get, you'll be convinced . . . and so will your customers.



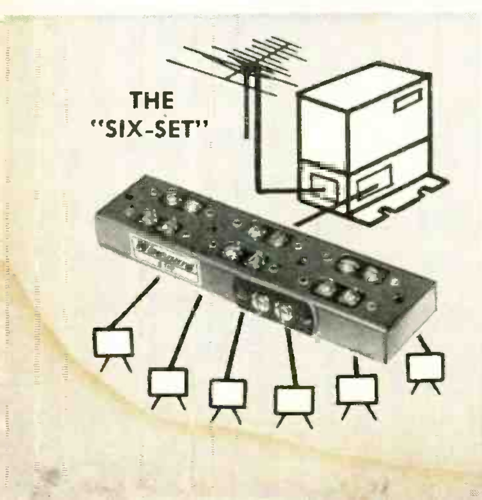

## NEW, TRANSISTORIZED CUT-CHANNEL YAGI POWERTRONS FOR THE FINEST INSTALLATIONS

Here are the highest gain (28 db) TV antennas ever made! Each is powered by a *built-in transistorized* amplifier. Because TV signals are amplified right at the point of interception, you get the best possible signal-to-noise ratio . . . resulting in the ultimate in reception!

Each Powertron yagi amplifier has two 75 ohm coaxial connectors: one for the down-lead to the power supply and one from the built-in coupler for connection to another Powertron yagi.

Because of the built-in mixing coupler, they can be connected directly to each other without interaction. The negligible power consumption of these transistorized antennas (.05 watt each) means you can tie as many as 8 Powertron yagis together and run them all from one power supply on one down-lead.

There are six (8-element) cut-channel and broad low band models—eight (12-element) cut-channel and broad high band models. Ideal for hotels, motels, apartment buildings or wherever the finest installation is needed.




**WINEGARD "SIX-SET" TV COUPLER**

With the Powertron, hook up 3, 4, 5, or 6 sets by adding a Winegard "Six-Set". Here's the only 6 tap coupler on the market. Six no-strip terminals give you instantaneous taps with complete electronic isolation. Model LS-63.

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**ANTENNA SYSTEMS**
Winegard Co., 3013-7 Kirkwood St., Burlington, Iowa

Write today for technical bulletin on Winegard's complete line of Powertron antennas. Ask your distributor for details.

*Speed up scope measurements with this versatile, all-transistor instrument*


# Build a calibrator for your scope

**By R. J. SHAUGHNESSY**

IS YOUR oscilloscope the indispensable, hard-working service tool it should be? Or is it just an elaborate showpiece—nice to have around the shop but limited in usefulness? Once the gloss of novelty has faded, far too many popular-priced scopes fall needlessly into the second category.

R1—3,300 ohms
R2—1 megohm
R3—300,000 ohms, 5%
R4—10,000 ohms
R5—1,000 ohms
R6—pot, 1,000 ohms, linear taper
R7, 8—2,000 ohms, 1%
R9—600 ohms, 1%
R10—400 ohms, 1%
*All resistors ½-watt 10% unless noted*
C1—.003 μf, ceramic
C2—470 μμf, ceramic
BATT—22.5 volts (Burgess U-15 or equivalent)
D—Zener diode, 5.2-6.4 volts, 250 mw (Hughes HZ-B148, Transitron IN762 or equivalent)
S1—2-pole 5-position rotary, nonshorting (Centralab PA-1003 or equivalent)
J1—insulated tip jack, red
J2—insulated tip jack, black
V1, 2—2N34
Battery holder
Terminal strips, 5 lug (2)
Case, 2 x 3 x 5¼ inches
Miscellaneous hardware

Perhaps the greatest reason for this shameful waste of what is certainly the industry's most versatile instrument is the feeling of frustration that comes from not being able to trust the vertical amplifier calibration. Ragged calibration methods can degrade even the best instruments and reduce them to little better than ball-park testers. This is unfortunate because good servicing techniques require accurately calibrated test instruments. Very often, one or two careful measurements with a reliable scope can lick the toughest trouble shooting problems.

Most of the popular low-priced oscilloscopes (kit or assembled) provide some means of calibrating the deflection amplifiers. The typical calibrating signal built into these scopes is a 1-volt

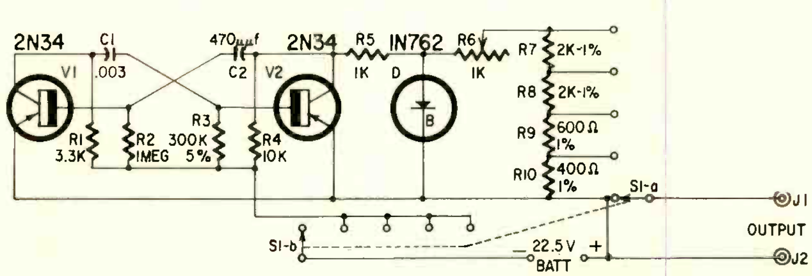



**Fig. 1—Circuit of the 2-transistor calibrator.**

60-cycle sine wave derived from the filament supply. Since there is no ac regulation, the signal amplitude can vary as much as 25% with line-voltage changes. Along with this, calibration with a low-frequency signal is likely to be misleading at higher frequencies unless the amplifier's response is flat to below 60 cycles. Again, when small signals must be measured, an accurate interpolation of the scale from the 1-volt calibrating level depends to a large degree on the amplifier's linearity.

The calibrator shown in Fig. 1 and the photographs was designed to minimize these effects. It has been used in a variety of test applications and has required no adjustment other than the initial setting up of the output voltages. A high repetition frequency (4,000 cycles), flat-topped calibrating waveshape and excellent amplitude stability put the calibrator on a par with those found in scopes in the $500 to $1,000 price range.

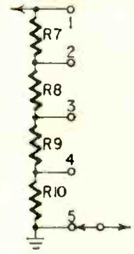
## What makes it tick?

The circuit is basically a clamped, free-running multivibrator whose output square wave feeds a precision-resistor dividing network. The transistors are general-purpose units with a maximum collector voltage rating of 25 and a minimum ac gain (beta) of 25. The multivibrator circuit is not critical and will free-run with most general-purpose units although R1 and C1 values may have to be trimmed for the desired degree of square-wave symmetry. The Zener diode has a useful regulating range of from 5.2 to 6.4 volts, the exact voltage being dependent on Zener current.

Four output amplitudes are available with the divider network shown in Fig. 1. They are spaced to provide optimum calibration coverage, but an almost endless variety of output combinations are possible. Resistor values and corresponding output voltages for three divider networks are given in Fig. 2.

For compactness and portability, the unit is housed in a 2 x 3 x 5¼-inch case. Those who prefer a built-in unit can mount the calibrator's components in a small corner of a scope chassis. If this arrangement is preferred, mount the output selector switch on the front panel and eliminate the battery by using the circuit shown in Fig. 3 to get the −22 volts for the calibrator. The unit draws only 3 ma and most transformers can handle this and the extra small drain needed for regulator diode D. R3 in Fig. 3 should allow about 7 ma to flow through the regulator. To find the proper value of this resistor for a particular scope supply, the rms voltage at the plate of the scope's low-voltage rectifier tube must first be determined. The peak value of this voltage

BASIC VOLTAGE DIVIDER NETWORK




RESISTOR VALUES FOR 3 POSSIBLE NETWORKS

| | A | B | C |
|---|---|---|---|
| R7 | 2K | 4K | 3K |
| R8 | 2K | 500Ω | 1.45K |
| R9 | 600Ω | 400Ω | 450Ω |
| R10 | 400Ω | 100Ω | 50Ω |

OUTPUT VOLTAGES

| NETWORK | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| A | 5 | 3 | 1 | .4 | OFF |
| B | 5 | 1 | .5 | .1 | OFF |
| C | 5 | 2 | .5 | .05 | OFF |

**Fig. 2—Output voltages are based on a 1,000-ohms-per-volt divider network at a current of 1 ma.**

(1.4 times the rms value) divided by the sum of the regulator and calibrator currents (10 ma) gives the total resistance ($R_t$) between ground and the plate of the rectifier tube. Since values for R1 and R2 are given in Fig. 3, the calculations reduce to

$$R3 = R_t - (R1 + R2)$$

where, $R_t$ = 140 times rms voltage at rectifier tube plate. In a typical case where the rms plate voltage is 350,

$$R_t = 140\ (350) = 49{,}000 \text{ ohms}$$
$$R3 = 49{,}000 - (10{,}000 + 4{,}700) = 34{,}300 \text{ ohms.}$$

If you decide to build the portable version, begin by drilling holes in the chassis box for the selector switch, calibrating pot and output jacks. Wire the divider network resistors to the switch before mounting it in the box. When soldering the transistors, use long-nosed pliers to grip the leads between body and soldering-iron tip to prevent damage to them. Be equally careful when soldering the Zener-diode leads.

To adjust the output voltages, you will need a peak-reading voltmeter or a precalibrated oscilloscope. After assembly, switch the calibrator on and connect its output to the vertical input terminals of your scope. The amplitude of the square-wave pattern should increase with each successive step of the selector switch if the circuit is wired correctly. If you don't have a peak-reading voltmeter to check the output amplitude, adapt your vom or vtvm to read peak values by using the simple circuit of Fig. 4. Set the selector switch to 5 volts and adjust R6 until the vom or vtvm reads exactly 4.8 volts. This reading allows for a 0.2-volt drop in the 1N34.

Since all the resistors in the divider network are accurate within 1%, only the 5-volt position need be calibrated. The remaining positions are then best checked by ratioing against the 5-volt position with the plastic scale on the scope face.

Even though total current drain is only 3 ma, be sure to switch the calibrator off after use. In normal operation the battery should last for several months. END

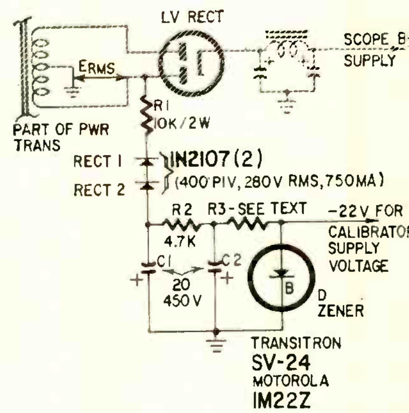



**Fig. 3—Power for the calibrator can be derived from the existing scope B-supply.**

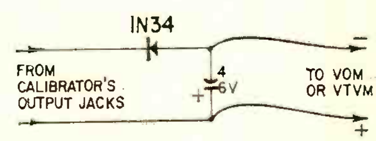
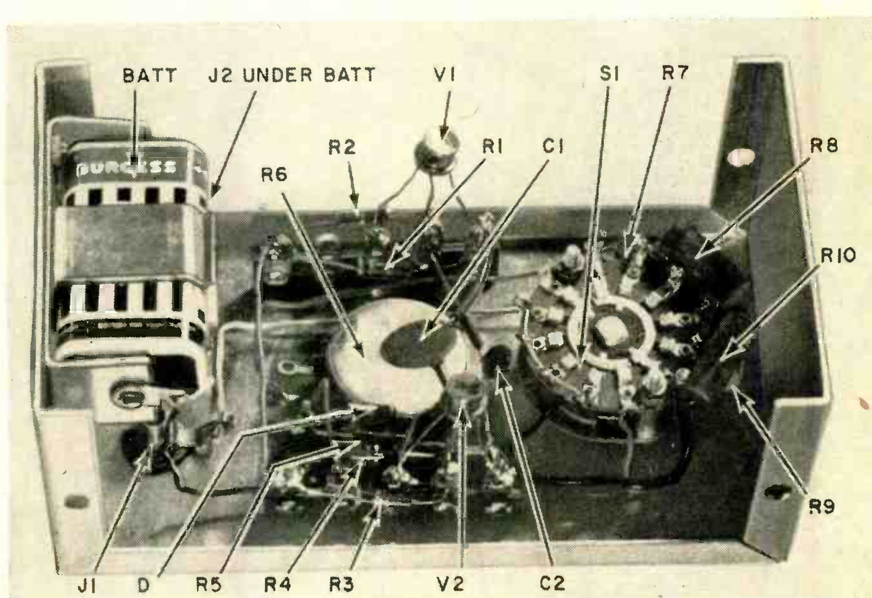
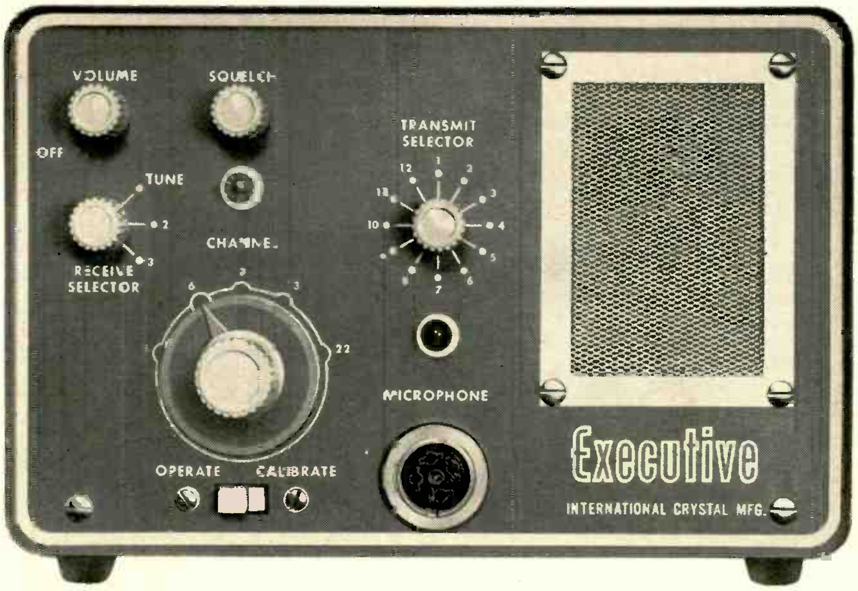


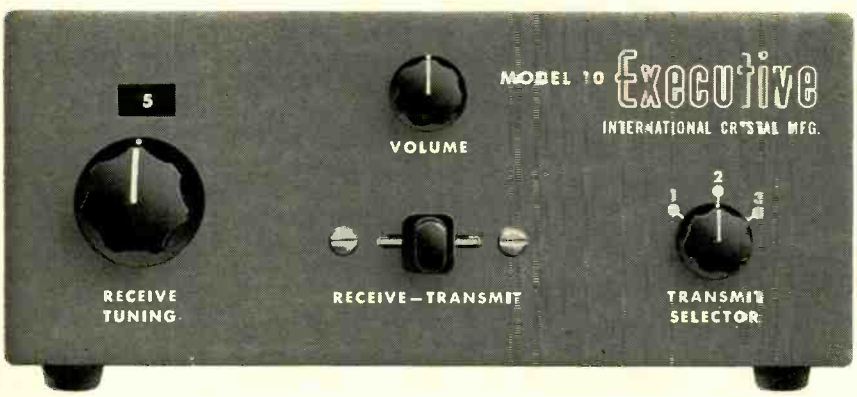

**Fig. 4—Adapter circuit converts vom or vtvm to read peak voltages.**




**Suggested parts layout can ease the wiring problem. Note terminal strips used to mount the transistors.**




**MODEL 100**
*Available after June 15*




**MODEL 10**
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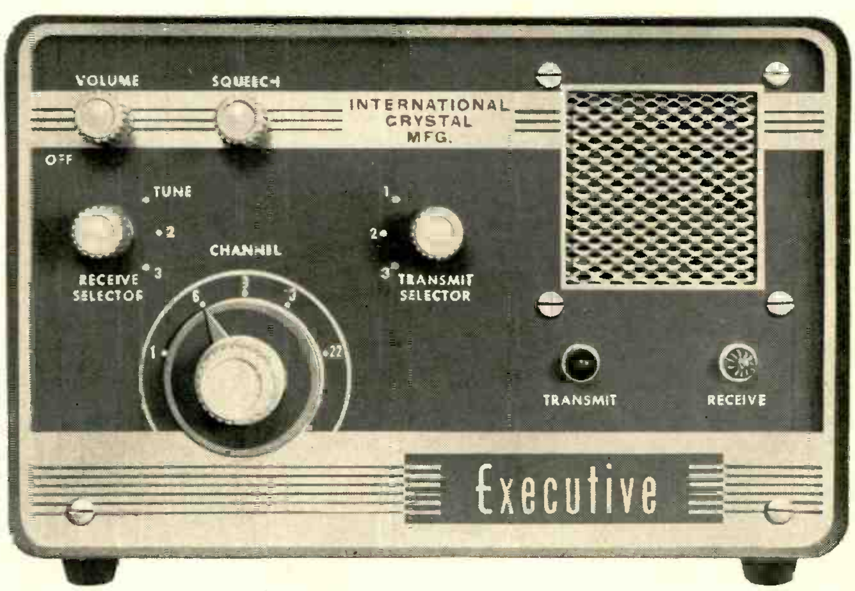


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# What's Your EQ—June Solutions

*Our reader's ideas of the photo-relay problem, also some comment on the other May quiz questions*

## *Frequency-divider puzzle*

At the time of writing, we have only the author's answer to this problem, and several people have suggested that there may be other (and possibly better) answers. Therefore we are waiting till next month, when we may be able to print more than one solution.

## *Service Stinker No. 2*

None of the troubles suggested by the author were found to exist! Despite the appearance of the set, trouble turned out to be heater–cathode short in the 6SN7 vertical multivibrator tube! (Left section, although with these circuit connections, it would seem to be immaterial which one.)

## *The voltage jungle*

Mr. Darling tells us it is possible to get 21 voltages from the 115-volt supply with the transformer he showed if all the possible connections are made. Of course some of them can be obtained in more than one way. Has any reader succeeded in beating the author at his own game and getting *more* than 21 voltages?

## *More on May*

THE PHOTO-RELAY CIRCUIT PROBLEM, published on page 56 of the May issue, was to maintain, with photo-relays, the temperature of an oven between 450 and 500°. The pointer of a meter would block off light to the phototubes at those points. The equipment was to work from a cold start. Fig. 1 shows the setup and the circuit used by Ed Bukstein, who proposed the problem.

Interestingly enough, none of the solutions received at the time of writing duplicate Bukstein's circuit exactly. The closest thing is a sort of complementary circuit (the relays are activated by light, not by its interruption) sent by I. S. Kerstetter of Lansford, Pa. (Fig. 2). It depends, however, on relay B operating faster than relay A. The heating element is connected in circuit and B locks in through its contacts 1 and 2. Then A operates, opening the original circuit through B. The heater circuit will now remain closed till the current through B is cut off when the phototube is blocked at 500°. The pointer falls back to 450°, interrupts A, closes the circuit to B through its back contacts, and the cycle starts again.

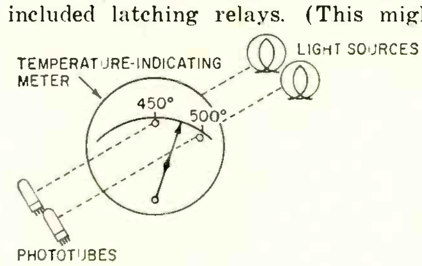
A circuit differing only in detail was proposed by electronic technician and TV repairman J. E. Michaud of Notre-Dame-du-Lac, Quebec. Mr. Michaud also proposed a one-relay circuit. It would, however, have required a special modification of the meter, with a thin metal plate instead of a pointer, so that the 450° hole would remain closed till the pointer reached the 500° point.

Kenneth A. Piletic of La Salle, Ill., uses a different approach. Both phototubes are connected to the coil of relay 2 (Fig. 3). When the line switch is closed, the element is heated through normally closed contact 1 of relay 1. At 450°, V1 goes into action, drawing current and closing circuits 1 and 2 of relay 2. The heater is now supplied through normally open contact 1 of relay 1. Relay 2's coil is locked in through contact 3, and relay 1's coil is locked in through its contact 1 till ac power is turned off.

When the pointer reaches 500°, V2 draws current, dropping the voltage across the load resistor enough to de-energize relay 2. Since relay 1 is locked in, the heater circuit remains open till the 450° point, when relay 2 closes again. Relay 1 is merely the cold-start device; relay 2 does all the work.

A proposal to use one relay and tube, which looks as though it should work, was submitted by Leonard Kasday of Flushing, N. Y. The phototubes (V1, V2) (Fig. 4) form a voltage divider across the grid of the thyratron. Resistors R1 and R4 are so selected that V3's grid is negative enough to keep the tube from firing. When the temperature reaches 500° V2 is cut off, its resistance rises to practically open circuit, and V3's grid goes positive through R1, R3 and V1. The relay is pulled in, opening the heater circuit and applying a positive bias to V3's grid on positive half-cycles. The relay remains energized till, at 450°, V1 is cut off and V3's control grid again goes negative, releasing the relay and turning the heater on.

Two other 1-relay circuits were proposed. They might well have operated, with proper selection of components, but were not as clearly worked out as the one just described. A few circuits included latching relays. (This might



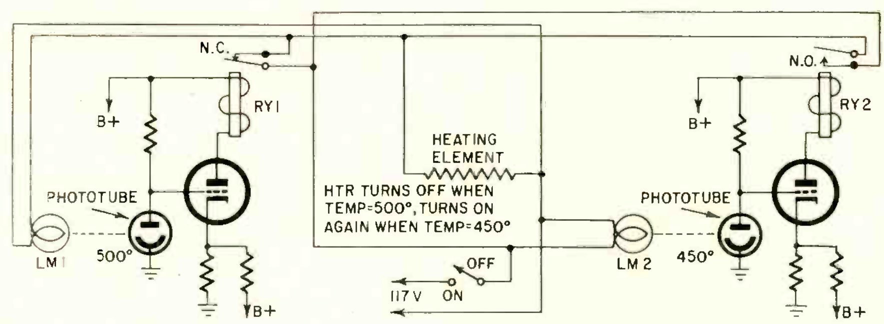




Fig. 1—Mr. Bukstein's original circuit. Relays are actuated by decrease in light.

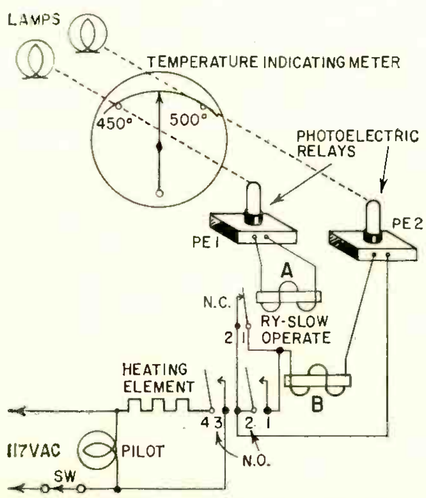



Fig. 2—One of the simplest circuits.

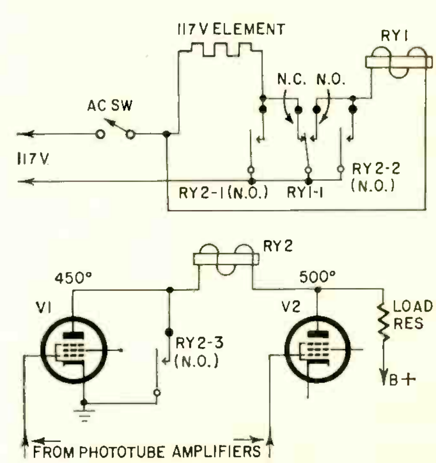



Fig. 3—Another effective solution.

be the simplest and most efficient approach.) One ingenious circuit, by John Jarvis, University of Florida, used an ac and a dc relay for on–off control. But the great majority of circuits included three or more relays. A few went beyond three, and one used five.

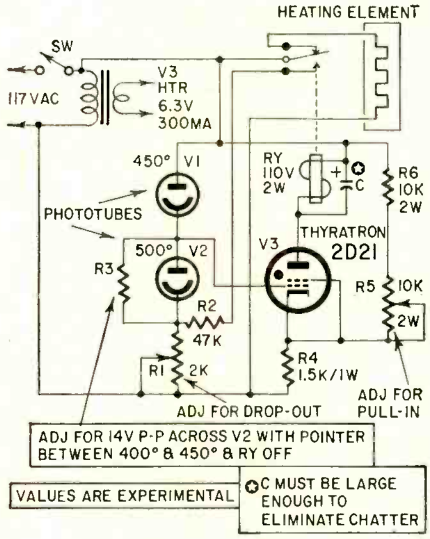


**Fig. 4—This circuit uses one relay.**

Most striking feature of the solutions to the photo-relay problem was the sophisticated nature of some of the entries. At least two were presented as finished engineering drawings, with all constants including ohmage of relay coils. One even named model numbers and tube types—included all the information necessary to buy the parts and construct the device. Unfortunately, some of the best prepared solutions were not entirely clear — the author expected to be read by another relay engineer. Possibly more than one good solution was not understood, due to unfortunate drawing and incomplete description.

### Service Stinker No. 1

In spite of the statement: no shorts to ground, most readers decided that the cathode capacitor was shorted. A small number—less than half a dozen—pointed out the correct answer, an open filter capacitor, and one reader pointed out that a shorted voice-coil winding or too-low output impedance might cause the tube to draw enough excess current to burn out the 470-ohm resistor.

### That black box

Strangely enough, the simplest puzzle produced the fewest correct answers and the largest number of wild guesses. Readers did point out, though, that there are *two* correct answers. If the power supply is dc, a chopper or vibrator can make the meters indicate voltage and current, but no power. A perfect reactance, such as a good capacitor, will of course produce the same result if the supply is ac. END

# How good is that electrolytic?

**By HAROLD REED**

THIS simple checking method may be used for servicing on the home workbench, where a capacitor analyzer is usually not at hand. It can also be useful to the technician whose analyzer is temporarily out of service.

The customary ohmmeter test may detect a shorted or leaky electrolytic, but seldom tells the whole story. We have all run into instances where capacitors were bad, but did not show up bad on the ohmmeter.

A good capacitor has a certain reactance (in ohms) at any given audio frequency. This reactance, $X_c$, may be calculated (using $X_c = 1/2\pi fC$) or read from a reactance-frequency chart (published in many electronic handbooks). If f = 50 cycles, as suggested below, the formula may be simplified to $X_c = 1/314 \times C$. (For 60 cycles the value would be 377 instead of 314.) The table gives the more common electrolytic capacitances and their calculated reactances in ohms (rounded off to the nearest whole number) at 50 cycles.

I chose 50 cycles because the reactance of a capacitor drops as the frequency is raised, and, with very large capacitors, the required test resistors would be in the order of fractions of an ohm.

If an audio-frequency test signal is impressed across a capacitor C, the voltage $E_1$ across it can be measured with an ac vtvm (Fig. 1-a). Now, if a resistor (R) is connected in parallel with C (as in Fig. 1-b) to cause the vtvm reading to drop to about 0.7 of the original voltage, its resistance will be approximately equal to $X_c$, the capacitor reactance at the test frequency.

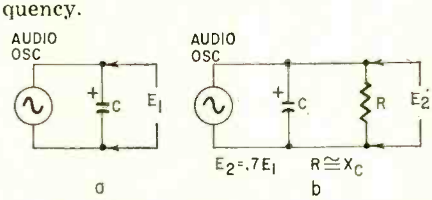


**Fig. 1-a—Measuring voltage across electrolytic; b—resistor shunted across the cap. If vtvm reading drops to 0.7 of reading in Fig. 1-a, its resistance value will approximately equal capacitor's reactance.**

### Making a test

To check an electrolytic, connect an audio vtvm across the output of an audio oscillator set for 50 cycles. Connect the oscillator output across the capacitor (C), as shown in Fig. 2. Set the oscillator output and the range of the vtvm for a zero reading on the decibels scale of the meter. Note the reactance in the table to be expected from the capacitor being tested. Connect a resistor (R) whose resistance is somewhere near this reactance value across the capacitor. If the capacitor is normal the vtvm reading will drop approximately 3 db. This is equivalent to 0.7 of the voltage that appeared across the capacitor without the test resistor.

For example, if a 50-cycle signal is impressed across a good 20-$\mu$f capacitor at a level that gives 0-db reading on the vtvm, and then the capacitor is shunted with a 150-ohm resistor, the meter should drop to —3 db. Thus, the 150-ohm resistor is about equal to the capacitor reactance, which is correct for a good 20-$\mu$f unit.

Tests were made satisfactorily on capacitors in the range from 50 to 2,000 $\mu$f where reactances range from 1.6 to 64 ohms. These values are small with

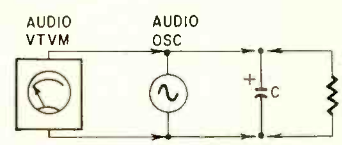


**Fig. 2—Test setup.**

respect to the generator impedance. In testing capacitors from 1 to 40 $\mu$f, where reactances are from 80 to 3,200 ohms, insert a 22,000-ohm series resistor in the generator output to increase the source impedance. Its value is not critical as long as it is at least about five times the value of the reactance being checked.

The series resistor may be left in the circuit to check the whole range from 1 to 500 $\mu$f. However, most generators will not develop sufficient voltage across the reactances of 1,000 and 2,000 $\mu$f with the series resistor included. So the series resistor can be omitted for the two highest capacitor values in the table, or the table could be stopped at 500 $\mu$f.

When the quality of an electrolytic is in doubt and an analyzer is not available, you can save time by measuring its reactance. END

**CAPACITANCE VS REACTANCE***

| Capacitance ($\mu$f) | Reactance (ohms) | Capacitance ($\mu$f) | Reactance (ohms) |
|---|---|---|---|
| 1 | 3,180 | 20 | 159 |
| 2 | 1,590 | 25 | 127 |
| 3 | 1,060 | 30 | 106 |
| 4 | 797 | 40 | 80 |
| 5 | 637 | 50 | 64 |
| 6 | 530 | 80 | 40 |
| 7 | 455 | 100 | 32 |
| 8 | 398 | 250 | 13 |
| 10 | 318 | 500 | 6 |
| 12 | 265 | 1,000 | 3 |
| 16 | 199 | 2,000 | 1.6 |

*F=50 cycles

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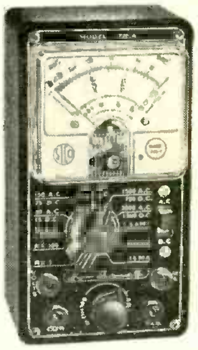

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**2 RESISTANCE RANGES:** 0-10,000 Ohms, 0-1 Megohm.

**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.

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**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.

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- **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).
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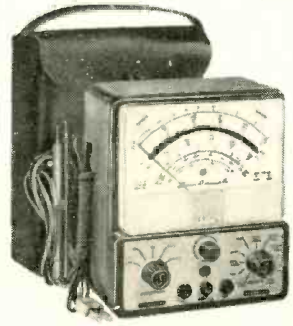

NOTE: The line cord is used only for capacity measurements. Resistance ranges operate on self-contained batteries.

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**MIRRORED SCALE** permits fine accurate measurements where fractional readings are important.

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**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.

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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, saddle-stitched Texon 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.

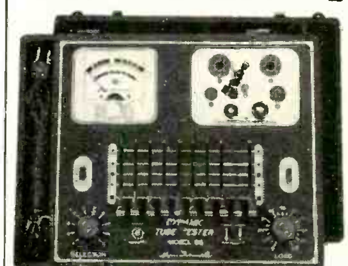
Model 83A will detect tubes which are apparently good but require rejuvenation. Such tubes will provide a picture seemingly good but lacking in proper definition, contrast and focus.

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**
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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.**

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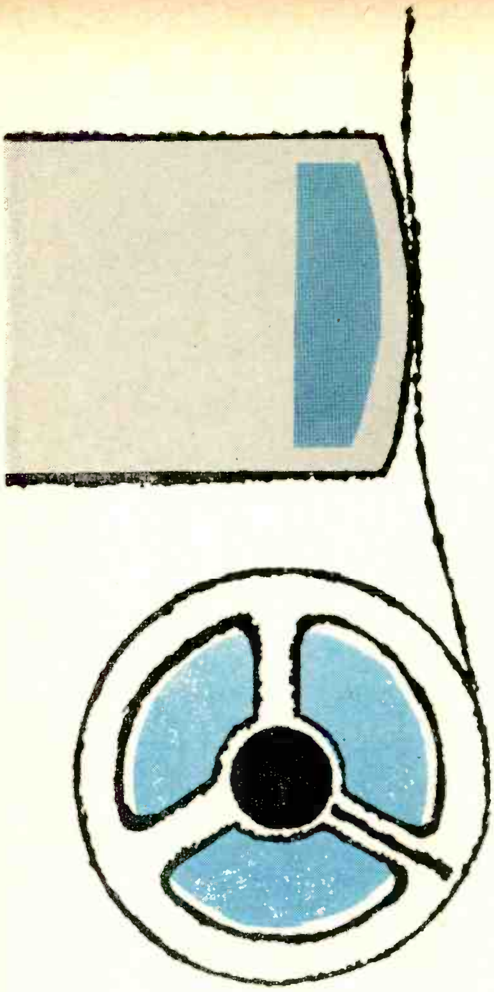


# ALL ABOUT TAPE RECORDERS

**PART III—THE RECORDING HEAD PLAYS ITS PART**

*This section will examine the many types of level indicators used in modern tape recorders. Then we will go on to see how tapes can be erased.*

By **JACK DARR**
SERVICE EDITOR

LAST TIME, WE EXAMINED THE VARIOUS types of overload indicators used in modern tape recorders. Then we went on to see how to erase signals recorded on tape. This month we will continue with a detailed look at recording heads and how they work.

The recording head is about the most important part of the machine, and it's time we looked into it in a little more detail. A typical head looks somewhat like Fig. 1. It is simply a specialized inductor—an iron-core coil wound with very fine wire. This coil, driven by the bias and signal, produces a varying magnetic field across the air gap. The tape is drawn across the head by the tape-transport mechanism, at a predetermined speed. As it passes the gap in the head, the signal impresses varying amounts of magnetic flux on it. The residual magnetism of the tape holds this signal until it is erased. As the tape passes over the same head during playback, the varying magnetic fields in the tape induce very minute voltages in the coil. These are fed to the input of a high-gain amplifier and reproduced as the original sounds. (NOTE: Although we are using the term recording head, all low-price machines use the same head for both recording and playback. For some reason, most technicians refer to them as recording heads, so we will too. But don't forget, the recording and playback heads are usually one and the same.)

Fig. 2 shows a disassembled recording head from an older machine. The Mumetal casting that holds the head is at the top left, and the top and bottom covers are at the top right and lower left, together with the small brass bolts used to hold the assembly together. Notice the small iron core that goes through both coils; the gap is built into it. Heads used in the very latest machines are much more compact than this type.

## Head alignment

Proper recording-head alignment with the tape is very important, most especially so in the four-track stereo machines. Four interwoven tracks are recorded on the tape (Fig. 3). Broadcast type tape machines use single-track heads, with one track (about 200 mil wide) in the center of the tape. Stereo tapes use two tracks, (each 90 mil wide) (Fig. 3) or 4 tracks 40 mil wide interlaced.

For the best results, the head and tape guides must be aligned so that the tape travels squarely across the gap as in Fig. 4. If this is not done, the tape will not be correctly recorded. It can never be played back on another machine, and may not sound right even on the one that recorded it! The diagram is exaggerated for effect, but does show you what is happening. If this tape is run through another machine, with the head correctly aligned, the slant of the recorded lines on the tape will prevent the playback head from reading the shorter wavelengths recorded. This will cause apparent lack of high-frequency response. Improper head height on a two-track machine will also cause such troubles as partial erasure of the lower track when recording the upper, recording off-track with loss of volume, and so on. Of course, if the machine happens to be stereo, the balance of the two tracks will be something strange and wonderful, especially if you're playing a prerecorded tape!

## Testing for head alignment

Testing for head alignment is usually fairly simple. The exact procedure is usually found in the service data. Two methods are used: one is direct measurement from reference points, and the other (the easier way) roughly setting

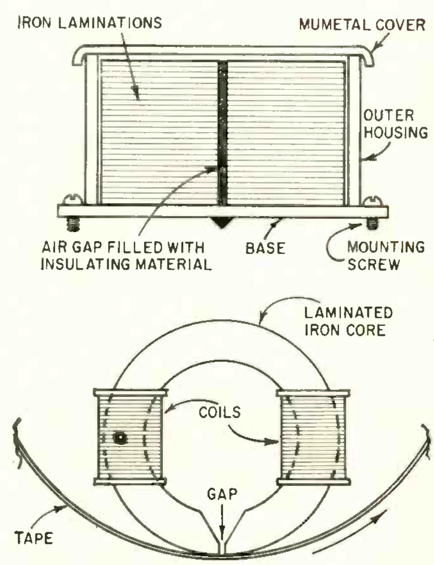



**Fig. 1—Typical recording head. Detailed view showing construction.**

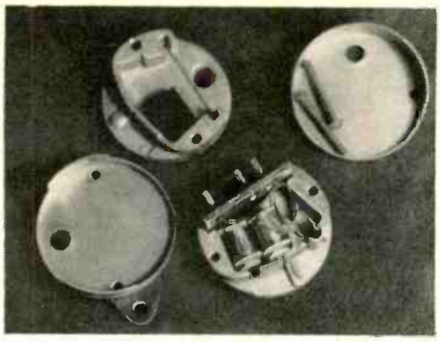


**Fig. 2—Recording head of older type disassembled to show construction. Modern heads are much more compact and usually cannot be torn down like this one.**

the heads by eye or rough measurements, then making the final adjustments with a prerecorded test tape, or even prerecorded music.

Unless head height has been altered by tampering, the only adjustments usually required are for correct azimuth (making certain that the head gap is vertical as in Fig. 4).

To use the first method, follow the procedure given in the service data for that particular machine. Test-tape adjustments can be made on any machine, provided that the test tape is a reliable standard. (Industry-wide standard is the Ampex alignment tape which is available for 3.75-, 7.5- and 15-ips tape speeds.) All tones are recorded across the entire width of the tape so that signals are read equally well by full, ½- or ¼-track heads. The tone used for azimuth alignment is the highest frequency to which the recorder is intended to respond—5,000 cycles at 3.75 ips; 7,500 cycles at 7.5 ips, and 15,000 cycles at 15 ips on most recorders.

To use, carefully demagnetize the recording heads and clean them thoroughly. Now thread the tape into the machine and set it up for playback. (Of course, any adjustments made during playback apply to recording too.)

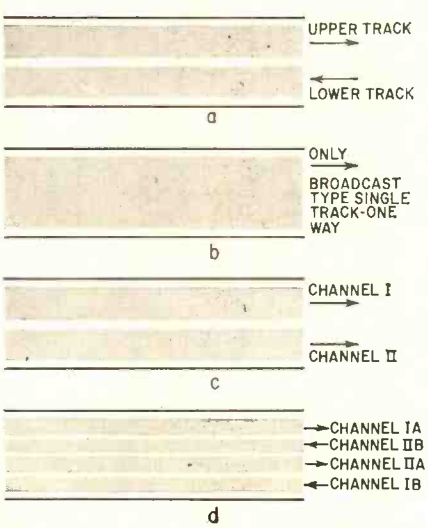



**Fig. 3—Tracks on tape: a—dual track mono; b—single track broadcast mono; c—dual track stereo; d—four track stereo.**

Connect an ac voltmeter across the speaker voice coil. Almost all machines now have an extension speaker jack. The output meter can be plugged into it. Run the tape through the machine and rotate the azimuth adjusting screw for maximum meter indication. Fig. 5 shows a typical method of adjusting tape heads. Do not move any other adjusting screws; resetting head height or restoring the face of the recording head to parallel the tape is a difficult and time-consuming job.

The adjustment itself is simple. A small ridge that acts as a fulcrum runs perpendicular to the tape on the bottom of the head housing. Mounting screws go through two ears on the head. By loosening one and tightening the other, the head can be rocked back and forth until it is exactly right. The four-way adjustments allow setting the head so the tape not only passes the gap correctly, but is not bowed or buckled by the head.

## Magnetized heads

Recording heads tend to pick up a bit of residual magnetism when very strong signals that result in amplifier clipping are applied. Magnetized tools brought too close to the heads can also magnetize them. When a head becomes magnetized, whatever the cause, it will not give good results. Distortion and noise rise rapidly and high frequencies tend to be erased. Heads should be cleaned and demagnetized as the first servicing step when working on any tape recorder.

To demagnetize heads you can use a commercial head demagnetizer or make your own unit (Fig. 6). It is powered by line voltage and no coil winding is called for since the coil of a 110-volt relay works well. Just attach the soft-iron pole pieces as shown to fit the curve of the recording head and wrap the assembly with electrical tape to eliminate any possible shock hazard.

The home-made unit is used just like the commercial job. Energize the coil, hold the pole pieces close to the head face and move the demagnetizer back and forth a few times. Then slowly withdraw it till you're several feet from the head before turning off the current.

## Head wear

Recording-head pole pieces are made of relatively soft materials selected for their magnetic characteristics. The head is then ecapsulated in plastic to give it a very smooth surface which keeps head wear to a minimum. While modern tapes are not as abrasive as some early types, there is always some slight abrasive action that grinds down the head with use. This can be aggravated and the grinding down speeded up by dust or grit picked up by the tape.

Head wear is usually easy to check (Fig. 7). The face of a good recording head will always have an extremely smooth, silvery surface. A worn head will show distinct grooving the exact width of the tape. Faceplate wear increases the gap in the head, reducing its ability to record high frequencies.

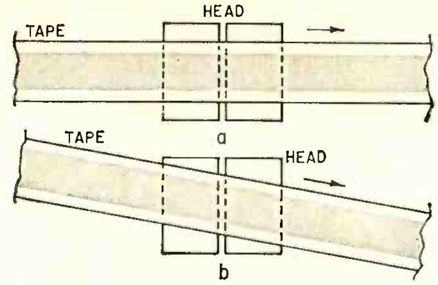



**Fig. 4-a—Proper tape alignment. b—Tape not properly aligned with head—exaggerated view.**

Some machines use heads with replaceable pole pieces, which take the wear. When worn, the pole pieces are pulled out and new ones inserted, leaving the coils undisturbed.

## Cleaning heads

As the tape passes the heads, dust, assorted lint and tiny particles of oxide are detached and stick to the head. This interferes with close contact between tape and pole piece and, in time, this accumulation of guck can cause severe loss of volume and high-frequency response if it is not removed.

Every time a machine is serviced, the heads should be cleaned. This, fortunately, is a simple process. Special tape-head cleaning fluids are available at your suppliers, but common TV-shop cleaning chemicals can do just as good a job.

Ordinarily, it is not advisable to use carbon tetrachloride on tape heads, especially the later machines. There may be some sort of plastic used in or around the head that would be attacked by this solvent. The best solvent for this work is xylene, an ingredient in many head-cleaning fluids. It is suitable for all machines except the Norelco 400 erase head, for which alcohol should be used. Use cotton swabs to apply the solvent to the face of the heads. A narrow toothbrush is also very useful. Take a discarded one and cut off two rows of the bristles, making a long narrow brush which can fit into the slot

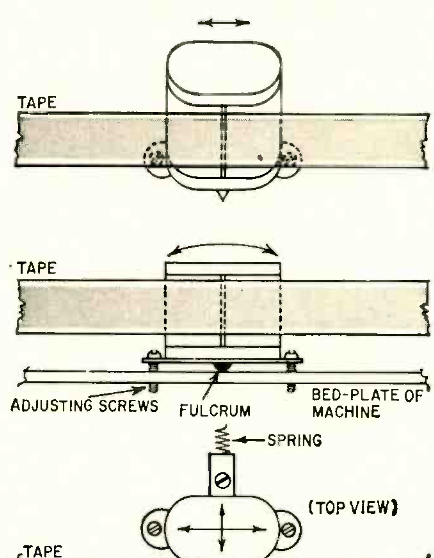



**Fig. 5—Typical adjustments for tape heads.**

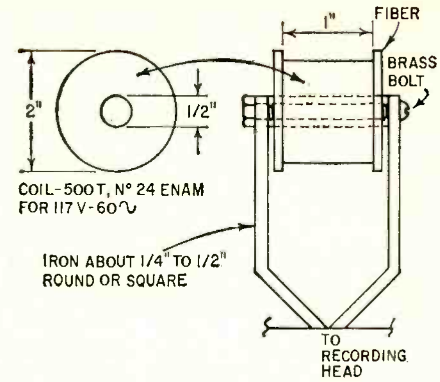



**Fig. 6—Home-made head demagnetizer. Coil from 110-volt relay may be used. Soft iron pole pieces can be made from frame of junked vibrator.**

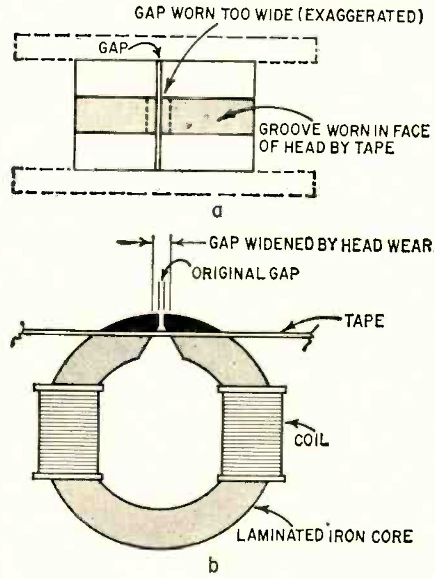



**Fig. 7—Face of head should always be shiny. Dust causes wear apparent after head is cleaned.**

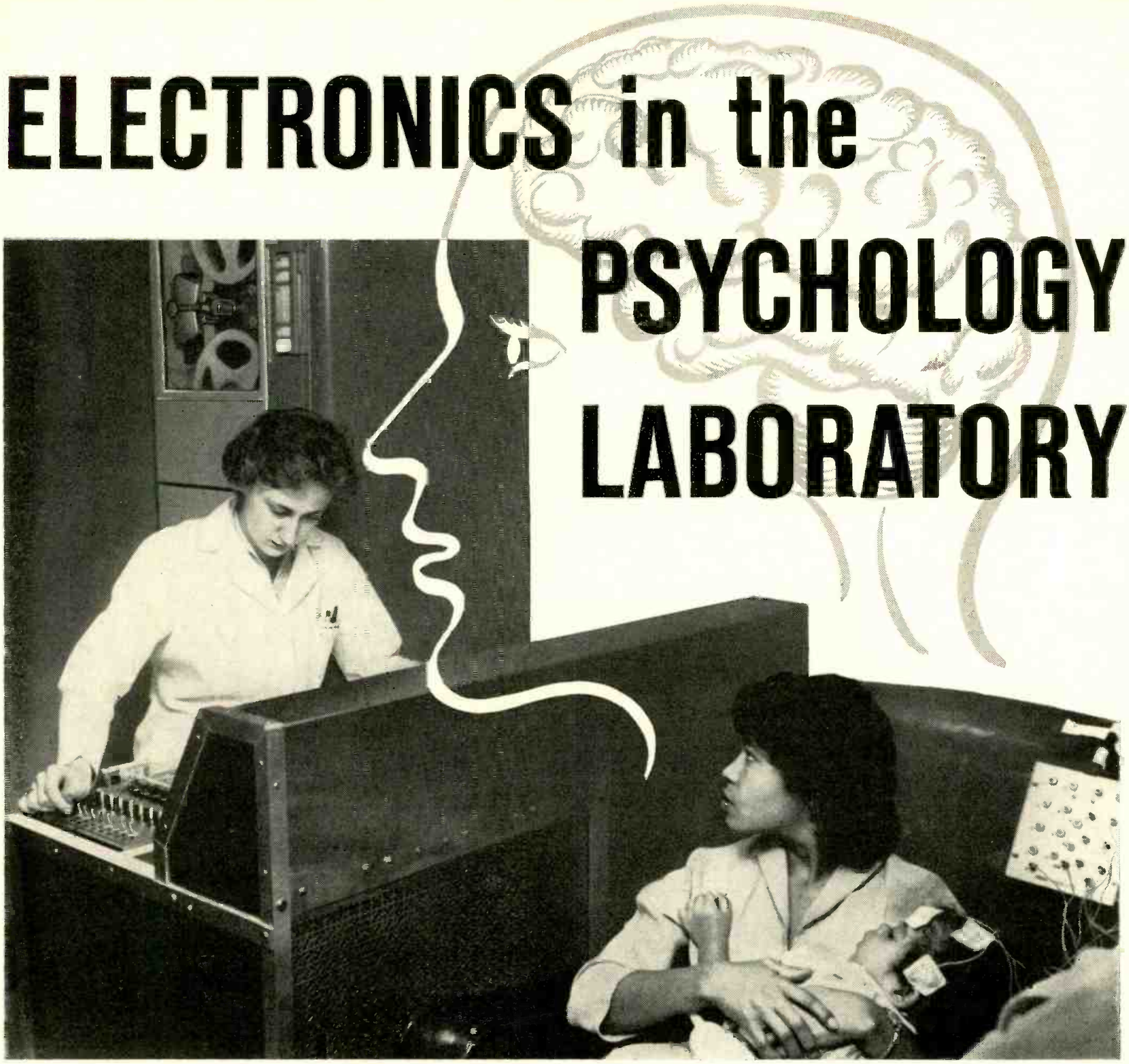
of the head. Several swabs should be used to remove every trace of tape residue. Machines which do not use pressure pads to maintain tape contact with the head may not record at all if the heads are very dirty. So all cleaning should be done before any servicing is attempted. Be very sure that all traces of solvent have evaporated before threading a tape through the machine or the chemical may attack the tape itself!

Special head-cleaning tapes can be bought. Made of a thin fabric, impregnated with a mild cleaner, they are made in endless loops. They are simply threaded into the machine, which is turned on and allowed to run for a short time. As the tape passes over the heads, it cleans and polishes them.

Well, we've gone and run out of space once again! Next month, we'll get into what is often the hardest part of any tape recorder repair—the mechanical end of these things! Tape transport mechanism, drives, brakes, tape tension, motors, switching, and so on. Some strange and wonderful gadgets are used in this section, and we'll be discussing them. See you.

TO BE CONTINUED

# ELECTRONICS in the PSYCHOLOGY LABORATORY



Brain-wave recording at St. Christopher's Hospital for Children, Temple University School of Medicine.

**By T. J. BOPKINS**

IN the laboratories of psychologists, objective and precise test data are in demand. Researchers are concerned with such variables as reaction time, a measure of how well an individual perceives a stimulus and how fast he can react to it. The problems of learning and memory, vision and audition, discrimination and constancy (judging the size of an object, no matter what its distance), emotion and pathology occupy the best efforts of experimental clinical and industrial psychologists and the human engineers in university and industrial laboratories all over the country. Needless to say, they must turn to electronics for some of their most exacting measurements. So varied and multitudinous are the applications that we will discuss only the more important ones.

Many experiments must be carried out on a large number of subjects to make certain that the characteristics measured are not peculiar to a few but occur in general for most people. Thus the results often are mountains of data which must be mathematically treated. Usually the treatment involves lengthy and complicated mathematics. So, psychologists have turned to the modern electronic computer to help them work out the results (many universities offer courses in computer programming for graduate psychology students). Large computers, such as the IBM 704 system, are available now at many universities.

The electroencephalograph is a sensitive recording instrument for measuring brain waves of man or animal and learning what is happening in the brain. For example, we can detect whether the subject is awake or asleep, in a coma or only mildly unconscious; whether the brain is functioning normally or perhaps shows epileptic tendencies or lesions of some kind. Fig. 1 shows a variety of brain waves to give you an idea of what the instrument can record. The waves in Figs. 1-a and -b were recorded while the patient was, respectively, awake and asleep. The waveforms in Fig. 1-c were taken during an epileptic seizure. The letters refer to electrode placement. L is *left*, R is *right*, F is *front*, PAR is *parietal cortex* and EAR is self-explanatory.

The circuitry is not particularly complicated: an encephalograph is primarily a very sensitive balanced amplifier with very-low-noise tubes, well shielded from magnetic and electric fields. The output drives a recorder pen. The instruments are now so well designed that in many cases it is no longer necessary to take the patient into a shielded room (see photo).

Many machines have a group of six

or eight pens which can record signals from many parts of the brain at once. Comparison of signals from different areas of the brain that occur at the same time can give valuable information. Tape recordings can be made and kept for future reference or translated from the tape into a permanent chart-type recording.

## Electrocardiograph

A similar recording instrument which need not be nearly so sensitive is the well known EKG (or electrocardiograph). This instrument records potentials generated by the heart muscle. Whereas brain waves are on the order of microvolts (0 to 100), heart potentials range from 5 to 20 millivolts. With a sensitive oscilloscope (with a very slow sweep), some heart potentials can be observed, but it is difficult to get a good record. Fig. 2 shows a typical EKG recording.

Why is the psychologist interested in brain waves, heart rate, and respiration rate? Under emotional stress, the heart beats faster, whether from fear or pleasure. When a subject who is resting is asked to solve a simple problem, there is a definite change in his brain-wave pattern. Thus the psychologist has some objective indicators of what is going on "inside" a person—things he would otherwise have no way of judging except by taking the subject's word for them *if* he could or would tell. But he cannot always do so. Fear reactions may, for example, be delayed as long as 30 seconds and be so mild that the subject does not even feel "butterflies." But sensitive electronic instruments will detect the reaction.

Electrical instruments were used in the psychology laboratory as long ago as 1870, when the galvanometer was perfected and first applied to measure changes in skin resistance of a subject under emotional stress. With a good ohmmeter you can detect such changes very readily. Let someone hold the probes (tips) of your ohmmeter firmly in his hands, and then do something to startle him badly. You will see the resistance drop very quickly. This principle is used in one of the records made by a "lie detector." In the lab, this is called the PGR or GSR (*P*sycho*G*alvanic *R*eaction or *G*alvanic *S*kin *R*eaction). It has been used extensively to determine whether subliminal advertising can be detected by subjects who get such brief flashes of information that they could not actually identify the word. Experi-

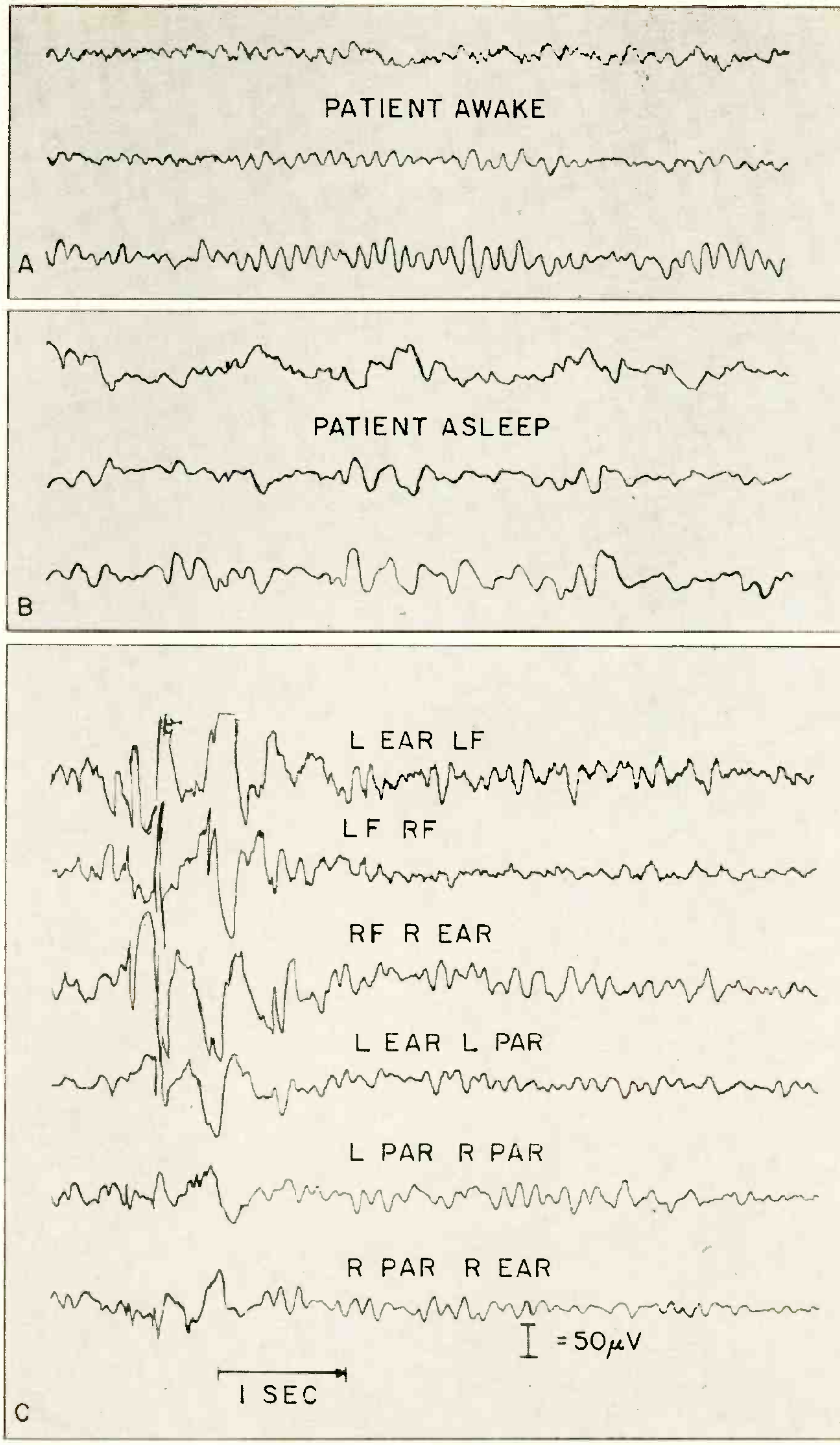



**Fig. 1—Brain waves taken of: a—an awake patient; b—a sleeping patient; and c—a patient during an epileptic seizure.**

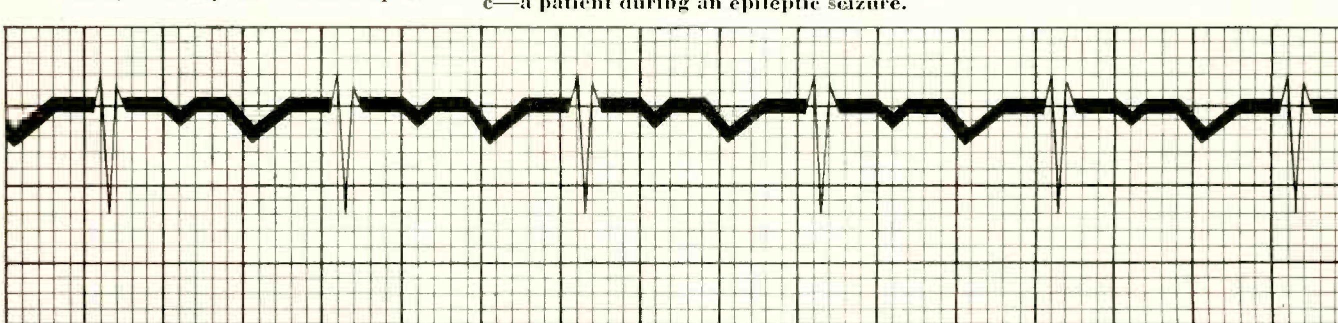


**Fig. 2—The electrocardiogram (EKG recording) shows normal heart action.**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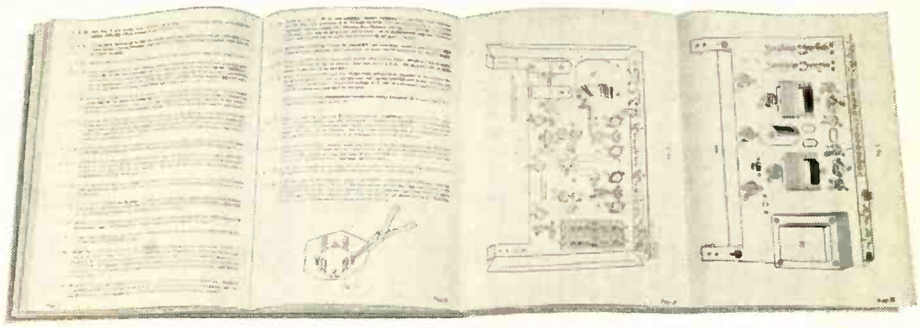

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Reveals dried out, shorted, or open electrolytics—in the circuit—with Paco's exclusive Capacity Dial. Instantly finds open or direct shorted capacitors without removing from circuit. Great time saver!

**Specifications:**

**SIMPLE SEQUENTIAL TEST:** reveals open or shorted capacitors, including electrolytic types.
**ELECTROLYTIC DIAL:** indicates actual electrolytic values while capacitor is in-circuit; any electrolytic which yields a capacity reading on Electrolytic Dial is automatically revealed as not open or shorted.
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**Model C-25:** Kit, complete with PACO-detailed assembly-operating manual. **Kit Net Price: $19.95**
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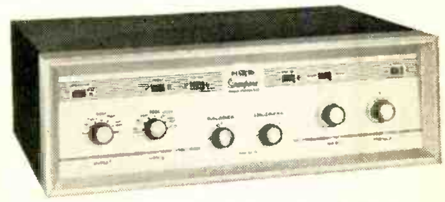
### TRANSISTORIZED DEPTH FINDER KIT

Protect your boat against shoals and underwater hazards with this compact, easy-to-read depth finder. Transistors prolong battery life, provide utmost accuracy and portability. A boon to fishermen—locates hard-to-find schools of fish. A low cost safety device for every boat owner.

**Specifications:**

**FULLY TRANSISTORIZED:** 5 transistors, with a low battery drain for extremely long battery life.
**HIGH INTENSITY INDICATOR:** for sensitive, accurate response under all conditions.
**FAST, EASY READINGS:** made possible by means of over-sized scale calibrated at one-foot intervals from 0 to 120 feet.

**Model DF-90:** Kit, complete with PACO-detailed assembly-operating manual. **Kit Net Price: $84.50**
**Model DF-90W:** Factory-wired, ready to operate. **Net Price: $135.50**



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Assemble a superb home music system with this true 40 watt stereo preamp-amplifier. Unmatched flexibility, less than 0.5% distortion, and handsome design make this the ideal component for music lover and audiophile alike!

**Specifications:**

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**RESPONSE:** 30 cps to 90Kc, ± 1.0% db
**HARMONIC DISTORTION:** less than 0.5% at 20 watts per channel output.

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ments by such well known psychologists as Lazarus at the University of California indicate that there is indeed a reaction.

### Time measurements

Time measurements are beginning to use electronic instrumentation. Modern electronic units with a "gate" that can be turned on and off, known as EPUT counters (*E*vents *P*er *U*nit *T*ime), are now used in the laboratory. A standard-frequency oscillator is used with the counter. The function to be measured for time duration is made to open and close the gate. The counter counts the number of clock pulses which the gate lets through. For example, in reaction-time experiments the subject may be asked to press a button as soon as a light goes on (the switch that turns on the light opens the gate). Pressing the button closes it.

If you are angry or stop to have just one drink after the hard day's work, is this going to affect your reaction time? You bet it is! Worry, fear, anger, drugs, such as tranquilizers, alcohol and many factors (even coffee) change your reaction time somewhat. If it is slowed too much, you may endanger your life or someone else's. Reaction time is also important in industrial situations, where control of fast machine tools may depend on the skill and reaction speed of the operator.

A very complicated and versatile instrument to measure reaction time and other sensory-motor functions (such as coordination) was recently described by its inventor, Frank Wagner, in Vienna. This instrument involves "tracking." The subject is asked to chase one blip (spot) on a cathode-ray-tube screen with a coordinate set (crossed horizontal and vertical lines) or another blip. Each time he succeeds, the blip reappears somewhere else.

All kinds of psychological factors can be measured this way. For one thing, we can tell how rapidly the subject can move the control lever (which looks something like an aircraft control stick) to cover the blip and how accurately he can do it.

We can learn how much practice will improve skill. If we move the blip in a preset but complicated program, we determine how fast the subject "catches on" and maybe can predict where the blip will be next. Or we can even measure the frustration (by GSR) of a subject when we contrive to move the blip when he has *almost* reached it with the coordinates or the other blip.

There are two versions of the apparatus. Both depend on creating two coordinate voltages for the blips (or the blip and the cross) since two voltages determine where the blip (or cross) will appear. One blip is moved by the machine, the other by the subject. He moves a lever which controls two potentiometers to provide the two voltages. An electronic switch shows the two patterns alternately, but, to the subject, they appear there simultaneously. As Fig. 3 shows, one system uses a blip or spot and a pair of crossed lines. The machine moves the blip, the subject moves the lines. The other version uses a blip and a circle. The machine moves the circle while the subject moves the blip.

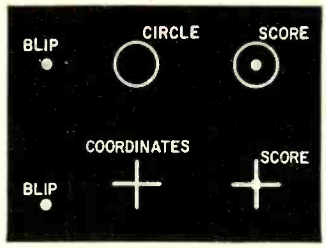



**Fig. 3—The subject must (by moving a control lever) center the spot within the circle or pinpoint it with the crossed lines.**

A set of coincidence tubes determines when one blip has covered the other. The voltages for both patterns determine their location, so it follows that when these are exactly the same the patterns coincide. Thus, if we apply these voltages to two sets of coincidence tubes (one for horizontal voltages and one for vertical), we can get a signal to activate a counter or a programming mechanism which will set up the next set of voltages. Fig. 4 shows a typical coincident voltage discriminator. The triodes are normally cut off. When a voltage is applied to one grid, there is some output. But both triodes must conduct to get a sizable signal from the combination. The voltages used to locate both patterns vertically are applied to one set of coincidence tubes and the horizontal voltages to another. Then the outputs of the two coincidence sets are applied to a third set, which puts out a signal *only* when both horizontal and vertical voltages are exactly the same. If we alter the bias of one of the coincidence tubes a little, we can move one blip before it is quite covered by the other one and thus frustrate the subject.

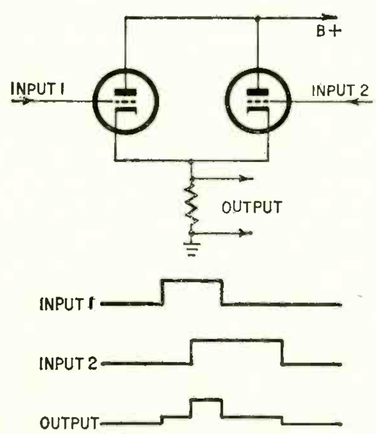



**Fig. 4—A typical (although somewhat simplified) coincidence discriminator. There will be no substantial output unless the signal is applied to both grids.**

### Frustration

A tape recorder with staggered heads can be used to frustrate subjects. A recorder with staggered stereo heads can be modified to do the job, but don't do it unless you are prepared to take the consequences (RADIO-ELECTRONICS, August, 1960, page 42). Subjects get furious when they are subjected to, of all things, their own voice. The trick is to play it back to them with enough delay so it sounds like an echo (about 1/10 second later). If you ask a subject to count into a microphone connected to the recorder, and the playback immediately repeats the words *in his own voice* (someone else's voice does not do it!!), he becomes extremely flustered and agitated, loses count and usually gets very angry. Blood pressure goes up an average of 20 points, heart begins to beat wildly (160 beats per minute have been recorded), respiration becomes irregular as when a person is very agitated (and indeed he is).

Artificial frustration can tell us how a person will react to danger, surprise and fear. Other ways to produce such changes are simpler: for example, in one set of experiments the subjects are bombarded with ultrasonic and subsonic waves to see if their performance on simple tasks requiring concentration is affected. Results are not entirely conclusive, but some definite effects have been measured. These experiments use electronics in the sense that the waves are created by speakers, amplifiers and oscillators. One instrument that has been used was the low frequency oscillator shown in the November, 1958, RADIO-ELECTRONICS, page 54. There is some connection between the effect of such sounds and the beneficial effects of background music in industrial plants. The background music may mask to a certain extent the "unheard" noises which reach us as pressure variations, but which we cannot perceive as "sounds."

Simple oscillators, accurately calibrated as to frequency and output level are connected to earphones and labeled "audiometers." They can determine the minimum level at which a person can hear any particular frequency. In the medical world this instrument is used to determine whether an individual has normal or defective hearing. In the psychology laboratory it is used to


*Beckman Inc.*

**A typical time-interval counter.**

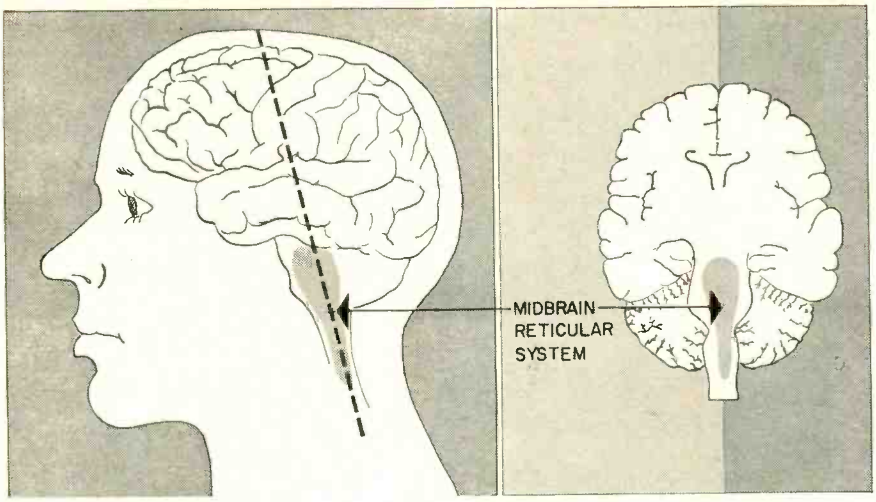



**Fig. 5—Cross-section of the human brain showing the midbrain reticular system.**

determine just how much a level or a frequency has to be changed to be noticeable to the subject. The measure recorded is the JND or *J*ust *N*oticeable *D*ifference.

Sometimes this is called *D*ifferential *L*imen (DL for short), which literally means the difference threshold. These DL's are important in that they give an insight into how the senses operate. Surprisingly enough we find that people can detect very small differences in frequency, sometimes as little as 1 cycle in 400.

The eye, too, is a very sensitive apparatus. It is claimed that a quantity of light consisting of only *1 photon* can be perceived. For this, we turn to another branch of electronics, photoelectric measuring devices. Instruments with sensitive photomultipliers are used to measure the amount of light falling on the eye. Since we are often dealing with exceptionally small amounts of light, the instruments must be accurate and sensitive (and, in most cases, carefully calibrated).

Stimulators of all kinds are used, to shock animals, to activate certain centers directly in the brain cortex (for Dr. Button's work with blind subjects see the December, 1958, RADIO-ELECTRONICS) or in the underlying structures such as the hypothalamus. Psychologists have discovered that they can control an animal's desire for food, water or even sex by directly stimulating certain areas in the hypothalamus; or sleep and wakefulness by directly stimulating a section of the brain stem at the top of the spinal column called the reticular area (Fig. 5). A whole new science of motivation may be in the making in these experiments.

The humble oscilloscope also finds many uses in the laboratory. One experiment requires subjects to adjust (by turning a potentiometer) the size of a circle on a screen (made by two sine waves 90 degrees out of phase) with their estimate of the size of round objects. It is interesting that, if you have been poor all your life and the round object is a coin, you are likely to overestimate its size. If, on the other hand, you were born with a silver spoon in your mouth, you will consistently underestimate it.

An interesting new use of the scope could be the creation of what is called "subjective color." Most of us have, at one time or another seen this effect. When we spin a wheel with a particular black-and-white pattern, we will (when the wheel is turned at a certain speed) see colors. This is an effect caused by the eye, for the colors are not actually on the wheel. Hence the name "subjective." The spiral patterns described in the January, 1958, issue of RADIO-ELECTRONICS can create subjective colors when rotated at the proper speed.

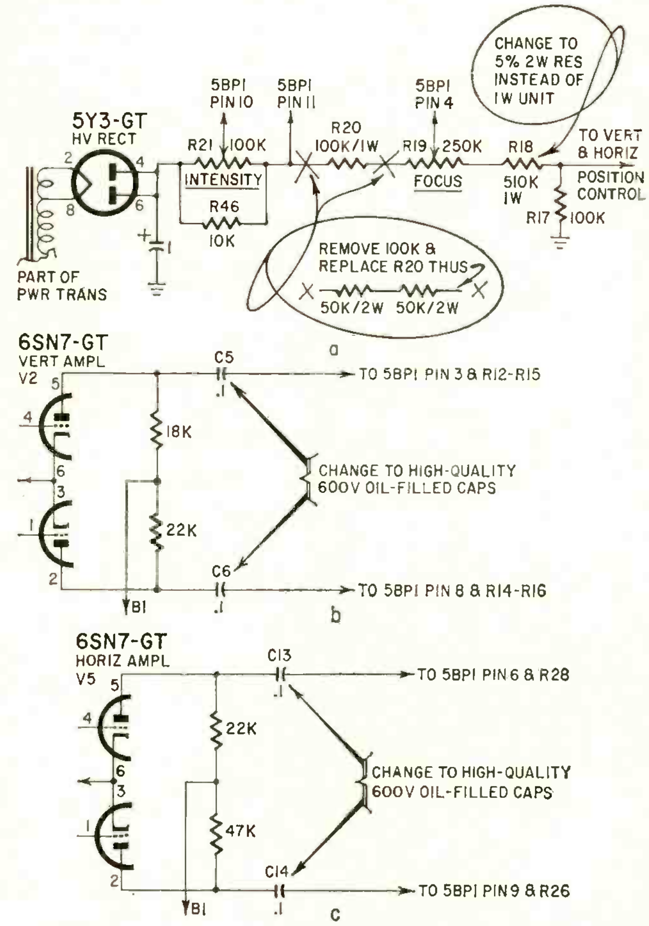
We have just scratched the surface of all the uses of electronics in the psychologist's laboratory, but you can see that the possibilities are almost unlimited. Just consider the furor about subliminal advertising, which may soon be a standard way of promoting breakfast cereal on your TV screen when you least suspect it! A motivational psychologist thought of the idea and he is not so happy with it now! But that is the penalty of progress and psychological laboratories are ready to take advantage of technological progress and apply the results to the understanding, and perhaps the control, of human behavior. END

## Space Suit Is Thermoelectric

Thermoelectric heating and cooling are incorporated in a new space suit designed jointly by Westinghouse and the Navy. The experimental air-conditioned suit contains a back-pack cooling and heating unit made up of a large number of semiconductor thermoelectric junctions. To cool the suit, current flow through the elements causes one end of the thermoelectric couples to cool. The cool air is circulated inside the suit by a small fan, while another removes the warm air created by the hot junctions and dumps it outside the suit. To warm the garment, the process is reversed.

## EICO MODEL 425 OSCILLOSCOPE

When the scope was used for long periods of time, the focus-control setting would start drifting and eventually sharp focus was lost, resulting in a blurred pattern. Also the vertical and horizontal positioning controls needed frequent adjustment.




Checking resistors in the voltage divider R17, R18, R19, R20, R21 and R46 revealed that R20 and R18 had increased in value. Both were replaced but a few months later the trouble reappeared. The cure was to substitute two 50,000-ohm 2-watt 5% resistors connected in series for R20, and a 510,000-ohm 2-watt 5% resistor for R18.

The problem of vertical and horizontal position drift was cured by replacing C5, C6, C13 and C14 with new high-quality 0.1-$\mu f$ 600-volt oil-filled capacitors.—*George P. Oberto*

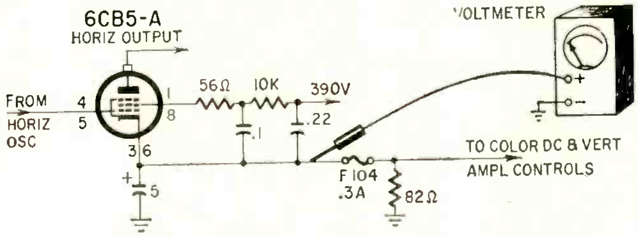
## CHEVROLET RADIO 987891

Several of these sets suffer from intermittent and erratic loss of high audio frequencies. Replacing the 12DS7 (af amplifier) seemed to clear up this condition, but after playing for several hours symptoms would reappear. The new 12DS7 would also show a short if kept in the tube tester for about 5 minutes.

Checking the printed-circuit board at the 12DS7 socket disclosed a jumper from pin 8 (cathode) to pin 2. The tube manual shows NC (no connection) for this pin, but apparently it is used as an internal tie point. This tie breaks down to pin 5, resulting in the cathode bias being shorted out, damaging the tube and causing the change in audio response. Scraping open the printed jumper between pin 8 and pin 2 of the 12DS7 cures this condition.—*Mitchel Katz*

### RCA CTC5 AND CTC5N CHASSIS

Measuring cathode current of the 6CB5-A horizontal output tube, in these sets can be difficult. But there is an easy way of doing it. Switch your voltmeter to its 10-volt range and connect it between the top of fuse F104 and the chassis. F104 is located near the front of the receiver. Since total




resistance in the cathode circuit is 35 ohms, current can be calculated by reading the voltages and using Ohm's law ($I = E/R$). For example, the voltage indicated in the service data for this set is 7.5 volts dc. This corresponds to a cathode current of 214 ma.—*Larry Steckler*

### G-E RADIO—MODEL 575

The complaint on this AM receiver was low volume, continuous crackling noise, with the volume occasionally jumping back to normal.

A check with a signal tracer pointed toward trouble in the output if transformer, but ohmmeter measurements showed both windings OK with no leakage to ground.

The receiver was plugged into an ac line booster and the voltage slowly increased. (During this type of test, the unit being checked should be carefully watched to avoid damage to other components.) With the increase in line voltage, the crackling increased and, at about 140 volts, a slight arc was observed coming from inside the if can.

I dismantled the if and found that the coil plate lead was just barely brushing the metal can and showed signs of discoloration. The lead was cleaned and redressed, and electrical tape was placed inside the can at critical spots to prevent a recurrence.—*Domenic Ripani*

### 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.**

### STEELMAN TRANSITAPE AND AIRLINE 7111-A

*Sympton:* Excessive noise recorded on tape.

*Cure:* Connect a scope to the output of the unit because it is easier to see transient noise than it is to hear it. With the scope on and a clear tape running through the recorder, try switching identical transistors around. Try new transistors or transistors from other units. Some transistors become sensitive to vibration and amplify it. Try moving the various leads near the motor. Try resoldering the grounds and shielding bonds. Check shielding leads for high-resistance grounds caused by plier pinches and wear-throughs at the casting edges. As a last resort, try a new motor.

NOTE: be certain to use a clean tape when making these tests. A tape with recorded noise will not let you spot any noise reduction you gain.—*Max Alth* END

# BREAKTHROUGH!

*When the FCC okayed FM multiplex stereo broadcasting, the clouds broke and the sun shone through. Will the decision usher in the Golden Age of FM? This article takes a closer look—tells you the extra equipment you'll need to receive FM multiplex stereo broadcasts, and how it will stack up against stereo records. Keep this one on file. Don't miss—*

**NOW – STEREO FM BROADCASTING**

*Servicing too should benefit from the multiplexing bonanza. The effervescent, sometimes controversial, but always stimulating Joe Marshall tells how to line up FM tuners and receivers quickly, easily, and efficiently—and without any special instruments. Be sure to read—*

**PRACTICAL HI-FI FM TUNER ALIGNMENT**

*Ever have a phone call machine-gunned by the "Untouchables," suffer mild nausea from an unpalatable commercial, get blasted from a mid-summer afternoon snooze by a home town home run? Here's an easy-to-build device using only a photocell, relay, potentiometer, switch and battery that makes you master of your household without leaving your easy chair. See—*

**TV SOUND SILENCER HAS ONLY FOUR PARTS**

*As if there weren't enough noise problems already with auto radios—Citizens Band and FM radios add more. Veteran service technician Wayne Lemons tells how he's solved some tacky car-borne radio noise headaches in many stubborn cases. Make this a must—*

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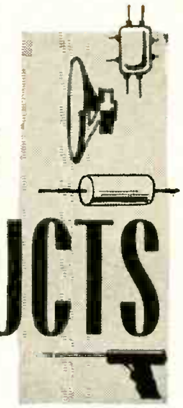
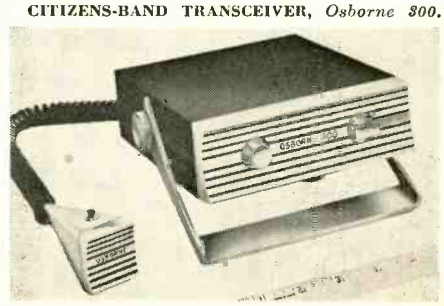


**MULTIPLEX ADAPTER,** *Model 335,* for stereo multiplex system just approved by FCC. Connecting cables supplied. 7 x 5¼ x 13 in.—**H. H. Scott Inc.,** Dept. P, 111 Powdermill Rd., Maynard, Mass.

**RADIO RECEIVER,** *Kit-tronics RB-10,* 3-stage, 2-tube, receives local broadcast stations. 1-tube regenerative receiver, 1-tube power amplifier and transformer-type half-wave power supply with selenium rectifier. 3 circuits each on own chassis bolt together to form final unit when wiring completed.—**Olson's International;** Dept. K-13, 6509 Whitman Ave., Van Nuys, Calif.

**AUTO RADIO CONTROL KIT** *ACK-100* contains 24 most frequently used replacement auto radio controls. All exact replacements.—**Centralab,** Electronics Div. of Globe-Union, Inc., 900 E. Keefe Ave., Milwaukee 1, Wis.

**CITIZENS-BAND TRANSCEIVER,** *Osborne 300.*



1/5th size and weight of average class-D equipment. Requires 10% of normal operating power. 4-channel selector with plug-in crystals. 9-transistor circuit. All-metal diecast case. 1⅞ x 6 x 7 in.—**Osborne Electronics Corp.**, 13105 S. Crenshaw Blvd., Hawthorne, Calif.

**INVERTERS**, electronic boxes that plug into cigarette lighter or connect directly to storage battery and change 6- or 12-volt automobile or marine battery current into 110 volts alternating house current. *Mighty Midget, model DME* and *Medium Power Portable, Models RME and RMF* (illustrated) for use with dictating machines,

record players and similar low wattage devices. *Model RHG* for tape recorders, small TV sets, PA systems and a wide variety of electrical devices.—**American Television & Radio Co.**, 300 E. 4th St., St. Paul 1, Minn.

**ELECTRONIC GARAGE-DOOR OPENER KIT**, *GD-20*, can be installed on any overhead track-type garage door up to 8 feet high. Transmitter mounts under hood of car; pushbutton under

instrument panel; antenna under car. Receiver mounts on garage mechanism. Safety device. Automatic light.—**Heath Co.**, Benton Harbor, Mich.

**MONOPHONIC AMPLIFIER**, *KN-611*. 10 watts, with frequency response of 1 db from 30 to 20,000 cycles. 10-watt rated output. 20-watt peaks. Less than 2% harmonic distortion. Hum


and noise 80 db below rated output. 2 EL84/6BQ5 audio output tubes.—**Allied Radio Corp.**, 100 N. Western Ave., Chicago 80, Ill.

**TAPE-DECK CARRYING CASE** for manufacturer's stereo/mono 4-track model. Holds two 7-in. reels. Wood and nickel-plated hardware

construction. Decorator-stitched charcoal gray vinyl covering.—**Electronic Instrument Co. Inc., (EICO)** 33-00 Northern Blvd., Long Island City 1, N. Y.

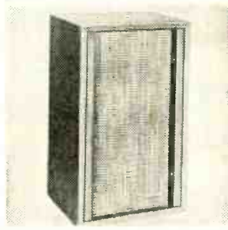
**SPEAKER SYSTEMS**, *JBL Lancer 33 and Lancer 66*, identical enclosure sizes, 12¾ x 23½ x 11¾ in. *Lancer 33* has special driver; *66* contains linear efficiency 2-way system with 10-in low-frequency loudspeaker and direct-radiator

high-frequency transducer. — **JBL International**, 3249 Casitas Ave., Los Angeles 39, Calif.

**LOUDSPEAKER SYSTEM**, *LSS-10*, designed to improve sound of electronic organs with original built-in speakers. Ducted-port enclosure tuned to 32 cycles with Electro-Voice SP12B speaker for full fundamental energy reproduction at low

frequencies. 40 watts of organ tone. 32 to 13,000 cycles frequency range. 24 x 19 x 36 in.—**Schober Organ Corp.**, 43 W. 61st St., New York, N. Y.

**SPEAKER SYSTEMS**, *S-2 and S-3*. With crossover circuitry for 3-way system each speaker



operates in optimum range. Separate, continuous mid-range spherical tweeter controls. *S-2*: 12-inch woofer, 2 mid-range drivers, separate tweeter; 23¾ x 14½ x 12 in. *S-3*: 10-in. woofer, 1 mid-range driver, separate tweeter; 23½ x 11¾ x 9¾.—**H. H. Scott Inc.**, Dept. P., 111 Powdermill Rd., Maynard, Mass.

**ENCLOSURE**, *JBL C51 Apollo*, accepts wide variety of loudspeakers and systems. 26⅛ x 26½ x 18 inches. Mahogany, tawny walnut, oiled wal-

nut, Danish teak and ebony.—**JBL International**, 3249 Casitas Ave., Los Angeles 39, Calif.

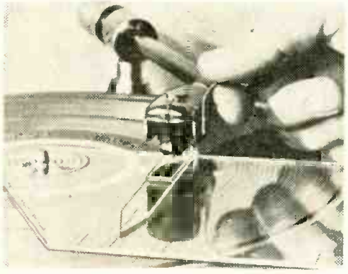
**MICROPHONE**, *SR 585*, with momentary on-off switch. For any fixed mounting application.

Chrome-finished die-cast housing on 16-in gooseneck. High- and low-impedance, crystal and ceramic models.—**Turner Microphone Co.**, 909 17th St., N. E., Cedar Rapids, Iowa.

**MICROPHONE DESK STAND**, for use with

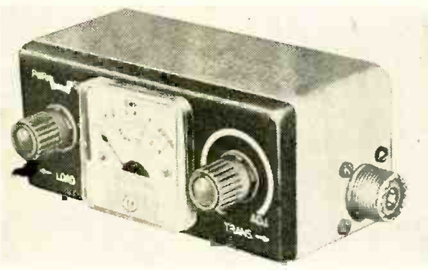
manufacturer's microphone. Black bakelite.—**Roberts Electronics Inc.**, 829 N. Highland Ave., Los Angeles 38, Calif.

**STYLUS ALIGNMENT**, with *Stereo Stylusmaster*. Controls electrical and mechanical distortion, crosstalk (channel separation), stylus



and record wear, shatter (ability to track heavily recorded passages) groove jumping.—**Prestige Products**, 13547 Bessemer, Van Nuys, Calif.

**METER**, *Micromatch 290*, measures actual rf power output in watts and standing-wave ratio



on calibrated scales. For class-D Citizens Band.—**M. C. Jones Electronics Co. Inc.**, 185 N. Main St., Bristol, Conn.

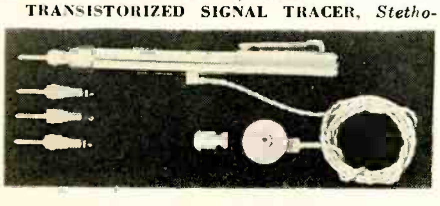
**OSCILLOSCOPE**, *Primer-Scope, Mark I*, for beginners, students, light industrial, service,

laboratory use. Frequency response: dc, 0 to 75 kc; ac, 20 cycles to 75 kc. 7¼ x 3½ x 11¼ in. 5¾ lb.—**Waterman Products Co. Inc.**, 2445 Emeral St., Philadelphia 25, Pa.

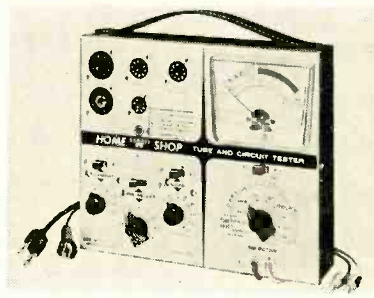
**VTVM/AC MILLVOLT/WATTMETER KIT.** Accuracy switch doubles ac/dc volt scale to allow measurements near full-scale meter indication.

Reads as low as 1 millivolt ac, alternating current from 150 ma to 5 amps, up to 1,600 watts at 110 vac and audio output watts. 6-in full-view meter face.—**Radio Shack Corp.**, 730 Commonwealth Ave., Boston 17, Mass.

**TRANSISTORIZED SIGNAL TRACER**, *Stethotracer*, pen-size, self-contained. Low-level microwatt audio and modulated radio-frequency signal is detected or demodulated, then amplified and reproduced at output stage. Complete with earphone, cord, plug, 3 attenuator probes, 1 rf detector demodulator, interchangable probes, ground clip lead and battery.—**Don Bosco Electronics Inc.**, 56 Route 10, Hanover, N. J.



**COMBINATION TUBE TESTER AND VOM**, *Home "N" shop-type, model TC101*, checks approximately 2,000 tubes for emission, shorts and leakage. Covers all popular hi-fi, TV and radio



tubes, including Five Star and foreign import. Becomes volt-ohmmeter for circuit testing with flip of function switch. 1-ma meter—**Gold Products Inc.**, 500 S. Westgate Drive, Addison, Ill.

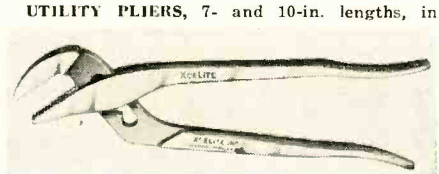
**TV FILAMENT RESISTORS**, *P25K-51* and *P25K-60*, a 25-watt, 51-ohm resistor and a 25-30 watt,


60-ohm unit respectively.—**Clarostat Manufacturing Co. Inc.**, Dover N. H.

**SCREWDRIVERS**, *Lock-Grip*, constructed so that soft sleeve is locked onto handle. Vinyl plastic for oil, water and gasoline resistance. Com-

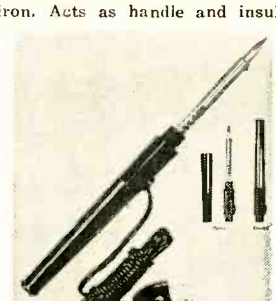
plete assortment.—**Rosenberg Bros.**, Smithtown, N. Y.

**UTILITY PLIERS**, 7- and 10-in. lengths, in



forged alloy steel. Box-joint construction and flush-ground rivet pin. 30% thinner.—**Xcelite Inc.**, Orchard Park, N. Y.

**SOLDERING IRON**, *Tuck-Away model SP-1*. Hollow bakelite sleeve can be attached to either end of iron. Acts as handle and insulates sur-

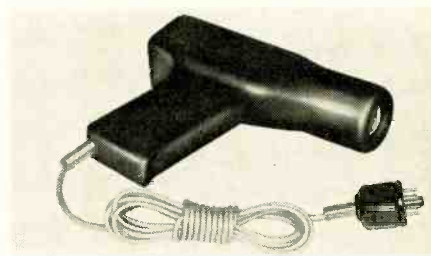


rounding objects from heat of tip at other end, thus permitting user to put soldering iron into tool kit on finishing job.—**Sampson Co.**, Electronics Div., 2244 S. Western Ave., Chicago 8, Ill.

**HOLSTER TYPE SOLDERING-GUN HOLDER**, *ETR-2582*, accommodates all popular soldering guns. Can be mounted under shelf or cabinet,

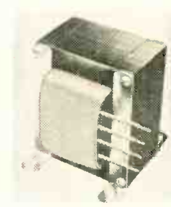
to edge of service bench or on peg board tool rack.—**General Electric, Distributor Sales, Electronic Components Div.**, Owensboro, Ky.

**IGNITION TIMING-LIGHT ACCESSORY**, *ID-11*. Bright white light shows timing marks even in brightly lighted areas. 0–1,250 flashes per minute speed range. Hard-rubber pistol-grip case with



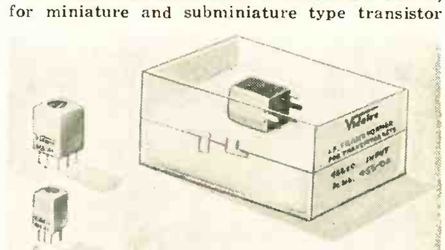
10-foot cable. 6 x 7½ x 2 in. Kit or factory-assembled. Used only with IO-20 ignition analyzer.—**Heath Co.**, Benton Harbor, Mich.

**FILTER CHOKES**, six: 2 high-current rated at 1 volt rms, 60 cycles; *C-2690* at 0.3 henrys at 1 amp dc with dc resistance of 3 ohms. *C-2691*



at 80 mh at 2.5 amps dc; 4 smoothing chokes for dc power supplies at 10 volts, 60 cycles.—**Stancor Electronics Inc.**, 3501 W. Addison St., Chicago, Ill.

**IF TRANSFORMERS AND OSCILLATOR COILS**, for miniature and subminiature type transistor



sets. 4 models in ¼ x ¼ size; 4 in ⅜ x ⅜ size.—**Vidaire Electronics Mfg. Corp.**, 365 Babylon Turnpike, Roosevelt, N. Y.

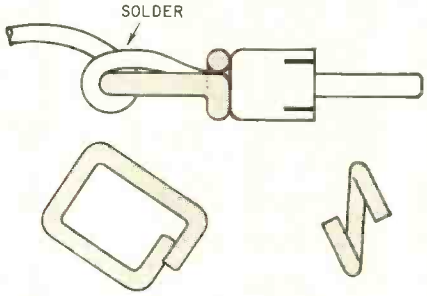
**HIGH-VOLTAGE PUTTY**, repairs and rebuilds tires on flyback transformers. Also stops arcing

in yokes and high-voltage cages.—**Colman Electronic Products**, PO Box 2965, Amarillo, Tex. END

**All specifications from manufacturers' data.**


### PHONO-PLUG HANDLE

Having trouble with phono plugs? Frequent use often loosens the ground connections, and their small size makes them difficult to grasp. Some types have handles and solderless connections but these may be too bulky to use in crowded equipment. A simple solution




is to use a short length of bus bar (or tinned coat-hanger wire) formed into a rectangle as shown in the drawing. The ends are bent to fit firmly against the ground lip of the plug and soldered. Shield braid may be soldered either to the plug, or to the bus bar to provide both a slim, easily gripped handle and a strain-free ground point. The shield may be unbraided or simply wound around the bus-bar handle and soldered.
—*William H. O'Brien*

### OSCILLATOR HINT

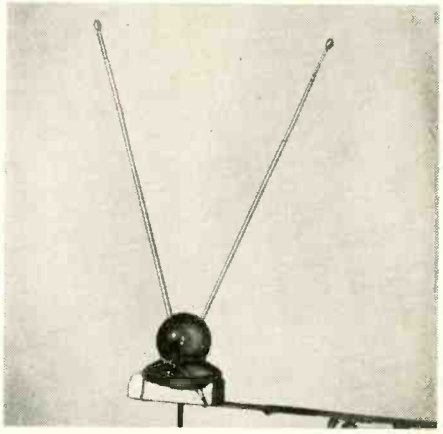
Some years ago I built a high-frequency oscillator which covered a wide frequency range with a single oscillator coil and a large tuning capacitor. Trouble was encountered immediately with this arrangement. If feedback was adjusted to suit the low-frequency range, the oscillator would squegg at the high end. Reducing feedback to suit the high end would result in oscillation ceasing before the low-frequency end of the range was reached.

Substituting a 6K7 remote-cutoff tube for the 6J7 sharp-cutoff tube previously used was a complete solution. Feedback was adjusted to suit the low end of the range and no squegging occurred at the high end. Indeed it was found impossible to make a 6K7 squegg in the circuit used.

Placing a remote-cutoff tube in a grid-leak-biased oscillator has been found useful on several occasions since. Variation in output is usually less across the tuning range with a remote-cutoff tube, and trouble has never been encountered with squegging. The 6AU6 and 6BA6 are examples of more modern counterparts of the 6J7 and 6K7.—*Roy Orvis*

### TEMPORARY TV ANTENNA

A winter storm had blown down the customer's antenna and coated the roof with ice. We made a temporary antenna by fastening a pair of rabbit ears to a wood block on the arm of an inexpensive photographic light stand, using rubber bands as shown in the photo. This brought the ears close to the



ceiling and gave satisfactory reception on two channels. With a longer lead and the stand set up in a second-story room, reception was excellent on the two channels and satisfactory on a third.

We set this arrangement in the living room of several customers who were doubtful of the value of an outdoor antenna. When they saw the better reception available with this simple device (which is untidy-looking, as we always point out), they all ordered the best antenna usable in this section. —*Raymond Dickison*

### SAVE THE SPEAKER

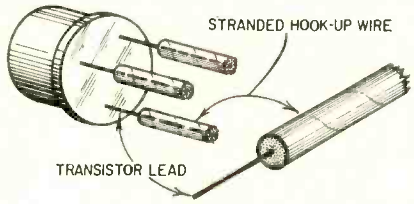
Before we begin working on a radio or TV set on the bench, we protect the speaker cone against damage from a slipping screwdriver by cutting a piece of cardboard to match the front of the speaker frame. Punch holes in the corners to match the holes in the speaker, and fasten it to the speaker face with paper fasteners bent over at the rear. When the job's finished, the cardboard protector slips off.—*Henry Josephs*

### SOLDERING ALUMINUM

Next time you are confronted with an aluminum soldering job, use this effective method. Chuck a medium-grit grinding wheel in a hand grinder and heat the wheel over the flame of a cigarette lighter. While the wheel is still warm and rotating, hold it against a bar of 40-60 tin-lead solder until it is charged with solder particles. Then hold the wheel against the aluminum surface to be soldered. The heat caused by friction will melt the solder particles causing them to adhere to the abraised surface. After this process has been completed, 50-50 tin-lead solder will produce an effective bond.—*John A. Comstock*

## TRANSISTOR CONNECTORS

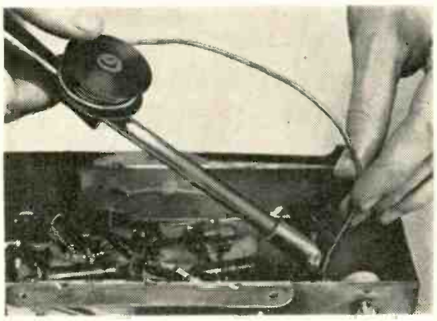
For wiring transistors into an experimental circuits try this gimmick. Cut




the transistor leads to about a ¾-inch length, and poke them into the ends of pieces of *stranded* hook-up wire—complete with insulation.—*Henry Josephs*

## IRON CARRIES OWN SOLDER

Attach a small typewriter ribbon spool to the wood handle of your soldering iron with a small woodscrew,



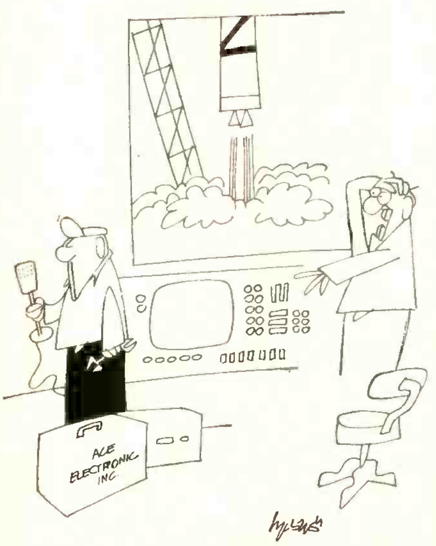
and wind on several feet of solder. No more hunting for that spool of solder or iron rest—the spool solves both problems.—*Joe C. Allen*

## NUT LOOSENER

A valuable ally in service work is a small bottle of hydrogen peroxide.

Put a few drops of it on the most stubbornly tight nut, screw, bolt, etc., and it will yield with magiclike speed and ease.

Let the peroxide soak a few minutes before attempting to remove the unit. —*Harry J. Miller* END




"Testing! Testing . . . 4, 3, 2, 1!"

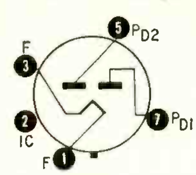
# NEW TUBES and SEMI-CONDUCTORS

An interesting variety of items were unveiled this month. There's a 3.3-volt rectifier, an if transistor for TV, a quadrature-grid FM sound detector, and several other tubes and transistors.

### 3DG4

A full-wave vacuum rectifier in an octal-based glass envelope. It is intended for use in the power supplies of TV receivers and in radio equipment having large direct-current requirements. Its heater is rated at 3.3 volts, 3.8 amperes.

(The odd heater ratings of this tube




3DG4

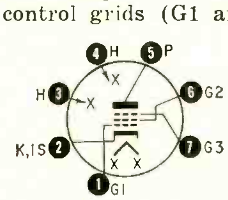
may indicate a new trend in power supplies of radios and TV receivers.)

Design maximum ratings of the RCA 3DG4 in rectifier service are:

| | |
|---|---|
| $V_P$ (peak inverse) | 1050 |
| $V_P$ (ac supply rms) (plate to plate) | 550 |
| $I_P$ (peak) (amps) | 1.2 |
| Filter input capacitor ($\mu f$) | 40 |
| Dc voltage output to filter | 300 |
| Dc output (ma) | 350 |

### 6GX6

A sharp-cutoff pentode in a 7-pin miniature envelope with two independent control grids (G1 and G3) is




6GX6

designed for use as a combined detector, limiter and audio voltage-amplifier driver in locked-oscillator, quadrature-grid FM sound-detector service.

The 6GX6 features:

- Two independent control grids with sharp-cutoff characteristics—to provide great flexibility in circuit design.
- High grid 1-to-plate transconductance—for high sensitivity.
- Good AM rejection.
- High audio output voltage with low distortion.

A typical sound detector circuit using the 6GX6 is shown in the diagram.

Maximum ratings of the RCA 6GX6 in FM sound-detector service are:

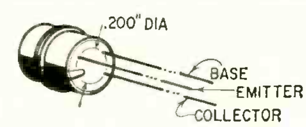
| | | |
|---|---|---|
| $V_P$ (plate voltage) | | 300 |
| $V_{G3}$ (control-grid voltage) (positive value) (dc and peak) | | 25 |
| $V_{G2}$ (screen grid voltage) | | 300 |
| $V_{G1}$ (control grid voltage) (positive bias value) | | 0 |
| (negative bias value) | | 50 |
| $P_P$ (plate dissipation) | (watts) | 1.7 |
| $G3_{input}$ | (watts) | 0.1 |
| $G2_{input}$ | (watts) | 1.0 |

### 2N1868

A germanium micro-alloy diffused-base p-n-p transistor for use as the final 45-mc if amplifier in TV receivers. It may also be used in general vhf applications to 200 mc, where low noise is not a major consideration.

Maximum ratings of the Philco 2N1868 are:

| | |
|---|---|
| $V_{CB}$ (collector-to-base voltage) | 20 |
| $V_{CE}$ (collector-to-emitter voltage) | 20 |
| $V_{EB}$ (emitter-to-base voltage) | 0.5 |
| $I_C$ (collector current) (ma) | 50 |
| $P_{total}$ (total device dissipation) (mw) | 60 |



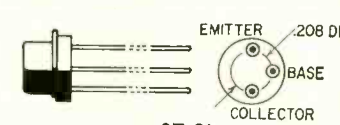

2N1868

Electrical characteristics are:

| | |
|---|---|
| $h_{FE}$ (dc amplification) (typical) ($V_{CE} = -10$ v, $I_C = 2$ ma) | 33 |
| $P_G$ (power gain) ($V_{CE} = -4$ v, $I_C = 2$ ma) (db) (typ) | 25 |

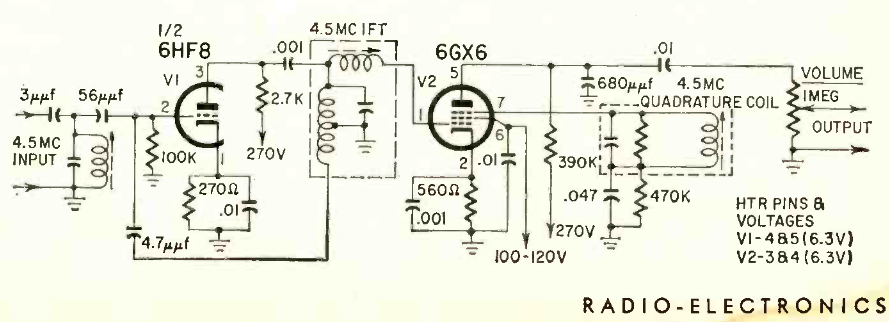
### GT-81

A p-n-p germanium alloyed-junction transistor particularly suited to audio




GT-81

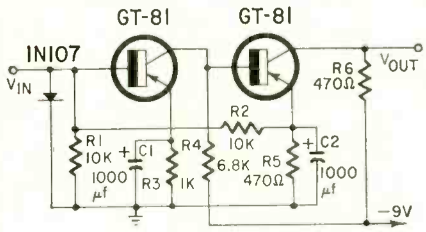
and other low-frequency applications. A temperature-compensated direct-coupled



audio amplifier using the GT-81 is shown in the diagram. It has a voltage gain of 62 db, power gain of 80 db.

Maximum ratings of the General Instrument GT-81 at 25°C are:

| | |
|---|---|
| $V_{CB}$ | 25 |
| $V_{EB}$ | 10 |
| $P_{total}$ (mw) | 150 |

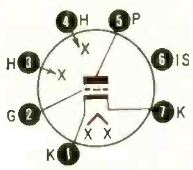



Small-signal characteristics are:

| | |
|---|---|
| $h_{fe}$ ($I_E$=1 ma, $V_{CE}$=5 v, f=1 kc) (minimum) | 50 |
| NF (noise figure) ($I_E$=1 ma, $V_{CB}$=5 v, f=1 kc) (typical) (db) | 16 |
| $G_e$ (power gain) ($I_C$=1 ma, $V_{CE}$=5 v, f=1 kc) (typical) (db) | 42 |

## 6GK5

A high-mu triode of the 7-pin miniature type designed for use as a grounded-cathode rf amplifier in vhf television tuners. Frame-grid construc-



6GK5

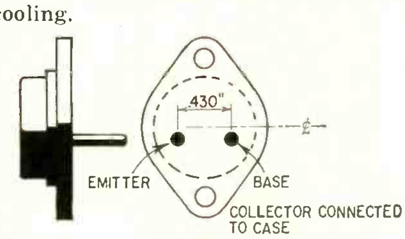
tion permits close electrode spacing, making possible very high transconductance (15,000 µmhos) at a relatively low plate voltage.

Characteristics of the RCA 6GK5 when used as a class-A1 amplifier are:

| | |
|---|---|
| $V_P$ | 135 |
| $V_C$ | −1 |
| $R_P$ (approx) (ohms) | 5,400 |
| $g_m$ (µmhos) | 15,000 |
| µ | 78 |
| $I_P$ (ma) | 11.5 |

## 2N242

A p-n-p junction transistor designed for high-power audio service in mobile battery-powered devices. The collector is connected to the case for conduction cooling.



2N242

Maximum ratings of the Tung-Sol 2N242 are:

| | |
|---|---|
| $V_{CE}$ | 45 |
| $I_C$ (amps) | 5 |
| $P_C$ (watts) | 50 |

Electrical characteristics at 25°C are:

| | |
|---|---|
| $h_{fe}$ ($V_{CE}$=12 v, $I_C$=500 ma) (minimum) | 30 |
| $f_{ao}$ ($V_{CE}$=12 v, $I_C$=500 ma) (maximum) (kc) | 120 |

END

# TECHNICIANS' NEWS

## NEW NATESA AFFILIATES

*Chicago, Ill.*—Added to the NATESA family are new locals at widely separated points.

In Iowa, TESA-Muscatine was launched by Secretary Len Gregson of TESA-Quint Cities, Illinois. This group, headed by Wes Hunter, though brand-new, is letting TV–radio set owners know they are around. Big ads, featuring the NATESA emblem, cover their area.

Moving into Ohio, Paul Lecoy, association governor for Ohio, Kentucky and Indiana, has finalized the application of SCIOTA, Portsmouth, Ohio. He was assisted in the final stage by Ray Braun and Guy Mitchell of TESA–Cincinnati. The president of this new affiliate is James Holcomb.

Pacific Northwest governor Les Quigley reports that another TESA has been born in Oregon, this time TESA–Yamhill County.—*Natesa Scope*

## TEA ANNUAL CLINIC

*Fort Worth, Tex.*—The Ninth Annual Clinic will be held here by the Texas Electronics Association Aug. 4–6. J. W. Williams Jr. and M. A. Dewveall of the association's Fort Worth chapter have been chosen as co-chairmen for the clinic, which will be held at the Hotel Texas. The schedule of sessions will be set up to allow enough free time, for any who desires, to see the town. An attendance of 1,000 is anticipated—500 technicians from the Dallas–Fort Worth area and 500 shop owners from throughout Texas.

## ITTA GETS TV PLUGS

*Indianapolis, Ind.*—Mutual advertising program between the Indianapolis Indiana Electronic Service Association and TV station WFMB nets the association two free spot commercials a day. In return, whenever an ITTA technician repairs a TV set, he sets the channel selector to channel 6 and attaches a yellow card which reads, "Your TV dial has been set at channel 6, WFBM-TV . . . first in news . . . first in entertainment . . . first in sports." The tag line on the card states: "Your set has been serviced by a member of Indiana Electronic Service Association."

## ELECTION RESULTS

*Miami, Fla.*—The newly elected officers of the Television & Electronic Service Association are: Daniel Prowler, president; Charles D. Pierce, first vice president; James P. Cresswell, Jr., second vice president; Samuel Kessler, recording secretary; Maxwell Reiser, corresponding secretary; Charles W. Minter, treasurer.

*Philadelphia, Pa.*—An election held by the Delaware Valley Television Service Association made Herman Shore, president; John Harfield, vice president; Steward Kirsting, corresponding secretary; Robert Martin, secretary, and Elmer Romig, treasurer.

Members of the board are Louis J. Smith, the outgoing president and Bernardt Blumenthal, Mike Finn, Sam Brenner, Dave Krantz, Elwood Walker, Ray Fink, John McCoy Jr., Tony D'Annibale and Herb Goldstein.

*Detroit, Mich.*—New officers of the Television Service Association–Michigan are: J. Russell Goode, president; Michael R. Dallen, vice president; Thomas J. Goode, secretary; Lawrence F. Nelson, treasurer.

## TESA–OZARKS REPORTS

*Springfield, Mo.*—New officers have been elected. They are William Shiner, president; Rue Johnson, vice president; Thomas Leftwitch, secretary-treasurer, and Mark White, Sergeant at arms.

Reed Radio Supply hosted Ozarks area technicians at a service clinic on troubleshooting sync circuits. Wayne Lemons was the instructor.

## A FEW BAD APPLES . . .

*Los Angeles, Calif.*—Seven firms account for 75% of all TV repair complaints, according to local Better Business Bureau's president, Robert J. Bauer. And 12 others are responsible for another 15%. So out of the hundreds of TV repair shops in Los Angeles, 19 account for 90% of the complaints.

## OFFICIAL CSEA PUBLICATION

*Fresno, Calif.*—The Modern Electronic Service Dealer has been named the official publication of the California State Electronics Association. It will carry news of all CSEA members and replace a number of unrelated publications serving individual chapters of the association.

## CODE OF ETHICS

*Columbus, Ga.*—Adopting a code of ethics was the business of the day at a recent meeting of the newly formed Television Repair Service Association. Operators of 21 local service shops attended the meeting at the Columbus BBB. Fred L. Hart was elected temporary chairman of the group. Permanent officers will be elected soon.

## LONG-TERM WARRANTY

*New York, N.Y.*—Sylvania announced a change in their radio warranty plan. Parts and labor warranty on tube radios would be extended to 1 year and on transistor radios to 5 years. According to *Home Furnishings Daily*, other manufacturers seemed to feel that they would not follow Sylvania and that the warranty is not necessary but is a promotion idea.

## TRI-STATE COUNCIL NEWS

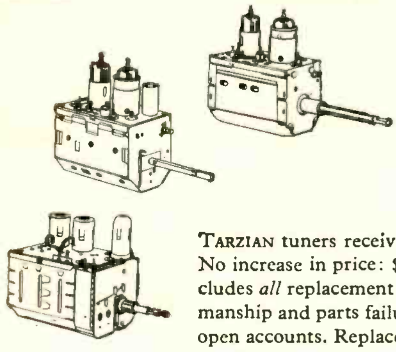
*Philadelphia, Pa.*—A transistor forum was held at the Peirce-Phelps auditorium by Harry Tellis, Zenith field engineer, for members of the Allied Electronic Technicians Association of New Jersey. Subject of the forum was service techniques for transistor circuits. Each technician attending the meeting received a Zenith transistor servicing manual.

*Trenton, N.J.*—At their regular meeting the Radio Servicemen's Association was shown a film of Sylvania's receiving tube manufacturing process. A lecture on the structure and uses of various types of transistors followed.

## TV SERVICING ON THE AIR

*Buffalo, N. Y.*—Four 15-minute TV programs on the importance of proper TV servicing are being put on WGR-TV Sunday mornings. The programs are being conducted by the Television Electronic Servicemen's Association of Greater Buffalo. The first program explained TV set problems and servicing procedures. END

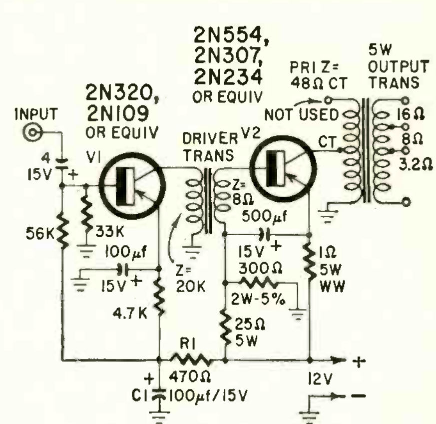

"If one of you fellers would be kind enough to lend me a pair of pliers . . ."



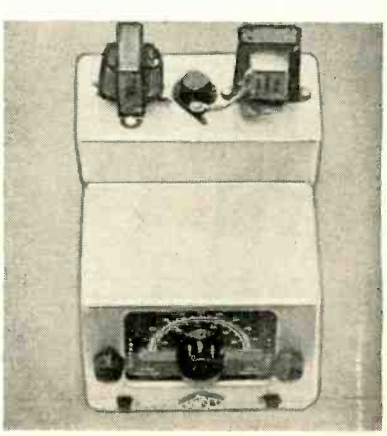

# NOTEWORTHY CIRCUITS

## 2-STAGE TRANSISTOR AMPLIFIER

This easy-to-build transistor amplifier delivers a hefty wallop to a 6 x 9-inch speaker, has good response, and should find a host of applications in mobile work or on the bench. The schematic diagram shows a two-stage, base-driven amplifier built around inexpensive, universal type transistors and noncritical parts. A 3 x 5 x 1½-inch aluminum Minibox houses all components and, in addition, serves as a heat sink for V2. V2 mounts directly on the chassis but is insulated from it by an anodized aluminum washer (Motorola or Workman). In a pinch, a piece of varnished cambric will serve satisfactorily as a heat-sink insulator. Apply a film of silicone grease to both sides of the washer before mounting it.



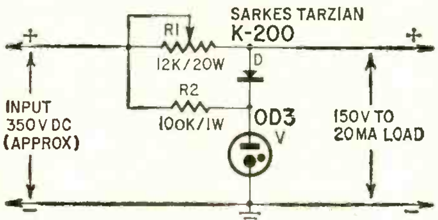

A universal output transformer is used as driver transformer, and the taps adjusted experimentally for best match but any output transformer works well. All other parts are standard items, and variations in values of up to 25% from the values given will not



appreciably affect the amplifier's operation. C1–R1 comprise a decoupling network to isolate the first stage from "hash" coming up the battery line. In most applications, it can be eliminated. The photo shows the amplifier mounted on a Gonset 40–50-mc mobile FM–AM tuner.—*Domenic Ripani*

### IMPROVED VOLTAGE REGULATION FOR RIG

Severe frequency shift is often a problem in push-to-talk transmitter operation when the oscillator is keyed on by applying regulated B-plus voltage. This chirp is caused by the fact that the voltage must climb to the V-R tube's minimum starting voltage (156 to 185 volts for the 0D3) before the V-R tube fires. Then the tube quickly pulls the voltage to the regulation level (150 volts). The alternative of leaving the V-R tube in operation during standby



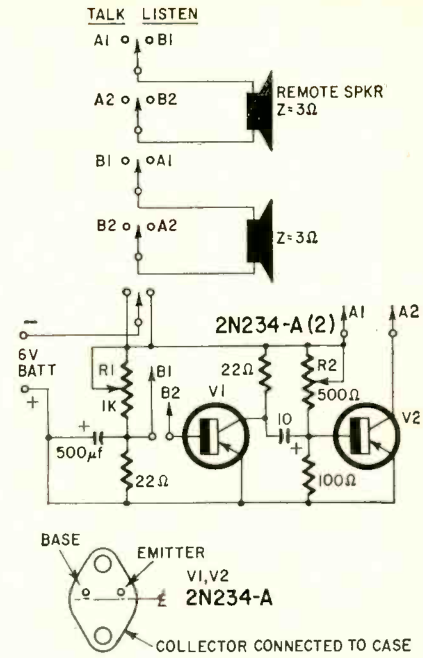

periods is objectionable in mobile or portable operation when total power drain becomes a critical factor. The circuit shown solves the problem by separating the two functions, applying a high voltage to the V-R tube to fire it, but never allowing the voltage on the load to rise significantly above the regulated level.

Initially the slider of R1 is adjusted to provide about 155 volts to the load with V-R tube V out of the socket. With V in the socket for normal operation, the voltage to the load will rise toward the 155-volt level when supply voltage is applied to the circuit. The voltage to the plate of V will rise much higher, however, since the voltage drop across R2 will be negligible at that instant. Diode D will be back-biased (the voltage on the cathode will be more positive than that on the anode) and V will not have fired yet, so the current flow through R2 will be zero. When this voltage becomes great enough to fire the tube, its firing will drop the voltage to 150. This will place a forward bias on diode D, causing it to conduct.

In normal operation the current which flows through V also must pass through D. However, the forward voltage drop across a silicon diode of this type is in the order of a volt or less and is essentially constant under the current fluctuations which might normally occur here, so the regulation is unaffected. The parallel path presented by R2 is sufficiently high in resistance to make its effect negligible on circuit operation.—*Otis Pedrick, W4OMV*

### TRANSFORMERLESS INTERCOM

Because of the low internal resistance of power transistors, a transformerless intercom can give very high gain and




power output by taking advantage of the direct coupling to the speaker. Such a unit was described by *Bendix Semiconductors* in a recent application note. It is a two-transistor unit that operates from a 6-volt lantern battery.

Note that resistors R1 and R2 are shown as potentiometers. They must be adjusted to set transistor base bias for 3 volts collector–emitter voltage across each transistor. Set the pots for proper bias, measure their resistance, then replace them with fixed carbon units.

The TALK-LISTEN switch should be a spring-return unit to give maximum battery life. Use either a lever or rotary type. Circuit layout is not critical and since the power transistor ratings are not exceeded, heat sinks are unnecessary.—*Warren Roy* END

## 50 Years Ago

### In Gernsback Publications

**HUGO GERNSBACK, *Founder***

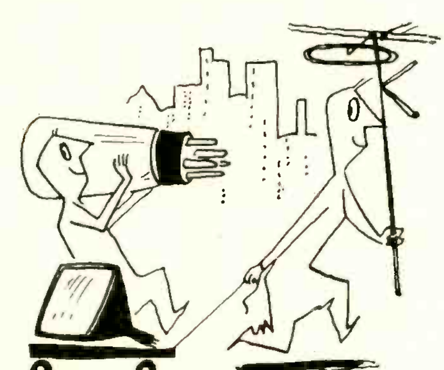
| | |
|---|---|
| Modern Electrics | 1908 |
| Wireless Association of America | 1908 |
| Electrical Experimenter | 1913 |
| Radio News | 1919 |
| Science & Invention | 1920 |
| Practical Electrics | 1921 |
| Television | 1927 |
| Radio-Craft | 1929 |
| Short-Wave Craft | 1930 |
| Television News | 1931 |

Some larger libraries still have copies of Modern Electrics on file for interested readers.

**In July, 1911, *Modern Electrics***

New System of Wireless Telephony, by Victor H. Laughter.
Pictures by Wireless.
Novel Generator of Electric Waves.
Wireless on Aeroplane.
Strengthening Wireless Signals, by Ellery W. Stone.
"Wireless Institute," by H. Winfield Secor.
Polarity Indicator, by Eberhardt Rechtin.
Rotary Detector, by E. Jay Quimby.
Portable Cane Wireless, by B. Moran.
Improved Condenser.





## MOVING?

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# new PATENTS

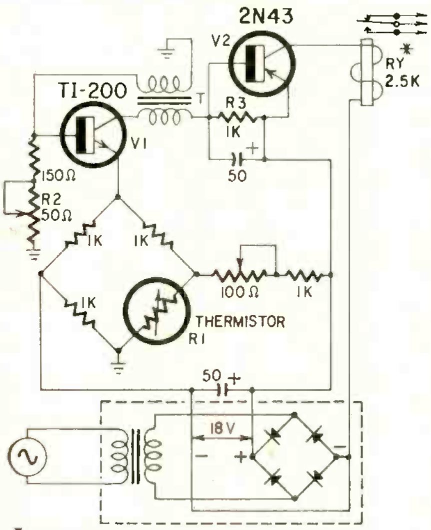
## RELAY CIRCUIT

**Patent No. 2,955,213**

*Donald K. Schaeve, Rockford, Ill. (Assigned to Barber-Colman Co., Rockford, Ill.)*

Adequate power must be supplied to a relay for positive action, or the relay may chatter or arc. This transistor circuit energizes a relay. Its output snaps from a low to a high voltage or vice versa, so relay action is positive.

R1 (Fig. 1) is a temperature-sensitive resistor whose value is 1,000 ohms at some critical temperature. Below that point, its resistance is lower than 1,000 ohms. The other arms of the bridge are 1,000-ohm resistors.




*2.5K TYPE KCP (POTTER & BRUMFIELD)

Fig.1

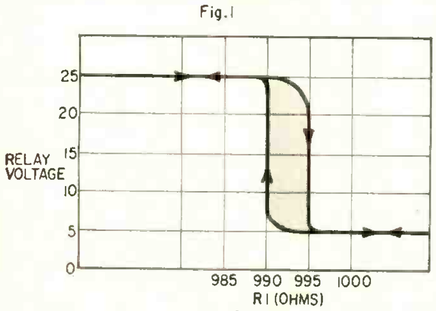



Fig.2

Below the critical temperature, the bridge output is a negative voltage which biases V1 to conduction. As the temperature falls still lower, V1's gain rises and it oscillates at a frequency determined by T. The ac flows through R3 and, after rectification by V2, biases it to conduction, to energize the relay.

Fig. 2 shows how the relay voltage snaps from about 5 to about 25 when R1's resistance falls to 990 ohms. Conversely, it snaps back to the lower value when R1's resistance rises to about 995 ohms, releasing the relay.

R2 sets the bias for V1.

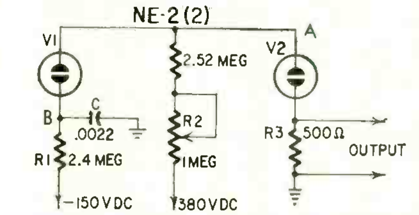
## SQUARE-WAVE GENERATOR

**Patent No. 2,963,659**

*Duane E. Dunwoodie, Palo Alto, Calif. (Assigned to Hewlett-Packard Co., Palo Alto)*

This neon lamp generator is suitable for calibration and testing purposes. Each lamp fires at 80 volts, after which its potential difference falls to 60 volts. Conduction is not sustained below 60 volts. Initially, assuming V2 is conducting, V1 blocked. Thus the potential at point A is 60 volts.

C charges through R1 till B reaches —20 volts, at which instant V1 fires. A falls abruptly to 40 volts, which extinguishes V2. Now C begins to charge through V1, R2, etc. The voltage at B rises. A following it 60 volts higher. When B



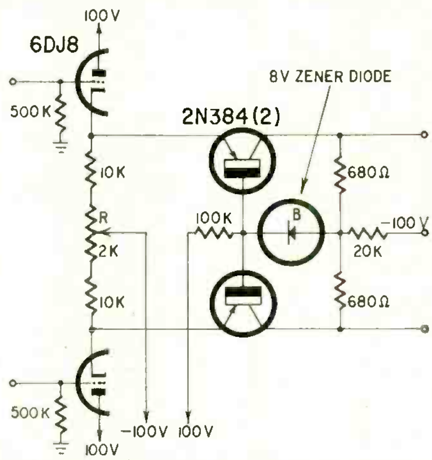

reaches 20 volts, A must be 80 volts, so V2 fires. At this moment, V1 extinguishes because A has dropped to 60 volts. This completes one cycle. There will be constant output voltage during V2's conduction, no output at other times.

## TUBE–TRANSISTOR AMPLIFIER

**Patent No. 2,963,655**

*Norman B. Schrock, Los Altos, Calif. (Assigned to Hewlett-Packard Co., Palo Alto, Calif.)*

This wide-band amplifier uses both tubes and transistors. It is especially applicable to such circuits as deflection circuits in oscilloscopes or other circuits where it may be desirable to am-




plify frequencies from dc into the megacycles.

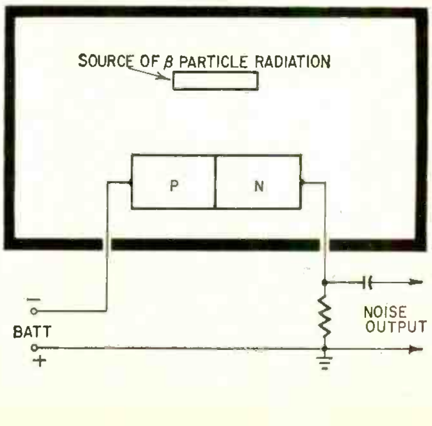
The duo-triode is a cathode follower with high-impedance import, low-impedance output. The two grounded base transistors provide low-impedance input, high-impedance output. Each stage amplifies and each is matched for optimum power transfer. R compensates for inequalities in the tubes and the transistors. A typical amplifier might be flat from zero to 60 mc.

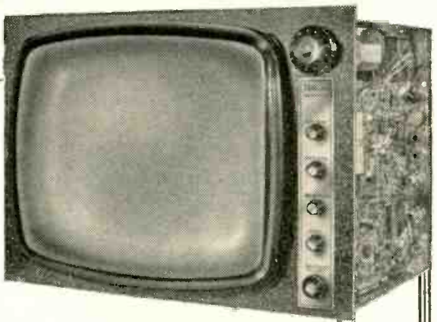
## NOISE GENERATOR

**Patent No. 2,952,817**

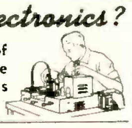
*David P. Kennedy, Waltham, Mass. (Assigned to Raytheon Co.)*

This device consists of a biased p-n junction near a radiation source. The rays generate hole-electron pairs within the semiconductor, and cause fluctuations in diode flow. A flat response from 100 cycles to 16 kc is obtained. END



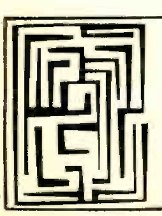


















# BUSINESS and PEOPLE

**Leslie H. Warner** (left) was elected president of General Telephone & Electronics Corp., New York, parent company of Sylvania Electric Products, New York. He succeeds **Don G. Mitchell** who becomes vice chairman of the board. Warner had been executive vice presi-

dent–manufacturing, and a director. **Gene K. Beare** (right) was elected president of Sylvania, succeeding **Robert E. Lewis**, who resigned to become president of Perkin-Elmer Corp. He had been president of General Telephone & Electronics International Inc.

**Allan W. Greene**, president of Heath Co., a subsidiary of Daystrom, Inc., Murray Hill, N. J., was elected a corporate vice president. He continues as president of Heath.

**Sidney Harman**, president of Harman-Kardon, Inc., was elected executive vice president of Jerrold Electronics Corp., Philadelphia, as a result of the merger of the two companies earlier this year.

**Frederick R. Lack** was elected to the new post of senior vice president in charge of research of Sprague Electric Co. He has been a director of the company since 1959. **Neal W. Welch** and **Dr. Wilbur A. Lazier** were named to the board of directors. Welch is senior vice president of marketing and sales, and Dr. Lazier is senior vice-president in charge of engineering.

**L. Donald Cole** was promoted to manager of marketing services for CBS Electronics, Danvers, Mass. He had been sales service manager. **E. Gordon Burlingham** was promoted to manager, distribution services. He was formerly manager, warehouse administration. **Martin W. Lyon** was named sales engineer, semiconductors, Midwest region. He joined the company from the National Semiconductor Corp., where he was central regional manager.

**Richard O. Ahlfors** joined Seco Electronics, Inc., Minneapolis, Minn., a subsidiary of Di-Acro Corp., as national field sales representative. He comes from Service Engineers, Inc.

**Ed Weisl** was appointed national distributor sales manager for United Catalog Publishers, Inc., Hempstead, N. Y., succeeding **Al Stevens** who has established his own manufacturers' representative firm and will represent United Catalog Publishers in the East. Weisl was recently distributor sales manager for DeWald Radio.

**JFD Electronics Corp.**, Brooklyn, N.Y., announced a comprehensive merchandising program for its exact replacement antennas for portable and tote-able TV receivers. The plan incorporates the use of three self-merchandising display racks.



**Switchcraft, Inc.**, Chicago, Ill., introduced a new Tini-Component counter display for distributors of its "Micro-Plugs and Micro-Jax.

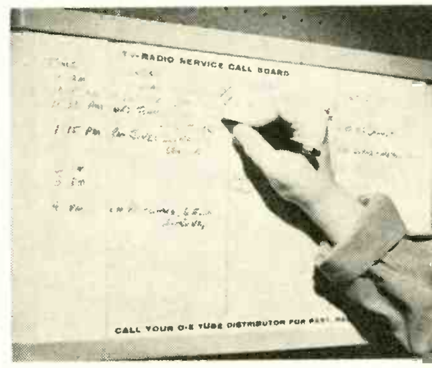
**Electro-Voice, Inc.**, Buchanan, Mich., has brought out a special package of point-of-sale promotional aids for its


Musicaster outdoor hi-fi speaker system to back up a consumer advertising campaign.

**Pickering & Co.**, Plainview, N.Y., is offering owners of its Stanton Stereo

Fluxvalve a free V-Guard Stylus Assembly for 78-rpm records in the new V-Guard Playmates stylus pack.

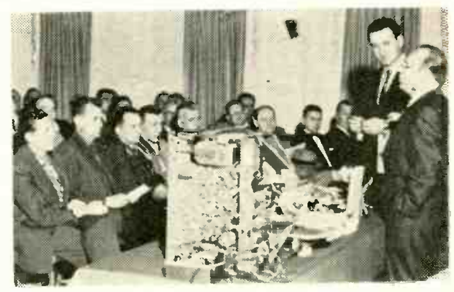
**General Electric Co.**, Distributor Sales Operation, Owensboro, Ky., has designed a rotating plastic-sleeve service



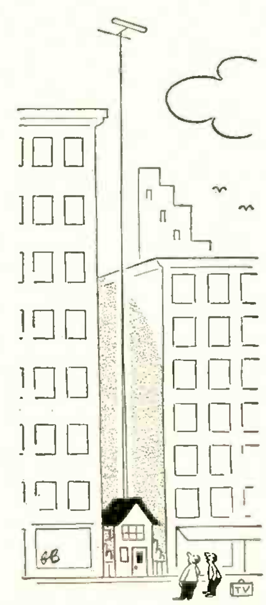

callboard for service technicians which will accommodate appointments for 7 days.

**Centralab**, the Electronics Division of Globe-Union, Inc., Milwaukee, Wis., has announced a new auto radio control kit which contains the 24 most frequently used replacement auto radio controls. The units are contained in a steel-shelved cabinet which is supplied without cost.

**Sencore, Inc.**, Addison, Ill., is continuing its series of service technician clinics. The two most recent were held in cooperation with Slate & Co., Mount



Vernon, N.Y., and Melvin Electronics, Oak Park, Ill. Over 200 technicians attended each of the sessions. Photo shows the Oak Park clinic in session. END



"That ought to do it!"

# 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.

**FLUTTER,** *Its Nature, Cause and Avoidance,* presents a study of the phenomenon and its associated disturbances, wow and drift. Basic theory is followed by a discussion of flutter measurement, causes, avoidance and anti-flutter maintenance of tape and film transports, and phonographs.—**Amplifier Corp. of America,** 398 Broadway, New York 13, N. Y.

**TRANSFORMERS** for industrial applications in wide choice ranging from units for high-reliability military applications to low-cost commercial transformers appear in extensively cross-indexed catalog. Full descriptions, illustrations, detailed dimensional information, complete electrical specifications and performance curves for units where applicable.—**Stancor Electronics Corp.,** 3501 W. Addison St., Chicago, Ill.

**ELECTRONIC TEST ACCESSORIES** described, illustrated and priced in *General Catalog 6-61.* Offers such products as patch cords, connecting leads, cable assemblies and test-socket tube adapters for systems, laboratories, computer installations, etc.—**Pomona Electronics Co. Inc.,** 1500 E. 9th St., Pomona, Calif.

**SOUND-EFFECTS RECORDS** library, for professional or home use, described and classified into 13 categories in conveniently indexed 56-page catalog. Collection includes over 2,000 real-life sound effects, among them rocket blast-off, space sounds, jets and weather.—**MP-TV Services,** 7000 Santa Monica Blvd., Hollywood 38, Calif. 25¢.

**REFERENCE GUIDE** is intended to aid in quick selection of proper mike mixer, transistorized mixer and interconnecting cord for any American tape recorder. Sizable illustrations and easy-to-read columns. In either standard reference page size 8½ x 11 in. or as large wall chart.—**Switchcraft Inc.,** 5555 N. Elston Ave., Chicago 30, Ill.

**STEREOTABLES** for 1961 and a new stereotable kit are featured in illustrated 8-page, 2-color brochure. All seven turntable models introduced by manufacturer built with hysteresis synchronous motors and new belt drive system.—**Rek-O-Kut Co.,** 38-19 108th St., Corona 68, N. Y.

**RECORD AND TAPE CATALOG** writes up manufacturer's classic, pop, jazz, Broadway show, novelty and other offerings. *Spring Music Festival Catalog No. 105* has 24 pages.—**Radio Shack Corp.,** 730 Commonwealth, Boston 17, Mass.

**ENCLOSURES AND SPEAKER SYSTEMS,** their applications and mechanical, acoustical and electrical specifications and features, are subject of *Stereosonics.* Some kits. Photos and diagrams.—**Karlson Associates Inc.,** 433 W. Hempstead Ave., W. Hempstead, N. Y.

**HI-FI COMPONENTS AND FURNITURE** are presented in colorful leaflet. Ample illustrations of components, cabinets, shelf and drawer units with hi-fi, TV, desk and bar and room layouts.—**Sherwood Electronic Laboratories Inc.,** 4300 N. California Ave., Chicago 18, Ill.

**INDUSTRIAL CATALOG** *CS-101* of transformers, chokes and filters for industry. Detailed drawings; some circuits. 34 pages.—**Stancor Electronics Corp.,** 3501 W. Addison St., Chicago 18.

**TAPE RECORDING REFERENCE GUIDE** explains basic principles of tape recording and conversion to 4-track stereo. Photos of tapes treated to show signal patterns on all standard-track systems in home use, phantom views of erase and record/playback heads, reference tables and replacement cross-reference.—**Nortronics Co. Inc.,** 1015 S. 6th St., Minneapolis 4, Minn. 25¢

**MICROWAVE TOWER** *Inspection and Maintenance Check List* emphasizes what should be checked and frequency with which inspection should be made on all parts of the equipment. Pocket-size booklet available in either English or Spanish.—**Tower Construction Co.,** 2700 Hawkeye Dr., Sioux City, Iowa.

**ELECTRONICS FROM JAPAN** stresses hi-fi equipment made by country's prominent manufacturers. Some hobby motors, reading glasses, tools, test equipment and components included.—**KPJ Sales,** Box 1252-N, Studio City, Calif.

**SCIENCE EDUCATION MATERIALS** consist of such units of study as basic heat engine models, gearing systems, space and light energy. Methods of instruction include actual models, book-labs, motograph charts, toys, songbooks and recordings and computer kits.—**Science Materials Center Inc.,** 59 4th Ave., New York 3, N. Y.

**MICROWAVE ANTENNAS AND RIGID COAXIAL TRANSMISSION LINES** outlined in *Catalogs Nos. 100* and *200* respectively. Types, specifications, photos, drawings and charts.—**Technical Appliance Corp.,** Sherburne, N. Y.

**INDUSTRIAL TUBE** *Replacement Guide* contains complete up-to-date listings for wide variety of types, among them backward-wave oscillators, klystrons, magnetrons, strobotrons, thyratrons, counter, gas switching, trigger and traveling-wave tubes. Code symbols for more than 35 manufacturers listed in tabular form to assist in selection of replacement.—**Sylvania Electric Products Inc.,** 1100 Main St., Buffalo 9, N.Y. END

# new BOOKS

**FUNDAMENTALS OF ELECTRICITY (4th Edition), by Kennard C. Graham. American Technical Society, 848 E. 58 St., Chicago, Ill. 5½ x 8¼ in. 342 pp. $4.75.**

This is an excellent beginner's book, brought up to date. It begins with the nature of electricity and magnetism. Both principles and applications are explained. The book is especially detailed on power circuits, motors and generators, batteries, transformers, etc. It also includes a study of radio, automation and measuring instruments.

Photos, cutaway views, diagrams and review questions help the student to understand the very clear text.—*IQ*

**HOW TO REPAIR SMALL APPLIANCES, by Jack Darr. Howard W. Sams & Co., Inc., Indianapolis 6, Ind. 5½ x 8½ in. 128 pp. $2.50.**

Describes the construction, operation and repair of most home appliances, heating elements and thermostats and small electric motors. Also included is a chapter, "Appliance Servicing as a Business," which gives some hints on time-saving tools and techniques as well as on the problem of parts procurement. There is a glossary of terms commonly used in the appliance field which may not be familiar to the electronic technician. The numerous photographs show the technician what to expect to find as he disassembles an appliance. —*FS*

**SURPLUS RADIO CONVERSION MANUAL (Vol. III). Edited by William I. Orr. Editors and Engineers, Summerland, Calif. 8½ x 11 in. 88 pp. $2.50.**

Gives detailed information on converting and modifying much of the military communications and electronic equipment available on the surplus market. Units covered include receivers and transmitters in the SCR-274N and ARC-5 command sets, the SCR-522 radio set, BC-312, -342 and -348 receivers, modulators, dynamotors, radio altimeters, and numerous other types of equipment. Indexes list the contents of the two earlier volumes.—*RFS*

**TRANSISTOR SUBSTITUTION HANDBOOK. Howard W. Sams & Co. Inc., 1720 E. 38 St., Indianapolis, Ind. 5½ x 8½ in. 92 pp. $1.50.**

**TRANSISTOR SUBSTITUTION GUIDEBOOK, by Keats A. Puller, Jr. John F. Rider Publisher Inc., 116 W. 14th St., New York 11, N.Y. 5½ x 8½ in. 56 pp. $1.50**

Sams lists 6,500 substitutions for transistors and hundreds of diode substitutes. There is also a separate listing of American substitutes for Japanese transistors. Rider lists 4,500 transistor substitutes. Both list domestic as well as foreign types, and include data on size and basing.

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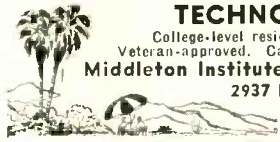

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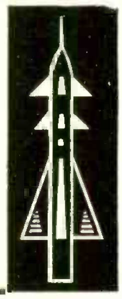

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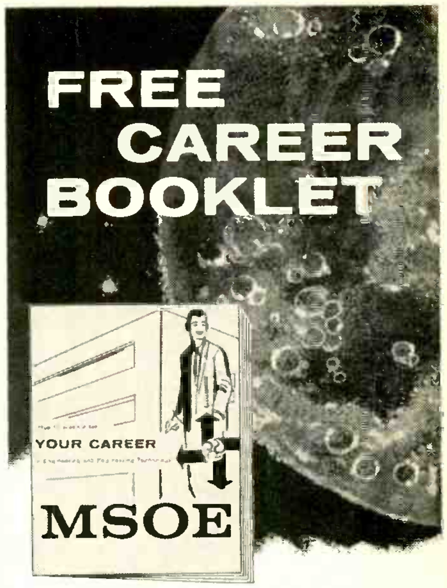


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For example, consider types 2N1143, 2N1142 and 2N1141 whose upper frequency limits increase in the order given. Sams lists the first two as replacements for the 2N1141. Rider gives no direct replacement for the first, and lists both 2N1141 and 2N1142 to replace the 2N1143.—*IQ*

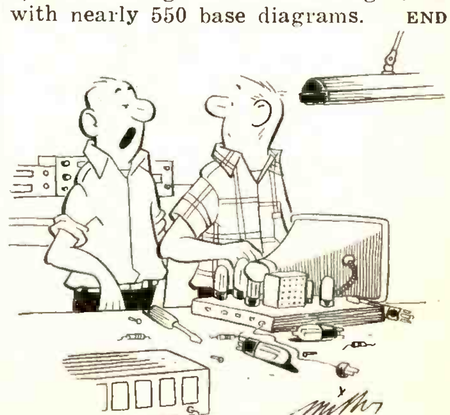
**MOST-OFTEN-NEEDED 1961 RADIO DIAGRAMS (Vol. R-21). 8½ x 11 in. 192 pp. $2.50.**
**MOST-OFTEN-NEEDED 1961 TELEVISION SERVICING INFORMATION (Vol. TV-18). 8½ x 11 in. 192 pp. $3. Both compiled by M. N. Beitman. Supreme Publications, 1760 Balsam Road, Highland Park, Ill.**

Compilations of the latest radio, television and phonograph servicing data and schematic diagrams prepared by leading manufacturers. Vol. R-21 contains service data on nearly 700 models and chassis including home, auto, portable and transistor radios and phonographs listed under 27 manufacturers and trademarks. Vol. TV-18 covers around 650 models and chassis of TV receivers and remote controls of 14 brands.—*RFS*

**THE RADIO AMATEUR'S HANDBOOK (38th Edition—1961). American Radio Relay League, West Hartford 7, Conn. 6½ x 9½ in. 724 pp. $3.50 in US, $4 in US possessions and Canada, $4.50 elsewhere.**

The radio amateur's Bible since 1926, the latest edition has been revised to meet current needs as a radio construction manual, reference book and text for class or home study. Special communication systems such as single-sideband and radioteletype are outlined in detail so the reader has no difficulty in grasping the basic principles. Related circuits and equipment are discussed. Transistor circuits are shown where applicable.

The chapter on vacuum-tube data alone is worth the cost of the Handbook for it includes listings of approximately 1,800 receiving and transmitting tubes with nearly 550 base diagrams. END



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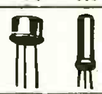

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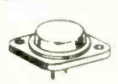

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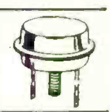

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| Qty. | Type | Price | Qty. | Type | Price | Qty. | Type | Price |
|---|---|---|---|---|---|---|---|---|
| | 0Z4M | .79 | | 6AX7 | .64 | | 12AF6 | .49 |
| | 1AX2 | .62 | | 6BA6 | .50 | | 12AJ6 | .46 |
| | 1B3GT | .79 | | 6BC5 | .61 | | 12AL5 | .45 |
| | 1DN5 | .55 | | 6BC7 | .94 | | 12AL8 | .95 |
| | 1G3 | .79 | | 6BC8 | .97 | | 12AQ5 | .52 |
| | 1J3 | .79 | | 6BD6 | .51 | | 12AT6 | .43 |
| | 1K3 | .79 | | 6BE6 | .55 | | 12AT7 | .76 |
| | 1LN5 | .59 | | 6BF6 | .44 | | 12AU6 | .50 |
| | 1R5 | .62 | | 6BG6 | 1.66 | | 12AU7 | .61 |
| | 1S5 | .51 | | 6BH6 | .65 | | 12AV5 | .97 |
| | 1T4 | .58 | | 6BH8 | .87 | | 12AV6 | .41 |
| | 1U4 | .57 | | 6BJ6 | .62 | | 12AV7 | .75 |
| | 1U5 | .50 | | 6BK7 | .85 | | 12AX4 | .67 |
| | 1X2B | .82 | | 6BL7 | 1.00 | | 12AX7 | .63 |
| | 2AF4 | .96 | | 6BN4 | .57 | | 12AZ7 | .86 |
| | 3AL5 | .42 | | 6BN6 | .74 | | 12B4 | .63 |
| | 3AU6 | .51 | | 6BQ5 | .65 | | 12BA6 | .50 |
| | 3AV6 | .41 | | 6BQ6GT | 1.05 | | 12BD6 | .50 |
| | 3BA6 | .51 | | 6BQ7 | 1.00 | | 12BE6 | .53 |
| | 3BC5 | .54 | | 6BR8 | .78 | | 12BF6 | .44 |
| | 3BE6 | .52 | | 6BU8 | .70 | | 12BH7 | .77 |
| | 3BN6 | .76 | | 6BY6 | .54 | | 12BL6 | .56 |
| | 3BU8 | .78 | | 6BZ6 | .55 | | 12BQ6 | 1.06 |
| | 3BY6 | .55 | | 6BZ7 | 1.01 | | 12BY7 | .77 |
| | 3BZ6 | .55 | | 6C4 | .43 | | 12BZ7 | .75 |
| | 3CB6 | .54 | | 6CB6 | .55 | | 12C5 | .56 |
| | 3CF6 | .60 | | 6CD6 | 1.42 | | 12CN5 | .56 |
| | 3CS6 | .52 | | 6CF6 | .64 | | 12CR6 | .54 |
| | 3DK6 | .60 | | 6CG7 | .61 | | 12CU5 | .58 |
| | 3DT6 | .50 | | 6CG8 | .77 | | 12CU6 | 1.06 |
| | 3Q5 | .80 | | 6CM7 | .66 | | 12CX6 | .54 |
| | 3S4 | .61 | | 6CN7 | .65 | | 12DB5 | .69 |
| | 3V4 | .58 | | 6CR6 | .51 | | 12DE8 | .75 |
| | 4BC8 | .96 | | 6CS6 | .57 | | 12DL8 | .85 |
| | 4BN6 | .75 | | 6CU5 | .58 | | 12DM7 | .67 |
| | 4BQ7 | 1.01 | | 6CU6 | 1.08 | | 12DQ6 | 1.04 |
| | 4BS8 | .98 | | 6CY7 | .71 | | 12DS7 | .79 |
| | 4BU8 | .71 | | 6DA4 | .68 | | 12DZ6 | .56 |
| | 4BZ6 | .58 | | 6DB5 | .69 | | 12EL6 | .50 |
| | 4BZ7 | .96 | | 6DE6 | .58 | | 12EG6 | .54 |
| | 4CS6 | .61 | | 6DG6 | .59 | | 12EZ6 | .53 |
| | 4DE6 | .62 | | 6DQ6 | 1.10 | | 12F8 | .66 |
| | 4DK6 | .60 | | 6DT5 | .76 | | 12FM6 | .45 |
| | 4DT6 | .55 | | 6DT6 | .53 | | 12K5 | .65 |
| | 5AM8 | .79 | | 6EU8 | .79 | | 12SA7M | .92 |
| | 5AN8 | .86 | | 6EA8 | .79 | | 12SK7GT | .74 |
| | 5AQ5 | .52 | | 6H6GT | .58 | | 12SN7 | .67 |
| | 5AT8 | .80 | | 6J5GT | .51 | | 12SQ7M | .78 |
| | 5BK7A | .82 | | 6J6 | .67 | | 12U7 | .62 |
| | 5BQ7 | .97 | | 6K6 | .63 | | 12V6GT | .53 |
| | 5BR8 | .79 | | 6S4 | .51 | | 12W6 | .69 |
| | 5CG8 | .76 | | 6SA7GT | .76 | | 12X4 | .38 |
| | 5CL8 | .76 | | 6SK7 | .74 | | 17AX4 | .67 |
| | 5EA8 | .80 | | 6SL7 | .80 | | 17BQ6 | 1.09 |
| | 5EU8 | .80 | | 6SN7 | .65 | | 17C5 | .58 |
| | 5J6 | .68 | | 6SQ7 | .73 | | 17CA5 | .62 |
| | 5T8 | .81 | | 6T4 | .99 | | 17D4 | .69 |
| | 5U4 | .60 | | 6U8 | .83 | | 17DQ6 | 1.06 |
| | 5U8 | .81 | | 6V6GT | .54 | | 17L6 | .58 |
| | 5V6 | .56 | | 6W4 | .60 | | 17W6 | .70 |
| | 5X8 | .78 | | 6W6 | .71 | | 19AU4 | .83 |
| | 5Y3 | .46 | | 6X4 | .39 | | 19BG6 | 1.39 |
| | 6AB4 | .46 | | 6X5GT | .53 | | 19T8 | .80 |
| | 6AC7 | .96 | | 6X8 | .80 | | 21EX6 | 1.49 |
| | 6AF3 | .73 | | 7AU7 | .61 | | 25BQ6 | 1.11 |
| | 6AF4 | .97 | | 7A8 | .68 | | 25C5 | .53 |
| | 6AG5 | .68 | | 7B6 | .69 | | 25CA5 | .59 |
| | 6AH6 | .99 | | 7Y4 | .69 | | 25CD6 | 1.44 |
| | 6AK5 | .95 | | 8AU8 | .83 | | 25CU6 | 1.11 |
| | 6AL5 | .47 | | 8AW8 | .93 | | 25DN6 | 1.42 |
| | 6AM8 | .78 | | 8BQ5 | .60 | | 25EH5 | .55 |
| | 6AQ5 | .53 | | 8CG7 | .62 | | 25L6 | .57 |
| | 6AR5 | .55 | | 8CM7 | .68 | | 25W4 | .68 |
| | 6AS5 | .60 | | 8CN7 | .97 | | 25Z6 | .66 |
| | 6AT6 | .43 | | 8CX8 | .93 | | 35C5 | .51 |
| | 6AT8 | .79 | | 8EB8 | .94 | | 35L6 | .57 |
| | 6AU4 | .82 | | 11CY7 | .75 | | 35W4 | .42 |
| | 6AU6 | .52 | | 12A4 | .60 | | 35Z5GT | .60 |
| | 6AU7 | .61 | | 12AB5 | .55 | | 50B5 | .60 |
| | 6AU8 | .87 | | 12AC6 | .49 | | 50C5 | .53 |
| | 6AV6 | .41 | | 12AD6 | .57 | | 50DC4 | .37 |
| | 6AW8 | .90 | | 12AE6 | .43 | | 50EH5 | .55 |
| | 6AX4 | .66 | | 12AF3 | .73 | | 50L6 | .61 |
| | | | | | | | 117Z3 | .61 |

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JULY 1961



SCHOOL DIRECTORY PAGE 109

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Phila. Wireless Technical Institute
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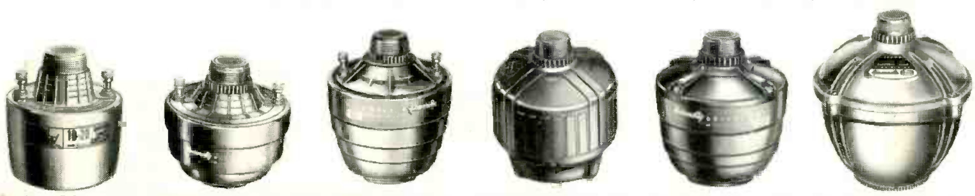

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