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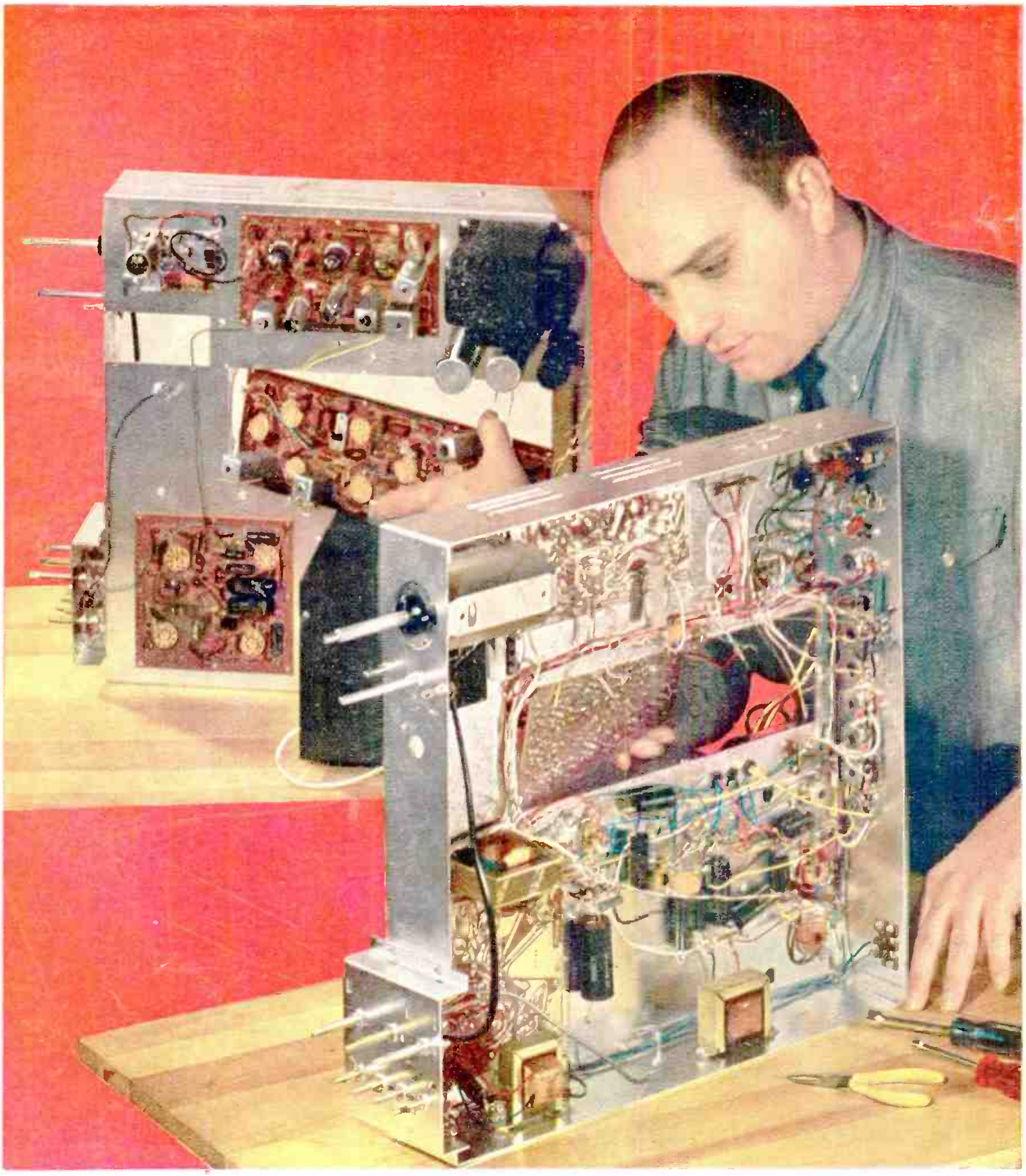

Good results from Kit-built Color TV

See page 40

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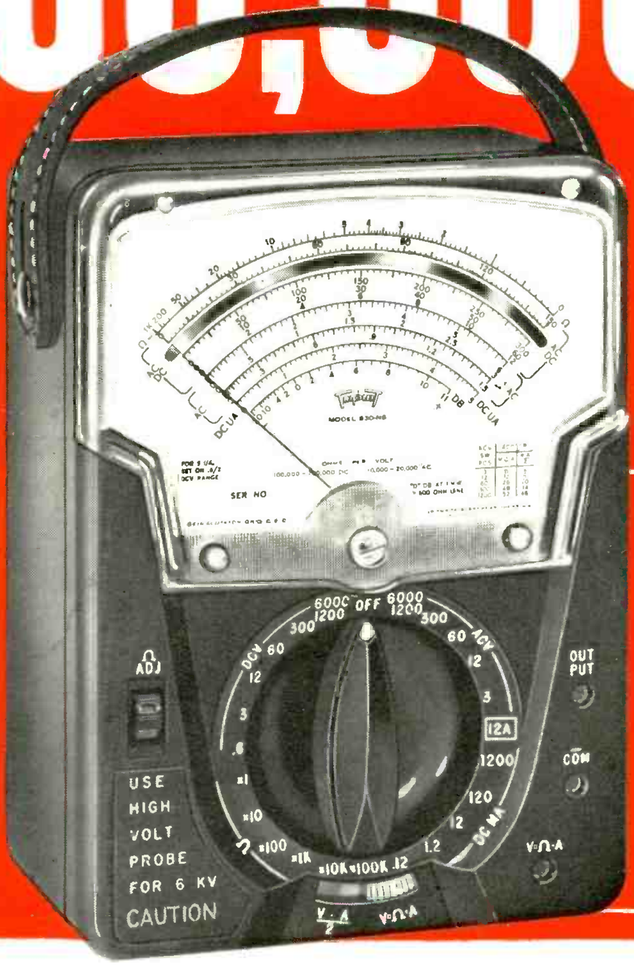


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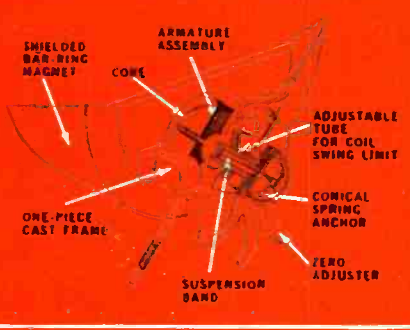


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| DB | -20 to 77 in 10 ranges. |
| D.C. MICRO-AMPERES | 0-5 at 300 MV. 0-60-600 at 150 MV. 0-120 at 300 MV. |
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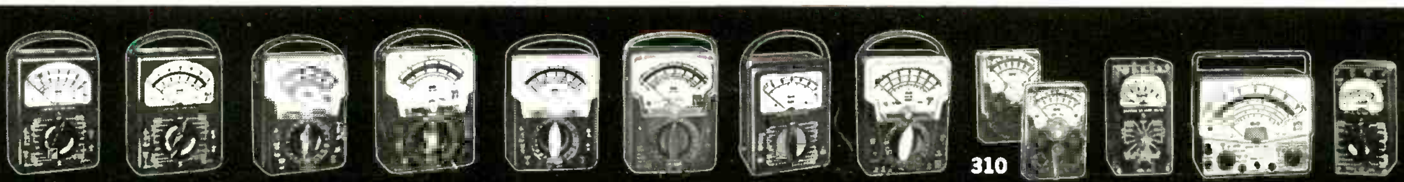

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# Radio-Electronics

AUGUST 1964 VOL. XXXV NO. 8

Over 55 Years of Electronic Publishing

## EDITORIAL



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## TELEVISION



## TEST INSTRUMENTS



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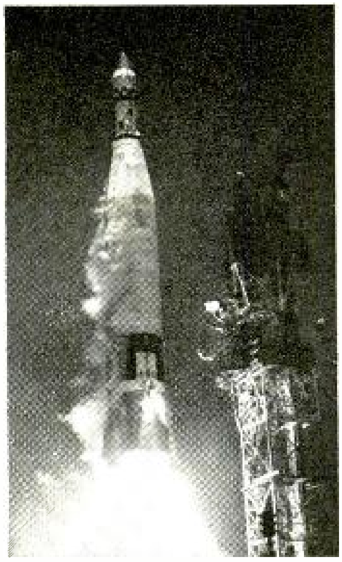

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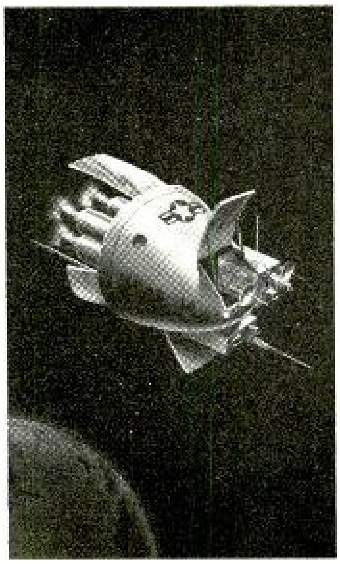

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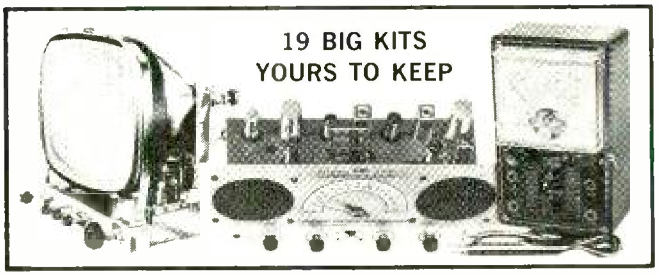


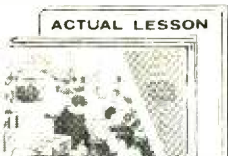


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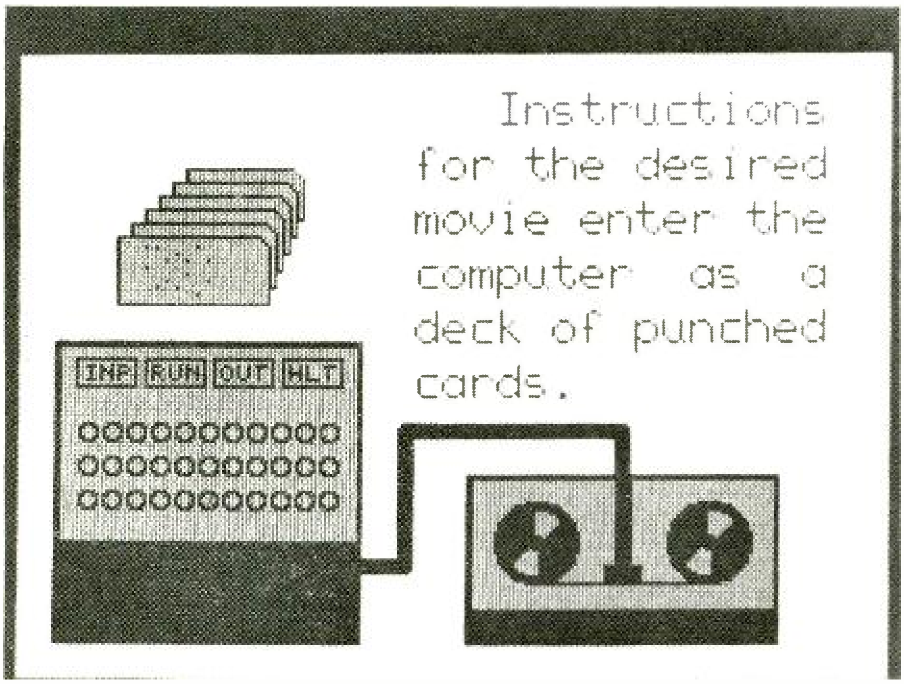



*One frame of the animated film showing how cards are supplied to the computer, how the computer puts an output on the magnetic tape.*

### NOW—COMPUTER MAKES MOVIES

Simple animated films can now be made quickly and cheaply with a computer by a special programming language, according to a report from Bell Telephone Laboratories.

The "movie language" was developed by Kenneth C. Knowlton of the Laboratories. It includes instructions for drawing pictures consisting of straight lines, arcs, complicated curves, letters, simple geometric shapes and shaded areas.

To make movies by the computer, each frame is divided into 184 rows of 250 square dots, which may be black, white or various shades of gray in between. The special computer language (called BEFLIX, for "Bell Flicks") directs the computer to develop arrays and patterns, to enlarge, shift or copy from one area onto another, and perform other operations.

The instructions are fed to the computer, an IBM 7094, on IBM cards. It makes a tape which is fed to a Stromberg-Carlson 4020 microfilm recorder. This contains a cathode-ray tube similar to a television tube, and a film camera. Each of the lines is displayed on the tube as it would be on a TV tube. The intensity at any point depends on the instructions sent from the computer by magnetic tape.

Delegates at the Joint Computer Conference held recently in Washington, D.C., saw a 17-minute movie in which the computer itself demonstrated the technique for producing animated movies.

The new technique, Dr. Knowlton says, can already be made at a cost that compares favorably with animation by traditional methods. Still experimental, all its possible applications cannot be foreseen, but it should be particularly valuable for educational films.

### METAL BASED TRANSISTOR EXTENDS FREQUENCY RANGE

A new type of silicon transistor, described by Richard R. Garnache of Sprague Electric Co., is expected to increase the useful frequency range by a factor of 10. Mr. Garnache said the device has a theoretical upper frequency limit of 20,000 mc, but is not likely to exceed 10,000 mc in its present state of development.

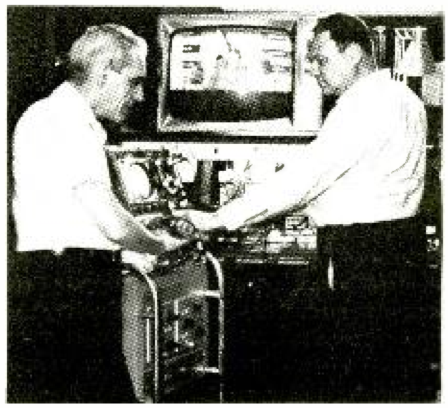
The metal-base transistor consists of two layers of single-crystal silicon separated by a layer of metal no more than 100 angstroms thick. It is an invention of Donovan V. Geppert of Stanford Research Institute, and is licensed exclusively to Sprague Electric.

### NEW VIDEO RECORDER OPERATES AT LOW SPEED

A new home video recorder has been announced by Stewart Hegeman, audio designer and engineer, and Robert Morrow, Baltimore designer and consultant. The new machine operates at 30 inches per second, as compared with the 120 inches per second of Fairchild and Telcan recorders previously announced in this magazine.

Hegeman states that the new *Par-Vision* recorder will use standard 7-inch tape reels with 1/4-inch wide audio tape. Recording is in two tracks, one for video and one for sound. The bandwidth is 2 megacycles.

Two engineers, after viewing a demonstration, felt the new machine had not advanced to the point of development of the Fairchild recorder. According to Hegeman, problems are about 85% licked and "We can see the end of the road without any major obstacles."

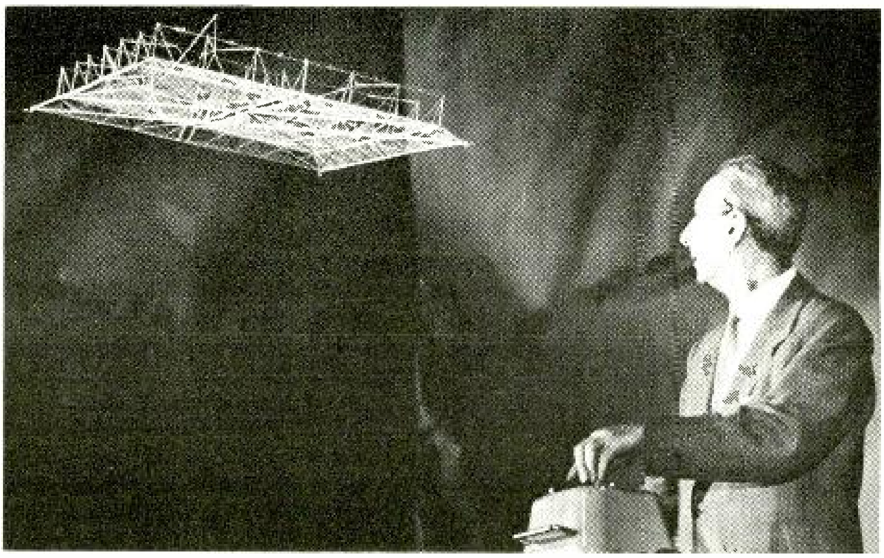


*Stewart Hegeman (left) and Robert Morrow, making adjustments on the new recorder (in background, below the TV receiver).*

Another home video recording device is expected in the early fall, when the IIT (Illinois Institute of Technology) Research Institute plans to demonstrate a low-cost recorder.

### ION-POWERED CRAFT COULD FLY AT 300,000 FEET

A model ion-powered craft which can lift itself off the ground and rise to a height of 20 feet in the laboratory has been demonstrated by Maj. Alexander P. de Seversky, aircraft designer and inventor. The invention was publicized



*Major de Seversky maneuvering his Ionocraft in the laboratory.*

immediately following issuance of the patent (No. 3,130,945).

The *Ionocraft*, as de Seversky calls it, keeps itself up by the "ionic wind" given off by a plane of emitting electrodes in the form of a mesh of hollow, lightweight rods or crossed wires. Below this plane is another similar one, charged to collect the ions emitted from the mesh above. Air molecules set in motion by the movement of the charged ions supply the lifting force. According to Major de Seversky, the test in an environmental chamber indicates that the lifting force is sufficient to give the Ionocraft a ceiling of approximately 300,000 feet (60 miles) above sea level.

A main application of the Ionocraft would be as an antenna. Two such antennas sustained approximately 65 miles high at strategic points in the United States would permit direct TV and radio transmission between New York and Los Angeles. The Ionocraft can be used also as an intercontinental ballistic missile interceptor, according to its inventor, who gives a large number of other possible applications.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### INVENTOR OF NEUTRODYNE DIES AT 77

Dr. Louis Alan Hazeltine, inventor of the neutrodyne radio receiver, retired consulting engineer, and former chairman of the physics department at Stevens Institute of Technology (New Jersey), died at his home in Maplewood, N.J., on May 24th.

Professor Hazeltine was famous chiefly for his invention in 1923 of the neutrodyne circuit, a means of preventing oscillation in the tuned-radio-frequency receivers of the period. The effect of tube capacitance was balanced out by small capacitors (*neutrodons*), and the radio-frequency transformers were placed at an angle (55–60 de-

### CALENDAR OF EVENTS

**National Alliance of Television & Electronic Service Associations (NATESA) Convention,** Aug. 13–16; Chicago, Ill.

**1964 Western Electronic Show and Convention (WESCON),** Aug. 25–28; Los Angeles Sports Arena and Hollywood Park, Los Angeles, Calif.

**International Convention on Military Electronics (MIL-E-CON 8),** Sept. 14–16; Shoreham Hotel, Washington, D. C.

**1964 Conference on Radio Meteorology,** Sept. 14–18; National Bureau of Standards Boulder Laboratories, Boulder, Colo.

MALLORY

## Tips for Technicians

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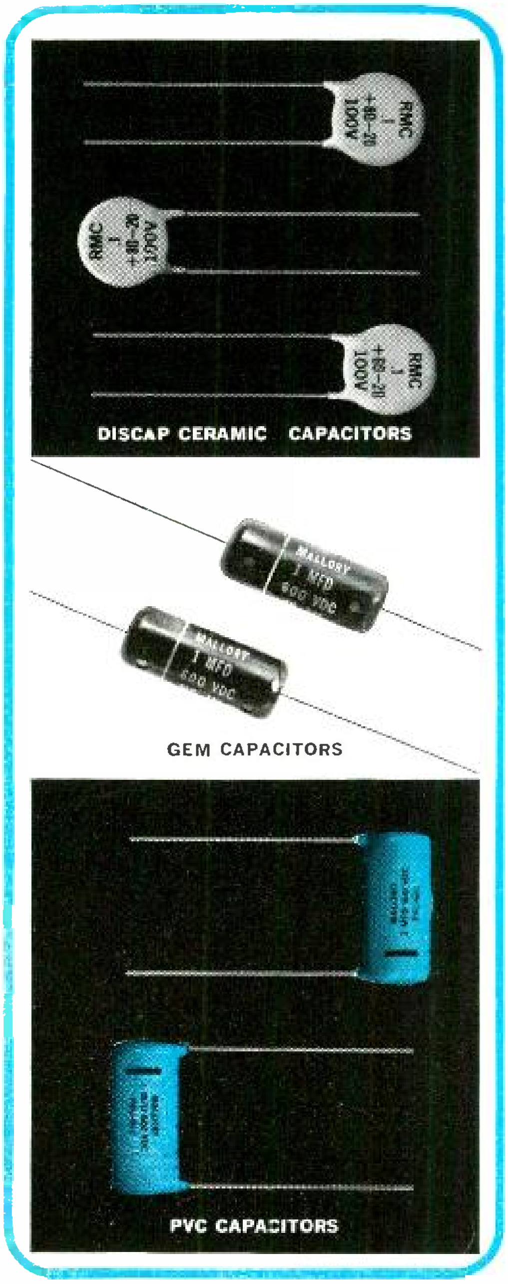
# How to break the capacitor replacement habit



DISCAP CERAMIC CAPACITORS

GEM CAPACITORS

PVC CAPACITORS

Ever hear of "original capacitor-itis?" It's a habit that has been plaguing service technicians for decades. Here's what it means. If you need to install a new capacitor, you automatically get one *exactly* like the one that was in the circuit. The original capacitor, in theory, is the best one for the job.

But . . . it ain't necessarily so. And breaking the habit can often save you money.

When you need to replace a mica capacitor, for instance . . . consider ceramics. They'll often do a better job, for less cost (and we mean up to ½ as much) than mica capacitors in most circuits. Ceramic capacitors often give you an extra safety factor in voltage rating, too; except for a few miniature and special types, their standard rating is 1000 volts DC. Some up to 30 KV. You can almost always replace mica with ceramic. But . . . you seldom can replace ceramic with mica, because ceramics are often selected by original equipment designers for temperature compensating functions.

Don't forget to think of ceramics, too, when you need to replace a molded tubular capacitor. They cost about the same or even less, value for value. If you've got 'em, you can use 'em.

Here are two tips that may save you time and money.

First . . . when you're replacing a capacitor, all you need 9 times out of 10 is the same microfarads and voltage rating. Not a round one. Or a square one.

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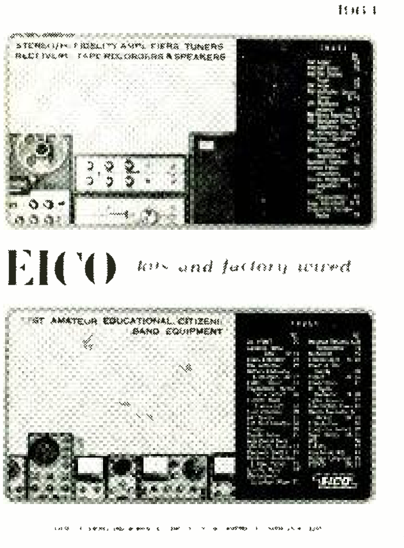



grees from the vertical) to prevent inductive interaction.

Professor Hazeltine sold his patent —for $1 million, according to reports— to a group who organized as the Hazeltine Corp. to license manufacturers under the Hazeltine patent.

In 1944 Professor Hazeltine retired from the faculty of the Stevens Institute and became a consultant to the Hazeltine Corp. He was also a director of the corporation, retiring 3 years ago.

Hazeltine was a Fellow of the Institute of Radio Engineers and president of the institute in 1936. He was also a Fellow of the American Institute of Electrical Engineers, and a member of the American Physical Society.

### HUGO GERNSBACK AWARD

Herbert Paul Maruska, a student in the School of Engineering & Science of New York University, has received the 1964 Hugo Gernsback Scholarship Award, a $1,000 grant presented yearly to a student chosen by the university's College of Engineering faculty.

Mr. Maruska was born in Dallas, Tex., in 1944. His parents moved to New York shortly thereafter, and he received his education in New York public schools and the Bronx High School of Science, becoming interested in electronics while attending high school. He is a member of engineering honor society Tau Beta Pi, and of the electrical engineering honor society Eta Kappa Nu. During last summer's vacation, he worked on medical electronics at the New York University Medical Center in Bellevue Hospital. He expects to work there again this summer. Mr. Maruska will graduate in 1965.

### LASERS REACH ULTRAVIOLET

Two recent reports from Hughes Aircraft Co. announce laser action at more than 60 new wavelengths, including the ultraviolet. One announcement speaks of a new class of gas ion lasers, using four gaseous elements: argon, krypton, xenon and neon, to achieve

*Latest laser (glass tube at right) emits blue, green, violet, red and yellow beams, spanning entire visible portion of spectrum.*

laser action.

The ion lasers cover a wide range of frequencies, a majority of the newly discovered color lines being in the blue-green portion of the spectrum.

Another report states that a Hughes Aircraft laser team has raised the efficiency of frequency doubling to obtain higher power than has previously been reported.

Between 25% and 30% conversion efficiency from ruby radiation to 3.471 angstroms (in the ultraviolet) was recently reported by Drs. Myer Geller and Walter Sooy. This represents a 10-megawatt output pulse at the ultraviolet frequency. The same group obtained between 15% and 20% efficiency in doubling infrared light at 1.06 microns to obtain 5,300-angstrom green radiation.

### BRIEF BRIEFS

The Bell System has asked the Government to approve rates for its see-as-you-talk system between public locations in three cities: New York, Chicago and Washington. Proposed rates would be $16 from Washington to New York, $21 from Washington to Chicago, $27 from Chicago to New York. Customers will be required to make advance arrangements.

New color TV tube introduced by Sylvania is said to get more than 40% higher brightness by using a new phosphor containing the rare-earth element europium.

New slumber-inducing device marketed by Majima Co., Tokyo, Japan, produces a "sleeping tone" which tranquilizes its users by emitting raindrop-like continuous sound. "Hearing the tone in bed falls you into deep sleep in a several minutes," says the maker. END

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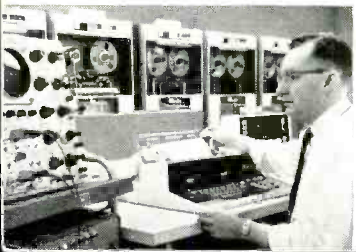

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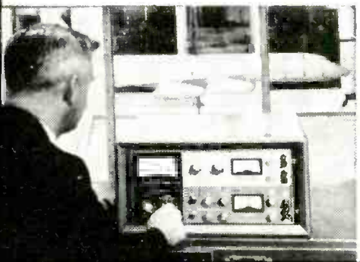

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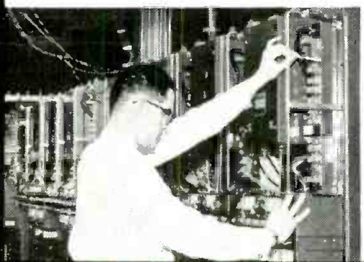

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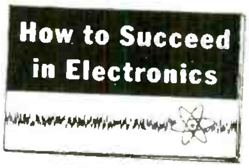


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# Correspondence

**DITTO: WE NEED THAT NATIONAL FACTS CENTER**

*Dear Editor:*

I agree 100% with your editorial, "Needed: A National Facts Center" in the May 1964 issue of RADIO-ELECTRONICS. Our facts should be gathered in a central place as the Library of Congress gathers books. The facts center should use the latest in information retrieval equipment to speed the gathering of those facts.

The computer in the center would be a little different from the regular scientific or business installation. Its principal function would be rapid recovery of information with little or no computing. This would mean lower cost because of simpler construction. It should be possible to store much of the information on photographic film rather than magnetic tape or cards. Film is, I understand, less expensive than tape or cards; also, the information is more permanent.

The data could be stored on the film by optical reduction, as in microfilm, or it could be changed to a binary code and stored that way. Computer retrieval would probably be easier with the binary code while manual retrieval would be easier with microfilm. The film could be stored in rolls, or on cards as film "chips". The type of storage would probably depend on the type of information. An information retrieval computer using all kinds of storage including photographic film is urgently needed to aid in the recovery of facts that might otherwise be lost.

Also urgently needed is Director John C. Green's "information scientist". His function would be, not only to collect and store the vast amounts of material coming off the printing presses, but to condense it with as little redundancy as possible. Today, we have not only tremendous amounts of new infor-

mation, but much of it duplicated and expressed in too many words! Consider, for example, all the material that has been published on audio amplifier design. For someone designing a new audio amplifier to gather it all would take far more time than designing the amplifier. If the information had been previously collected and condensed, getting the data would be much simpler and faster. The reader can doubtless think of many other examples.

The "information scientist" is needed more and more all the time. If we do not conquer our facts, they may conquer us.

DAVID W. JOHNSTON
*Washington, D. C.*

### A VOTE FOR HIGH-GRADE TEST-INSTRUMENT PROJECTS

*Dear Editor:*

The article "A Lab-Quality Audio Generator," by Jon Idestam-Almquist, is excellent (May 1964 issue). This is the kind of test instrument I have been looking for, for a long time now in a magazine. I believe many like myself prefer "better than available kits" test instruments. May I suggest that you keep on publishing more articles along this line. To follow up this audio generator, I suggest a good squarer (square-wave shaper), in conjunction with this generator.

A tube or transistor version of a good radio-frequency generator will be very much welcomed—one with crystal-controlled frequencies available.

More power to RADIO-ELECTRONICS!

BENJAMIN RESELLA

### PRAISES PROJECTOR SERIES

*Dear Editor:*

The series "Servicing Sound Movie Projectors" (October 1963 through January 1964) was most welcome. Your service editor, Jack Darr, has done an excellent job on this series, as well as on many others. I would appreciate having future series on equipment not usually handled by the radio-TV technician.

I would like to make a few comments on Mr. Darr's statement about captive service policies (January 1964, page 44). In the last few years I have had several sound projectors in for service and have run into just that problem. Many companies refuse to sell parts to independent servicers. Yet sometimes they fail to provide good service themselves; thus independent shops can usually get all the projector work they can handle.

The best source I have found for special parts is LaVezzi Machine Works, 4635 W. Lake St., Chicago, Ill. It is the largest manufacturer of film sprockets and other parts for manufacturers. Catalogs are furnished on request, and items can be ordered on company letterhead or purchase order.

It would appear that the best answer to captive service is an independent organization with outstanding technical ability that can give the equipment user service quality unequaled by even the manufacturer.

Continue to bring us specialized service articles. I would also like to see more construction articles on laboratory-type test equipment.

D. K. HISKEY
*Yorba Linda, Calif.*

### OPPOSES SCOUT SIGNALING REQUIREMENTS CHANGE

*Dear Editor:*

The proposed Revised Requirements for Boy Scouts of America, which become effective in September 1965, change the signaling requirement for a First-Class Scout. Instead of learning the International Morse code, he would be permitted to fulfill the requirements by learning semaphore. As a veteran Scouter, a Quarter Century Club radio amateur and a professional in communications for more than 25 years, I feel sure that this change will not benefit Scouting, national defense, the communications field, the Scout's pleasure or his community during an emergency.

In a small open launch off the coast of New England on a subfreezing, windy winter day, my companions and I found, as we wanted to get going again after a stop, that we had fouled the screws of the inboard engine with the anchor line. Efforts to free the line failed. We drifted and tossed close to threatening rocks. About then, someone sighted an approaching ship—possibly our only chance of being rescued.

I took a legal-size sheet of white paper and held it taut in the wind with two hands. I turned it flat-side-to and then edge-to the ship, alternately, trying to signal, like a blinker light, "SOS PROP FOULED" in Morse code. I kept on as the ship approached, passed a few miles away and continued on its course.

Just as it was about to go out of sight, it changed course into a large cir-

cle, coming close enough to us so we could hear its power megaphone. They said they had read our message, but, because of the rocks, would not get closer to us as long as we were afloat. However, they had radioed for assistance and would watch over us until help came.

Eventually we were towed back to port, grateful that someone able to read code had been aboard that ship.

Partly because of that experience, I am opposed to reinstating semaphore as a signaling option. It would not have worked in a case like the one just reported. I learned it as a Scout about 30 years ago and have had virtually no opportunity to use it. But there are many opportunities to use Morse code. There are more than a quarter million radio amateurs in the US, and many more overseas. There are about 600,000 registered First-Class Scouts, many ex-Scouts, communications men and others able to copy code in some degree. Radio amateurs are well known for their aid in time of disaster, and Scouts have been one of the principal sources for radio amateurs.

Ships usually use Morse blinker rather than semaphore for visual contact. Morse is certainly no harder to learn than semaphore, and is much more versatile: it needs only a single flag, blinker or audible signal.

Though semaphore might possibly be left as an option in the Signaling Merit Badge requirements, it should certainly not be an optional alternate to Morse code in the First-Class requirements.

I solicit your aid in preventing this change. Express your opposition to the National Council, Boy Scouts of America, New Brunswick, N. J.

WALTER TUCKER, K4BRI
*Springfield, Va.*

### TRANSISTOR-PORTABLE POWER SUPPLY FILLS A NEED

*Dear Editor:*

A word of praise for the transistor radio power supply designed by Wayne Lemons ("Bench Supply for Transistor Radios," May 1964, page 38). This instrument certainly fills a definite need. It performs perfectly, and fits neatly under a shelf just above my workbench.

I consider Mr. Lemons one of your ablest contributors.

GLEN H. BRYANT
*Hoisington, Kan.*

END

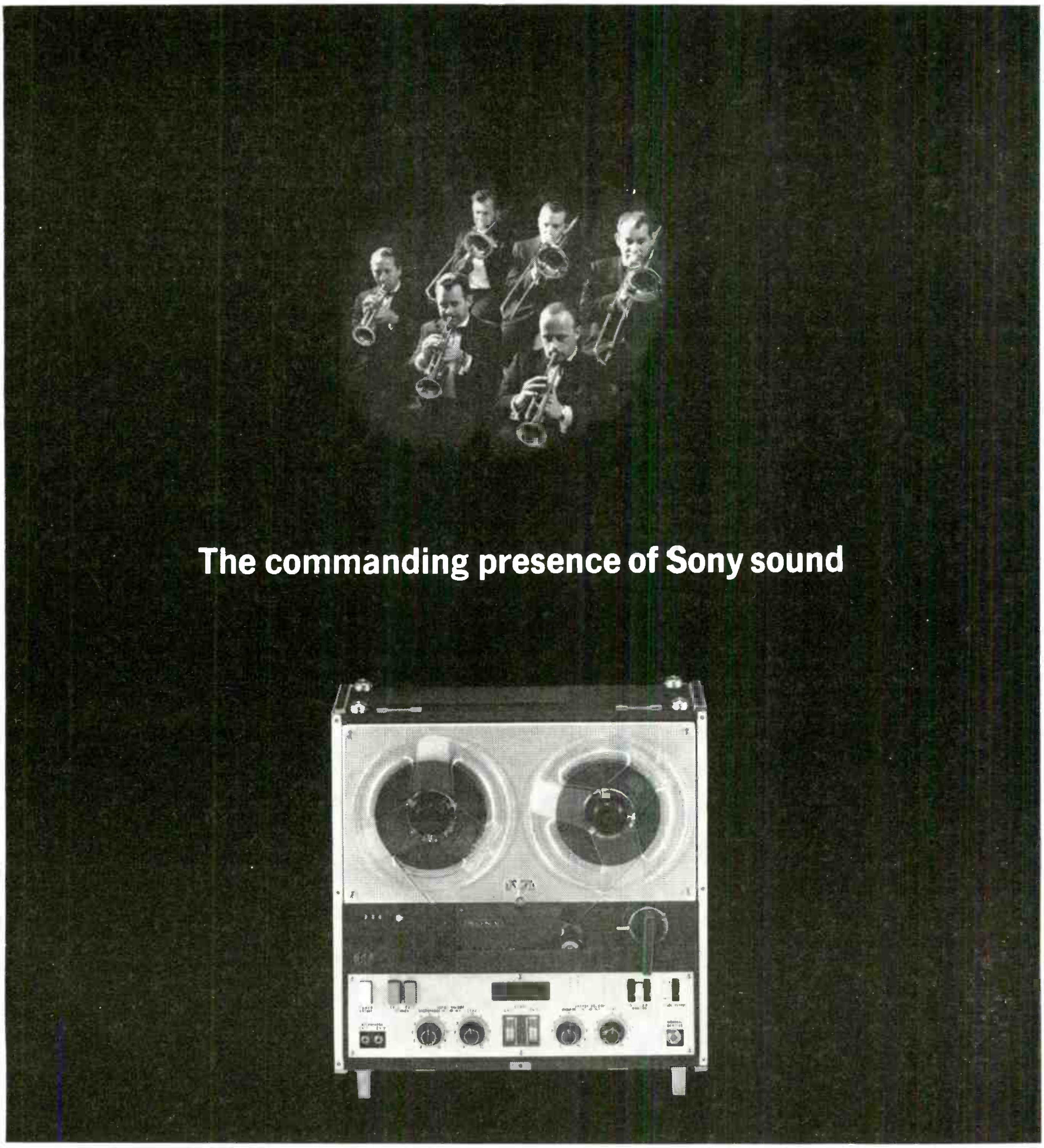
## OUR STANDARD ABBREVIATIONS

RADIO-ELECTRONICS has always tried to maintain a consistent style in the abbreviations used in text and artwork (diagrams and photo "call-outs"). New abbreviations are developed as new terms are added to our electronic vocabulary. We are printing this revised list of abbreviations to bring our old readers up to date and to help readers who have not been with us long enough to recognize the forms consistently used in our magazine.

The abbreviations are indexed by symbol with Greek letters treated like English phonetic equivalents. Many of those listed are always spelled out in the text and are abbreviated in our art work. Terms used only in artwork—and those capitalized in text—appear in capitals. Abbreviations in lower-case letters are so used in text and are capitalized in art work. Periods are used in abbreviations only where the abbreviation might be confused for a word. For example, rf and i.f. are our abbreviations for radio frequency and intermediate frequency, respectively.

| ABBREVIATION | ELECTRONIC TERM |
|---|---|
| A | ampere(s) |
| ac | alternating current |
| acc | automatic chroma control |
| ADJ | adjacent, adjustment |
| af | audio frequency |
| afc | automatic frequency control |
| AFT | audio-frequency transformer |
| agc | automatic gain control |
| AM | amplitude modulation |
| amp | ampere(s) |
| AMPL | amplifier |
| ANT | antenna |
| apc | automatic phase control |
| ATTEN | attenuator |
| AUTOTRANS | autotransformer |
| avc | automatic volume control |
| AWG | American wire gage |
| b or base | base (of transistors) |
| BAL MOD | balanced modulator |
| BALUN | balanced-to-unbalanced transformer |
| BATT | battery |
| BCI | broadcast interference |
| bfo | beat frequency oscillator |
| BO | Barkhausen oscillation |
| BTO | blocking-tube oscillator |
| c | collector (of transistors) |
| C, CAP | capacitor (capacitance) |
| CALIB | calibrate |
| cath (K on tube diagrams) | cathode |
| CATH FOLL | cathode follower |
| CENT | centering |
| CH | choke |
| CHAN | channel |
| CHG | charge |
| CKT | circuit |

(*continued on page 22*)


The commanding presence of Sony sound

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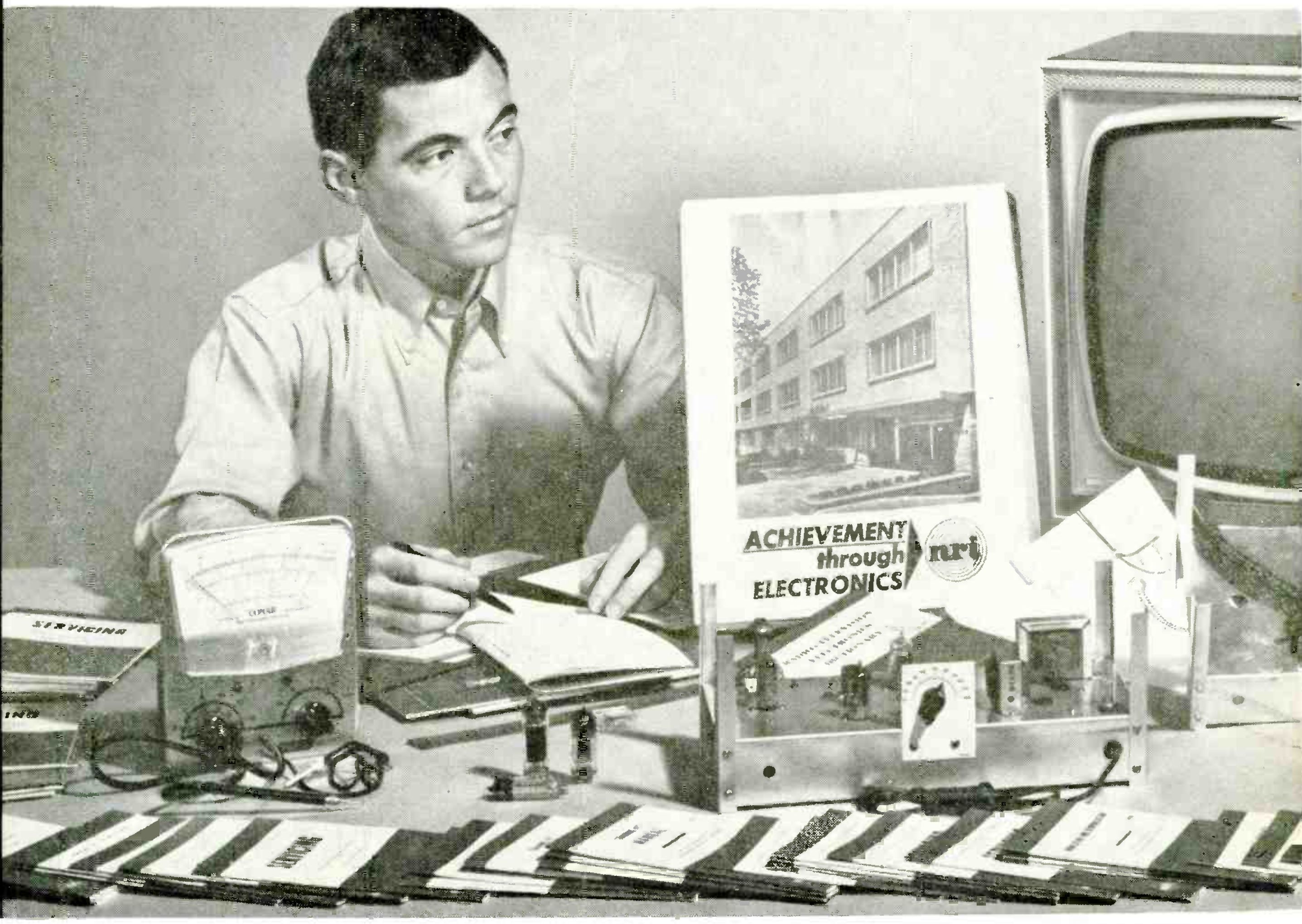

*(continued from page 16)*

| ABBREVIATION | ELECTRONIC TERM |
|---|---|
| CKT BRKR | circuit breaker |
| coax | coaxial |
| COM | common |
| COND | conductor |
| CONN | connection |
| CONT | control |
| CONV | convergence, converter |
| counter emf | counter electromotive force |
| C-R | cathode-ray (tube, etc.) |
| CRO | cathode-ray oscilloscope |
| CRT | cathode-ray tube |
| CT | center tap |
| CW | continuous wave |
| D | diode |
| db | decibel |
| dc | direct current |
| dcc | double cotton covered (wire) |
| DC REST | direct current restorer |
| DEFL | deflection |
| DEMOD | demodulator |
| DET | detector |
| df | direction finder |
| DIELEC | dielectric |
| DIFF | differentiator |
| DISCH | discharge |
| DISCRIM | discriminator |
| dpdt | double pole double throw |
| dpst | double pole single throw |
| dsc | double silk covered (wire) |
| DYN | dynamic |
| dx | distance |
| e | emitter (of transistors) |
| E | potential |
| E (sometimes V in transistor diagrams) | voltage |
| ECO | electron coupled oscillator |
| ELEC | electric; electrolytic |
| ELECT | electrode |
| emf | electromotive force |
| ENAM | enameled (wire) |
| EQUIV | equivalent |
| ERASE HD | erase head |
| ERP | effective radiated power |
| EXT | external or extension |
| F (f as suffix) | farad(s) |
| f, FREQ | frequency |
| FIL (F in tube diagrams) | filament |
| FM | frequency modulation |
| FOLL | follower (-ing) |
| G (in tube diagrams) | grid |
| GCA | ground controlled approach |
| GDO | grid dip oscillator |
| GEN | generator |
| GND | ground |
| h | henry (ies) |
| HD | head |
| hf | high frequency |
| HORIZ | horizontal |
| HTR (H) | heater |
| I | current |
| IC | internal connection (on tubes) |
| i.f. | intermediate frequency |
| IFT | intermediate frequency transformer |
| ILS | instrument landing system |
| IM | intermodulation |
| INT | integrator |
| INV | inverter |
| ips | inches per second |
| K | thousand |
| K | cathode (on tubes) |
| kc | kilocycle |
| kw | kilowatt |
| λ (lambda) | wavelength |
| L | inductor (inductance) |
| L | coil |
| lf | low frequency |
| LIM | limiter |
| LIN | linearity |
| μ (mu) | micro- (one-millionth) |
| μf | microfarads |
| μh | microhenry(ies) |
| μμf | see pf |
| μsec | microseconds |
| M | meter |
| M | million |
| ma | milliampere(s) |
| max | maximum |
| mc | megacycle(s) |
| meg | megohm |
| mh | millihenry(ies) |
| mike | microphone |
| MIN | minimum |
| MOD | modulation (modulator) |
| MPX | multiplex |
| MULT | multiplier |
| MVB | multivibrator |
| NBFM | narrow-band FM |
| NC | neutralizing capacitor |
| N.C. | normally closed (switch or relay) |
| NE | neon |
| NEG | negative |
| NET | network |
| N.O. | normally open (switch or relay) |
| n-p-n | negative-positive-negative (transistors) |
| OSC | oscillator |
| P | plate |
| PA | public address |
| PC | photocell |
| PERM | permanent |
| pf | picofarad (μμf) |
| phone(s) | telephone, headphones |
| PHOTO MULT | photomultiplier |
| pix | picture (TV) |
| PL | pilot lamp |
| PM | permanent magnet (speaker) |
| PM | phase modulation |
| p-n-p | positive-negative-positive (transistors) |
| POS | positive |
| POT | potentiometer |
| PP | peak-to-peak |
| PPI | plan-position indicator (radar) |
| pps | pulses per second |
| preamp | preamplifier |
| prf | pulse repetition frequency |
| PRI | primary |
| PT | phototube |
| Q | reactance-resistance ratio |
| Q | transistor |
| QUAD | quadrature |
| R | resistance (resistor) |
| RCDG | recording |
| RCDR | recorder |
| RECT | rectifier |
| REG | regulator |
| regen | regeneration |
| rf | radio frequency |
| RFC | radio-frequency choke |
| RFT | radio-frequency transformer |
| rms | root mean square |
| RY | relay |
| S | switch |
| scc | single cotton covered (wire) |
| SCR | silicon controlled rectifier |
| sec | second |
| SEL (RECT) | selenium (rectifier) |
| SEP | separator |
| SG | screen grid |
| SIG | signal |
| SLD | solenoid |
| spdt | single pole double throw (switch, etc.) |
| SPKR | speaker |
| spst | single pole single throw (switch, etc.) |
| SSB | single sideband |
| ssc | single silk covered (wire) |
| SW | shortwave, switch |
| SWR | standing wave ratio |
| sync | synchronization |
| T | transformer, trimmer |
| TELEG | telegraph |
| TERM | terminal |
| tptg | tuned plate tuned grid |
| TRANS | transformer |
| trf | tuned radio frequency |
| TVI | television interference |
| uhf | ultra-high frequency |
| v | volt(s) |
| V | tube |
| va | volt-ampere |
| vac, vdc | volts ac, dc |
| VAR | variable |
| VC | voice coil |
| VERT | vertical |
| VFO | variable frequency oscillator |
| vhf | very high frequency |
| VIB | vibrator |
| VOL | volume |
| VOM | volt-ohmmeter |
| VR | voltage regulator (tube) |
| vtvm | vacuum-tube voltmeter |
| VU | volume unit(s) |
| W | watt(s) |
| X | reactance |
| xtal | crystal |
| Z | impedance |

—END—

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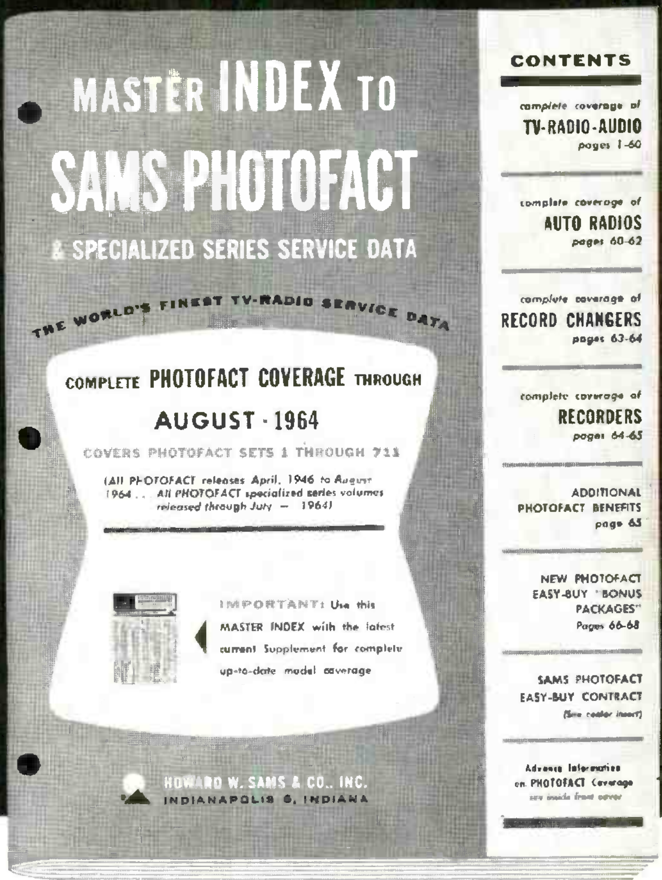


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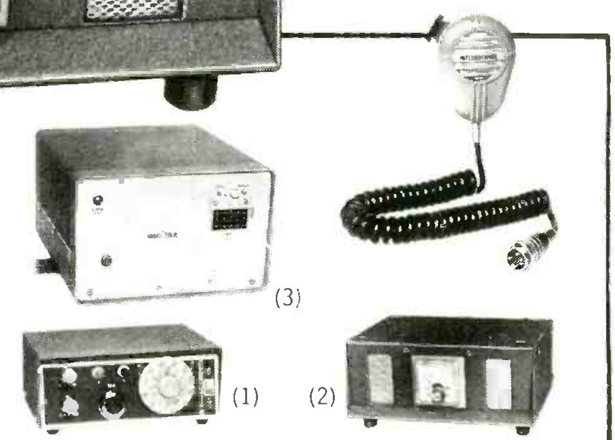
The International **Executive 750-H** introduces a transceiver that is quickly adaptable to all types of mobile or base installations.

The remote console, which is normally installed under the auto dash, has a new companion speaker console. It may be combined with the remote unit or mounted separately. The speaker makes a perfect base when the remote console is used on a desk. Provision has also been made for adding an S/meter.**

What's more, the Executive 750-H is loaded with extra performance features; such as, 23-crystal controlled channels, illuminated channel selector dial, a new speech clipper, increased selectivity, new connections for easy cabling.

The Executive 750-H is complete with crystals, mounting rack for the remote console, trunk mounting rack for the set, push-to-talk microphone, power cable kit, plus all necessary connecting cables. Operates on 6 vdc, 12 vdc, or 115 vac.

Your International dealer has a liberal trade-in plan. **Step up to an Executive 750-H today!**




The Executive 750-H consists of three units: (1) the remote console, which turns the set (in the trunk) on or off, adjusts speaker volume and squelch; (2) the speaker console; (3) the main set which houses all other transmitting and receiving components.

*Performance—Construction—Design—Components
**S/meter available as an accessory item.

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# MEDICAL ELECTRONICS

*. . . An Immense Field Beckons the Researcher . . .*

THE FOLLOWING partial reprint is taken from our *July 1950 editorial*. Most of it is probably as true today as it was then. What prompted the reprint can be found in our last month's editorial, "Electronics' Future."

**It is particularly addressed to the more than 67,000 professional engineers, technical and production workers who have been laid off recently because of Government cutbacks and cost-cutting programs. Many or all of these workers, mostly electronic technicians, anxious to make new connections, could not do worse than re-establish themselves in a vast new field: *medical electronics*. Many laboratories, large hospitals and other institutions always have openings for trained electronic men anxious to explore this new technology field. It can be very lucrative for the right men.**

There is perhaps no field today which requires bio-electronic applications more urgently than medicine. Medicine is as yet not an exact science, but rather an art. The medical man still falls back upon most of his five senses when he makes a diagnosis. His trained eyes see many tell-tale signs: his ear evaluates heart, chest and lung sounds: his nose can often recognize certain diseases, such as measles, scarlet fever and others that have characteristic odors. Old-time practitioners touched the backs of their patients' hands with the tip of their tongue—the salinity, the acidity, etc., of the skin frequently was a good index of certain diseases.

Methods such as these seem crude and archaic in the electronic age. Yet the human body is a most complex machine, with most of its machinery hidden and inaccessible. Its electric organs are delicate and deep-seated. Its chemical plants are distributed widely throughout the body and are often difficult to contact. The body's heating and cooling plants are still not understood too well. The blood circulatory system—while better explored—still holds many unsolved problems.

Thousands of medical books covering every part and function of the human body cannot begin to more than suggest the extent of its complexities. This is particularly true of the vast field of diagnosis.

Electronically the human body can be compared to a sealed up radio or television receiver, with only a few exposed connections. The service technician parallels the physician who now is called upon to locate the hidden defect. But neither service technician nor the physician today has a universal "analyzer" that can locate all faults or troubles throughout a radio or TV set, or the vast and complex domain of the "sealed-unit" human machine.

There no longer remains any valid reason why electronic science should not give the medical practitioner a biological–electronic analyzer that could in time diagnose *any* disease, *any* dysfunction. The oscilloscope, the amplifier, the millivoltmeter and microammeter, the sensitive thermocouple and dozens of other electronic instruments can all be combined into a portable *bio-analyzer* in the future.

Even now, medical science uses thermionic amplification plus a graphic galvanometer for recording heart impulses, brain waves and uterine contractions. The photoelectric cell has already been made an indispensable part of biochemical technique: the colorimeter is calibrated to read grams of haemoglobin per hundred cubic centimeters of blood directly, or milligrams of nitrogen . . . or creatine or uric acid. Heart sounds are accurately analyzed on a tape: murmurs are measured to a hundredth of a second. It is only a question of time until these present uses and others added are all integrated into one unit.

Once such an instrument has been evolved and perfected and the practicing physician has learned how to master its complexities, medicine will have a valuable tool to combat disease effectively. There will then no longer be any guesswork in diagnosis.

The doctor then can make his blood tests, his blood count on the spot—without puncturing the patient's skin—and without the necessity of going to a technician who specializes in such work. He will take his cardiogram on the spot. He will know the *exact* status of an appendix and will know if it is to be excised or if it can be treated. Puzzling rises of temperature of a patient can be tracked down fast—hidden abcesses for instance can be located by local temperature variations. Usually the site of an internal abcess has a higher temperature index than other parts of the body. Hundreds of similar examples could be cited to prove that bio-electronic diagnosis *is* possible and that undoubtedly it will be commonplace in the not too distant future.

Much research will have to be done in the meanwhile to make it an accomplished fact. Electronic and medical research teams will have to pool their joint talents and knowledge in collaboration with instrument technicians to evolve a medically acceptable bio-analyzer. Finally doctors will have to be trained to use the instrument and to evaluate all its ramifications. Admittedly this will take time, effort and money but it *will* be done.

### What About the Immediate Future?

For many years, editorially and otherwise, the present writer has been talking about a replacement for (or a new or better addition to) our present X-rays. Good as they are, X-rays are at best only *shadowgraphs*. They give only vague outlines of our major organs. Today, the heart, the lungs, the kidneys, the adrenals, the liver, the internal sexual organs, the appendix and others must always be interpreted by qualified technicians. Disease does not always show. Incipient cancer rarely shows up clearly.

In the Christmas 1953 issue of the writer's *Forecast* magazine, he said:

"In the future, the medical technician will *actually* see all your interior organs and will watch them work.

"This will be done by a device placed directly against your body. It will be a light source, several times as powerful as the sun—but it will be *cold light*. The light source will be

*Continued on page 74*

PART ONE:

Two kinds of rotators and how they work, and where to look for trouble in them

# HOW TO REPAIR ROTATORS

**By HOMER L. DAVIDSON**

MANY RADIO-TV SERVICE TECHNICIANS JUST WON'T REPAIR or install antennas or rotators. They quote many reasons, but I suspect the main one is that it is just too much work. Here's an illustration from a distributor salesman who calls on us every Friday afternoon.

He had just called on another shop. Its owner was standing looking out his window and worrying about business. He hadn't had one service call all morning. His bench man was sitting and hoping for 5 o'clock to come so he could go home. The shop owner was wishing that he had chosen another trade. At that moment the telephone rang and the helper answered it. A customer wanted his rotator fixed: his antenna was stuck in the wrong direction for the channel he wanted to watch. The helper said, "We don't do any antenna or rotator work," and hung up the phone. He sat down again on his stool to do nothing. The salesman asked the service man why he didn't do antenna and rotator work. The answer was short and simple: No money and a lot of hard work.

Yet I know for a fact that the antenna repair business is good. Money can be made in it. And the help is kept busy, keeping that overhead down. Only a few things mark up to forty to fifty percent. Antenna and rotator work do if labor is properly charged for.

This article deals strictly with rotator repair. Insurance people are requiring that antennas and rotators be repaired if possible. If not, they can be replaced with new ones. Insur-

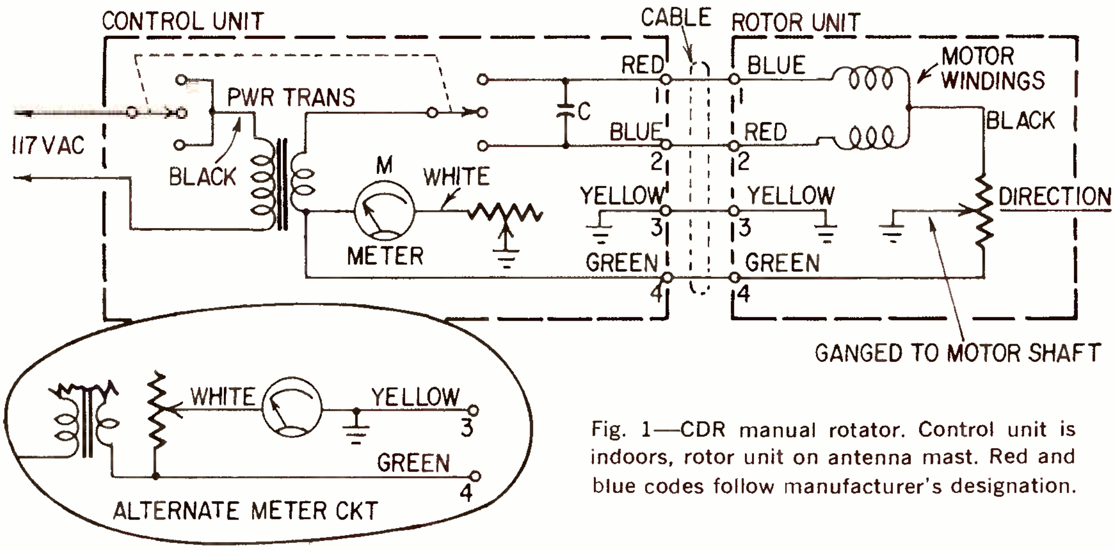



Fig. 1—CDR manual rotator. Control unit is indoors, rotor unit on antenna mast. Red and blue codes follow manufacturer's designation.

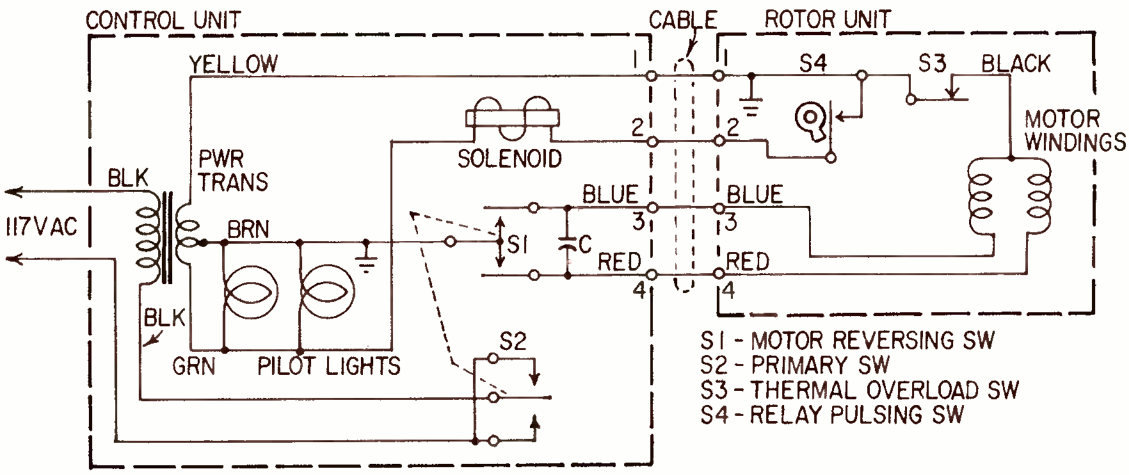



Fig. 2—CDR automatic rotator.

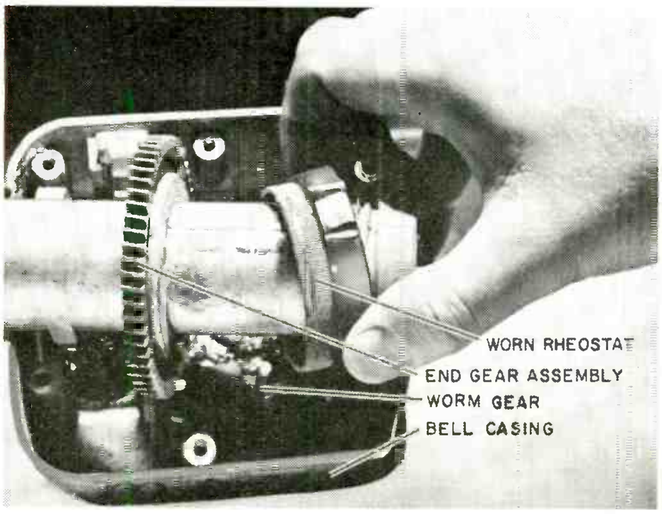



Fig. 3—Worn direction-sensing rheostat being removed.

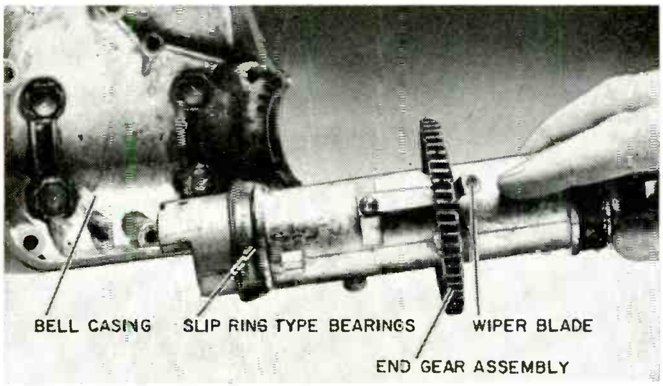



Fig. 4—Rheostat wiper blade is electrically common to case and frame.

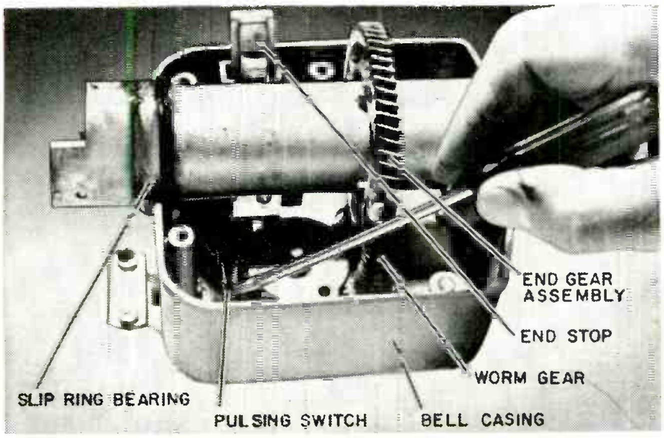



Fig. 5—Screwdriver here points to pulsing switch in automatic unit. Contacts are open.

ance work is sure money, if properly handled.

A rotator installation actually consists of three units: the rotator control box, rotator motor, and interconnecting rotator wire. Trouble in any of the three will keep the rotator from turning.

Fig. 1 is a schematic diagram of a manual rotator. The ac line voltage feeds to one side of a ganged switch. In most rotators this switch is held down by the operator. Press down on the right-hand side, and the rotator turns clockwise. Press down on the left side, and the rotator turns counter-clockwise. The switch transfers the supply to one side or other of the motor winding, reversing the field and direction of rotation.

A potentiometer in the motor assembly turns with the motor and acts as a direction sensor. Wire 4 is a return wire to the meter direction indicator and is in series with a small rheostat which is used to align the meter with the corresponding direction of the motor unit. The rheostat and wiping blade are shown in Figs. 3 and 4.

Fig. 2 is a diagram of an automatic rotator. This kind stops automatically at a preset point on a dial. The operator turns the direction knob to the direction he wants. The rotator turns to that direction and stops. A pulsing solenoid relay, pulsing switch and direction knob are basically the only differences between a manual and an automatic rotator.

The direction indicator knob which operates S1 is turned to the desired direction. S4 is a pulsing switch and is turned by the small rotator motor. (This switch is pointed out in Fig. 5.) When S1's and S2's contacts are closed, voltage is applied to the stepping or pulsing solenoid in the control unit. The solenoid clicks or pulses until the desired direction is reached and switch S2 opens This removes the 117 volts ac on the primary side of the power transformer. The relay stops pulsing and the unit shuts off. If the direction indicator knob is turned in the opposite direction, the motor reverses and again pulses until the desired direction is reached. Fig. 6 shows the pulsing relay.

A rotator can be checked easily by substitution and continuity testers. An ohmmeter or light bulb and battery will check the continuity of the wiring and rotator. If the control box appears to be bad, substituting a new one will clear up the situation. Check the continuity and try substitution *before*

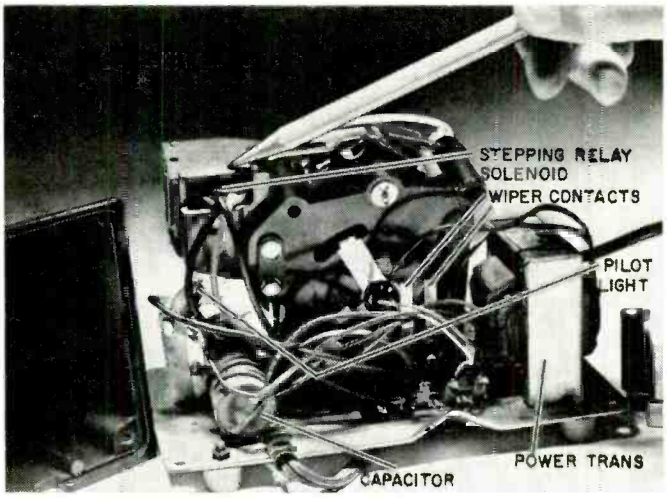
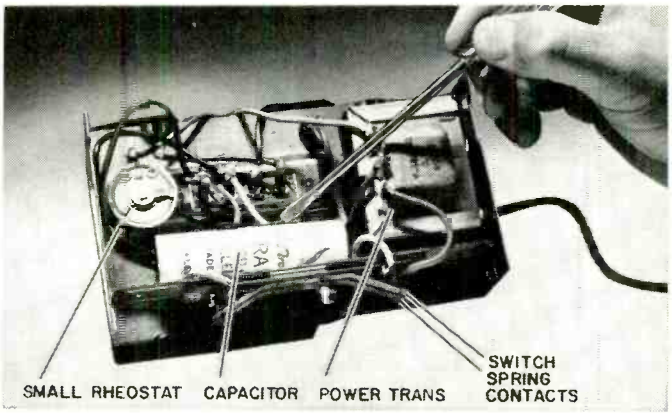



Fig. 6—Pencil shows stepping relay solenoid.

Fig. 7—Inside nonautomatic rotator control box.



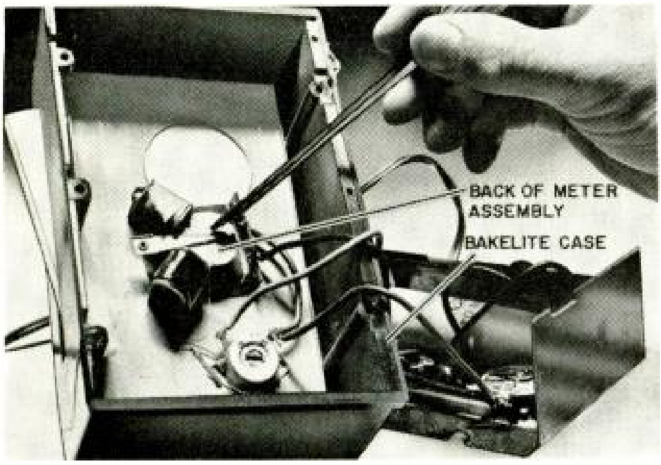
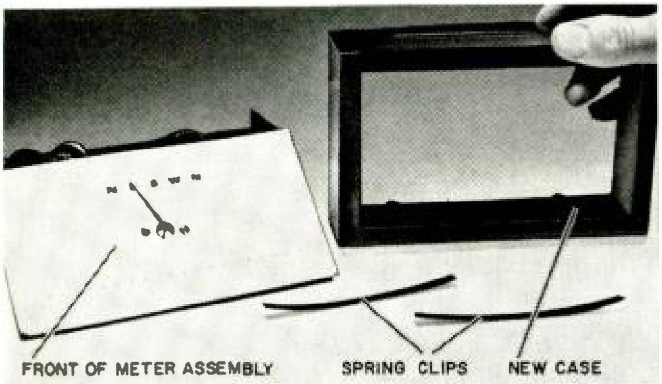



Fig. 8—Back of meter assembly (manual type).

Fig. 9—Manual unit comes apart easily. Curved strips in foreground are spring clips that hold meter to case.




you climb up on the roof. If the rotator motor is bad, it must be dismounted from the antenna mast and repaired or replaced.

The rotator itself consists of a motor and control box. Let's take an Alliance T12 control box and examine possible troubles. Most likely are a defective capacitor, burned-out transformer, open meter and a cracked control box. Fig. 7 shows the starting capacitor, power transformer and small rheostat. In Fig. 8 the back of the meter assembly is illustrated. A broken meter case is being replaced in Fig. 9.

Four bolts in the back can be removed to let the control unit slip out of its case. Check continuity of the meter and rheostat. Measure the transformer secondary voltage. It should be between 25 and 35 with the meter connected. Parts are available at most local distributors who sell rotators.

As an example, let's take a case where the meter will not read but the rotator turns. The meter is definitely bad and must be replaced. First unsolder the red, black and brown wires from their components. Pull back the two spring clamps at the back of the meter and remove the meter. Replace the meter assembly, spring the clips back into place and resolder the three color-coded wires. That's all.

Rotator repair is quite simple; there are only a few parts to replace. Instructions are usually included with replacement conponents by the manufacturers.

Next month we'll discuss troubleshooting, repairing and replacing defective rotator motors, and say some words about wind damage insurance for rotator assemblies.

TO BE CONTINUED

# Booster Triples Radio Output

**By HARRY E. STOCKMAN***

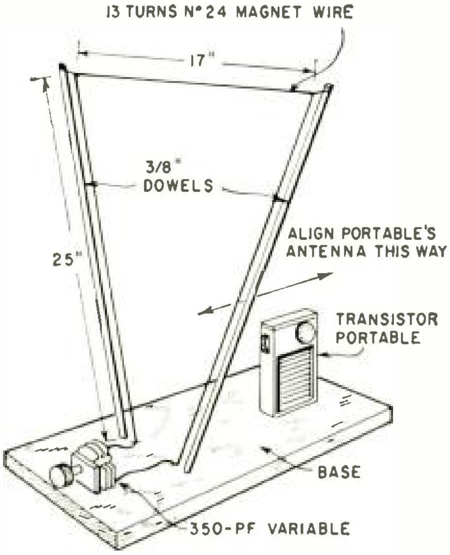
YOU CAN BUILD THIS SIMPLE GADGET IN an hour, and then sit back and marvel at the improved performance of your little transistor portable. This antenna is a parasitic device: it uses no tubes, transistors or batteries, and is not connected in any way to the radio.

Construction is shown in the drawing below. Though only one turn is shown, you will need about 13. Use No. 24 enamel or double-cotton-covered magnet wire. The loop is held upright by two ⅜-inch wooden dowels mounted in a vertical "V". The 350-pf variable is connected across the loop. Its value is not critical (a 365-pf variable can be used just as well).

To use the antenna, place your transistor portable so that its built-in ferrite-rod antenna is coaxial with (that is, "pokes through") the parasitic antenna. Turn on the radio and tune in a station (a weak or moderately weak one will show the greatest improvement).

Now tune the parasitic antenna's capacitor until you hear an increase in volume. It should be very noticeable.

For skeptics, some explanation is in order. In ordinary ferrite-rod antennas, the length-to-diameter ratio is important to sensitivity. Because of space limits, this ratio is often well below what it should be, and a small set often doesn't perform as well as it might. Sometimes, too, low-Q ferrites are used. The parasitic antenna's function is not very different from that of any parasitic element on, say, a Yagi antenna. It helps intercept the signal, and its energy is coupled into the ferrite antenna by a kind of transformer action.




Measurements show that the audio voltage output from a particular station increases about three times when the parasitic antenna is used, though the exact improvement depends on the design of the transistor portable. Smaller antennas will work, too. One half the size of the one shown will still improve reception noticeably. A bigger one, on the other hand, gives even better results.

You can expect quite a bit of selectivity from this arrangement, to the point where sideband cutting produces distortion and loss of highs. In that case, detune the parasitic antenna slightly.

Directivity of this system is quite a bit better than that of a ferrite-rod antenna alone. If you mount this assembly on a rotating table, you have a dandy direction finder! END

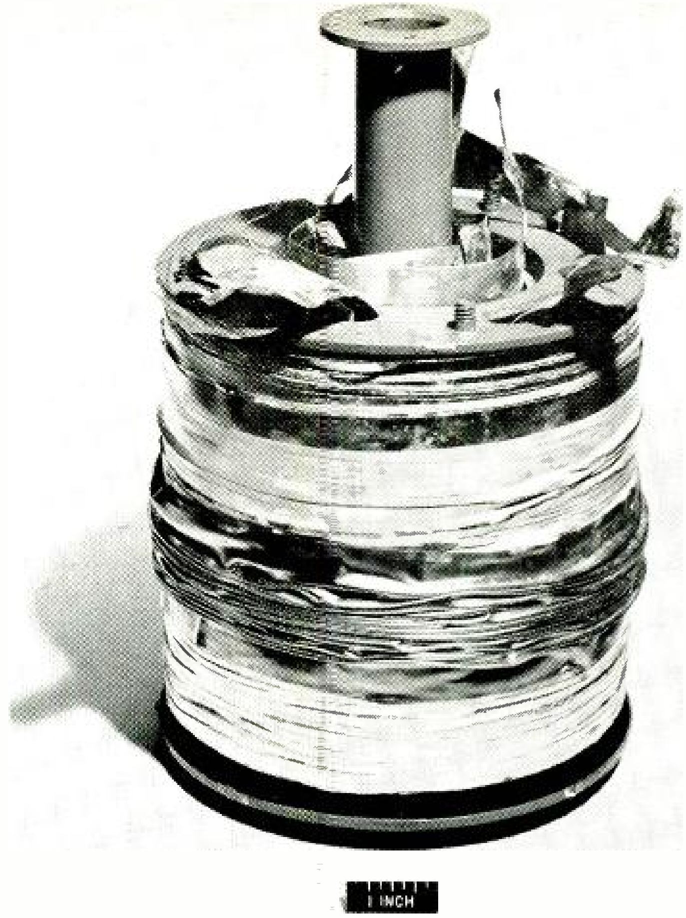
*Professor of electrical engineering, Lowell Technological Institute, Lowell, Mass.

# The 1960's—Superconductivity's Decade?

**By ERIC LESLIE**

AS THE 1940's WERE MARKED BY THE transistor: the 50's by discovery of the maser-laser, so may progress in the 1960's be linked with the phenomenon of superconductivity. Already it is suggested that it may be instrumental in "achieving an exotic generation of high-performance computers, microwave radar and communications equipment, magnets, scientific instruments, high-current storage batteries, magnetohydrodynamic power supplies, and propulsion systems for outer space." The fact is that superconductivity is still so new in application that, like the laser in the 1950's, its possible applications are still largely unknown.

Unlike the laser and the transistor, which were absolutely new when brought to public attention, the principles of superconductivity have been known for many years. In 1911, Kammerlingh Onnes, experimenting with the production of extreme cold, discovered that certain metals lost all their resistance when lowered to the temperature of liquid helium (4° K approximately).




When this superconducting magnet "went normal" (out of superconductivity), fantastic power of magnet pleated heat-absorbing copper sheet around center of magnet winding. Magnet still worked after that! Light-colored flat ribbon above and below accordion-pleated copper is niobium-tin alloy winding, which becomes superconducting at low temperatures. Wrinkled flat strips at top of winding form are connecting leads.

Not much use was made of this phenomenon for many years, for the simple reason that the magnetic field set up by any great amount of current through the superconductor would cause the superconductivity to disappear immediately. In recent years new superconductive materials, "hard superconductors", have been found that will work at higher temperatures and higher currents.

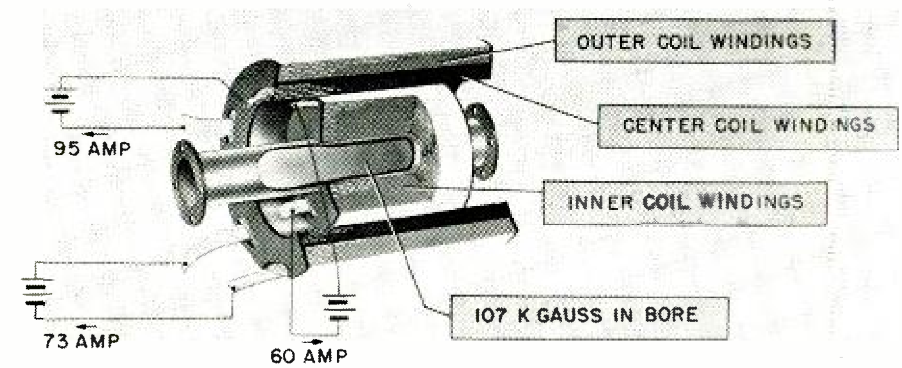
A niobium-tin mixture has the greatest ability in this direction, but until recently was so brittle that it could not be made into usable conductors. A number of processes have been developed for using the niobium-tin compound. Possibly the most successful is that of Dr. J. J. Hanak, of RCA Laboratories, who evaporates niobium stannide on a stainless-steel ribbon.

A magnet made of ribbon produced by this process was demonstrated at the David Sarnoff Research Laboratories recently. A field of 107 kilogauss makes it one of the strongest magnets of the world; yet it is only about 6 inches in diameter and uses a fantastically small fraction of the power required by other magnets of similar type.

At the same demonstration, RCA showed a microwave amplifier that uses superconductivity to work in the gigacycle frequency range, a superconductive computer memory and a high-speed electronic switching system usable in computers.

All these devices, of course, depend on operating at extremely low temperatures. Other companies are developing the necessary "refrigerators" which will make it possible to handle such *cryogenic* devices efficiently and economically. END

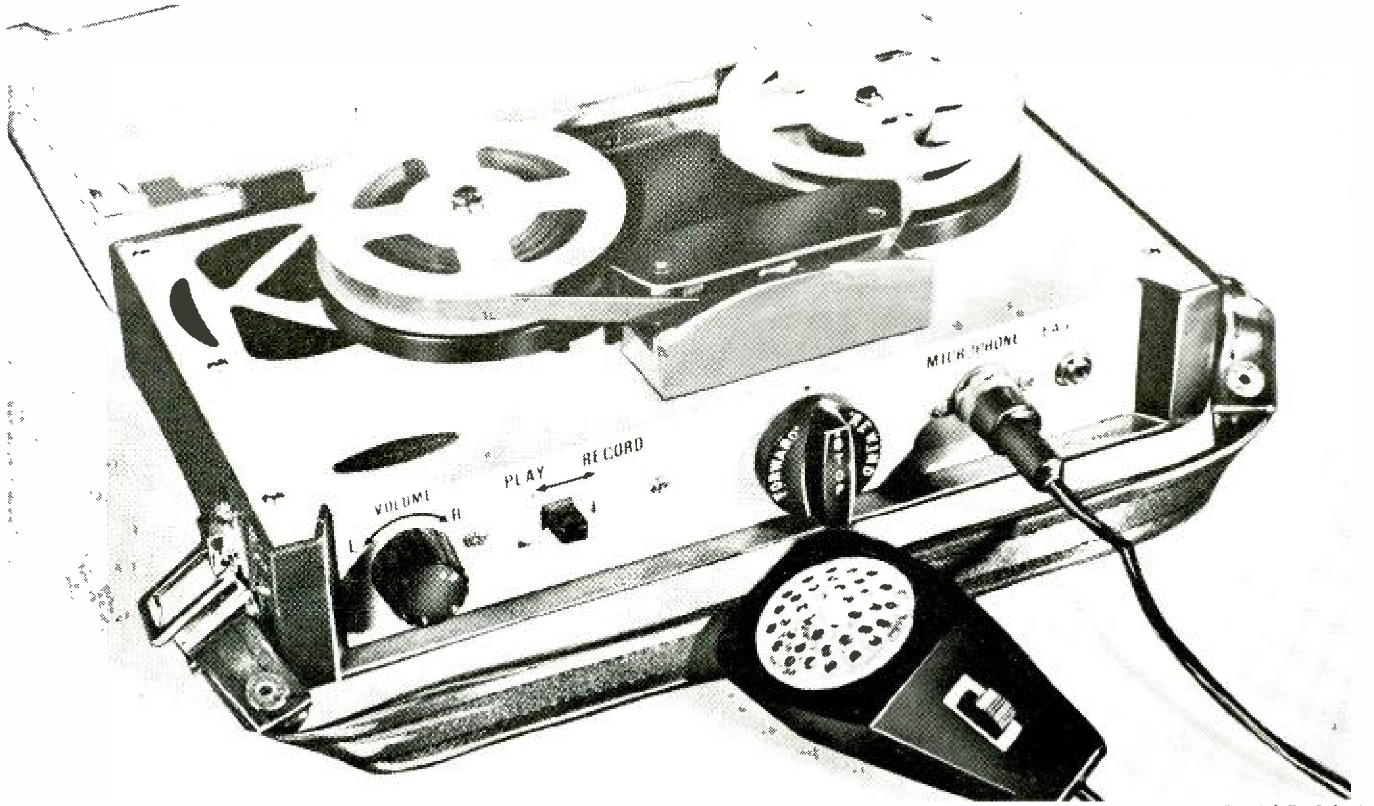
Detail of RCA's mighty supermagnet shown in the photo.




**SPECIFICATIONS OF THE RCA 107-KILOGAUSS MAGNET**

| | |
|---|---|
| Weight | 26 pounds |
| Total length $Nb_3$ Sn | 4,450 meters |
| Total turns | 15,370 |
| Magnetic field in 1 in. bore | 107 kilogauss |
| Magnetic field in 3.4 in. bore | 56 kilogauss |
| Stored energy | 20,500 joules |
| Inductance | 6.8 henrys |
| Magnetic pressure | 7,000 psi |

HOME-MADE FOOT SWITCH AND PUSH-TO-TALK MIKE TURN LOW-PRICE PORTABLE TAPE RECORDER INTO GOOD DICTATING MACHINE




*Daniel R. Schmitz*

# THE LITTLE DICTATOR

**By WILLIAM D. REXROAD**

THOSE WHO HAVE HAD AN OPPORTUNITY to use dictating machines have found them tremendous time-savers. Unfortunately, their high cost prevents them from being used more widely by businessmen to write letters, by students for dictating papers and by many others whose valuable time could be saved by speaking into a microphone instead of writing. An inexpensive Japanese tape recorder can be made into a good dictating machine for less than $25. The modified recorder has all the features of a much more expensive commercial counterpart.

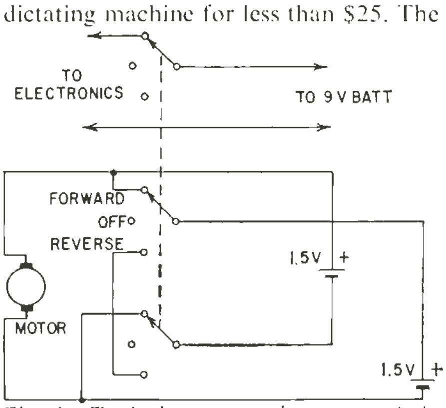



*Fig. 1—Typical motor and power switching circuit of miniature portable recorders. Two 1.5-volt cells are paralleled for forward drive, in series for faster rewind.*

Just what is a dictating machine? Basically, a recording device—a tape, wire or disc recorder. More than that, it must include a hand-held microphone with a push-to-talk switch, and some provision for transcribing the information from the recorder to paper. That usually consists of an earphone for the secretary, and a foot switch so that the recorder may be stopped and started conveniently while it is being played. The unit should be small and battery-powered so that it may be carried easily on trips or business calls, and used without plugging it into an ac outlet.

Several brands of Japanese-made tape recorders on the market today are small, lightweight, battery-powered, and, most important, inexpensive ($15 to $20). Such a recorder is a natural as the foundation of a cheap but versatile dictating machine. Your electronic junkbox will probably supply most of the parts necessary for the modification, which consists of rewiring the motor circuit to provide remote on-off control, adding a switch to the microphone and constructing a foot switch. If you have to buy the parts, they will add less than $5 to the cost of the unit.

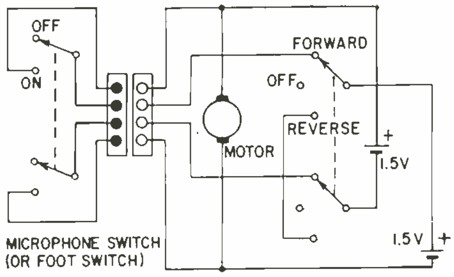



*Fig. 2—Remote switch (foot pedal or on mike) starts and stops recorder conveniently.*

### Where to begin

Fig. 1 is a diagram of the motor circuit in a typical Japanese tape recorder. In the FORWARD position of the function switch, the two 1.5-volt cells are in parallel to drive the motor, and a 9-volt battery is connected to the electronic circuitry. In the OFF position, none of the batteries are connected. In the REVERSE position, the 1.5-volt cells are connected in series to rewind the tape at a higher speed, and the 9-volt battery is disconnected from the electronics.

The motor circuit must be modified to control the motor remotely only when the switch is in the FORWARD position. The remote on–off switch should be completely out of circuit in the STOP (or OFF) and REWIND positions. Fig. 2 shows how the motor circuit is rewired to provide these features. The leads to the FORWARD contacts of the switch are broken and brought to a connector mounted on the recorder. A dpst switch in series with these leads provides remote on–off control when the function switch is in FORWARD, and does not affect the control circuit in OFF or REWIND.

Any small connector with at least six pins can be used to terminate the motor control wires. I used an ordinary seven-pin miniature tube socket installed in the hole formerly occupied by the microphone jack. The original hole is just the size for the screw of a ⅝-inch chassis punch. If you don't have such a punch, you can file or drill out the hole to ⅝-inch diameter. Regardless of the kind of connector you use and the size hole you make–or how you make it –protect the parts in the recorder from metal chips and filings.

After installing the connector, solder the leads from the original microphone jack to two of the pins, and the motor control wires to four others. I used pins 6 and 7 for the microphone leads, and pins 1 through 4 for the motor control wires. This completes the modification of the recorder.

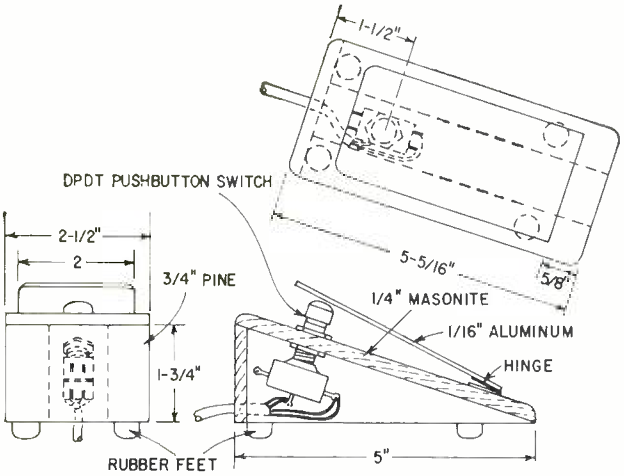


*Fig. 3—Dimensions and details of the foot-pedal switch. It can be modified to suit any similar switch and whatever parts you have on hand.*

Two methods of remotely controlling the recorder are required: a switch on the microphone for dictating and a foot switch for when the tape is being transcribed. In both cases, a two-pole single-throw (dpst) switch is used.

The foot switch construction is shown in Fig. 3. A momentary-contact pushbutton switch is mounted in a housing so that it can be operated conveniently by the foot control. The housing is constructed of scrap pieces of pine and ¼-inch Masonite. A small piece of sheet aluminum, which acts as a foot pedal, is attached to the housing with a small hinge, as shown in the illustration. Rubber feet prevent the foot switch from slipping.

The cable from the foot switch should be at least 5 feet long. It consists of four wires, no smaller than No. 26, enclosed in a piece of sleeving, which improves the appearance of the cable. The free end terminates in a plug which mates it with the connector on the recording unit. I used a seven-pin Cinch-Jones plug which mates with a seven-pin tube socket. To keep the wires from breaking off the plug, and to provide a means of gripping it, it was encapsulated in epoxy resin. I made a mold which consisted simply of concentric holes drilled in a block of plastic (Fig. 4). I filled the mold with epoxy resin (the type used in automobile repair kits will do nicely) and allowed it to cure.

A microphone with an on–off switch may be obtained in several ways: you can buy a commercial unit, or tape a switch to the microphone provided with the recorder. I bought an inexpensive crystal microphone cartridge and slide switch and molded them into an integral microphone unit. Fig. 5 shows the details of the unit I made. The mold was constructed by soldering pieces of thin sheet copper together. The dpst slide switch and mike cartridge were mounted in it, the cable attached, and the mold was filled with epoxy resin and allowed to cure. The opposite end of the cable was terminated with a plug identical to that used on the foot switch.

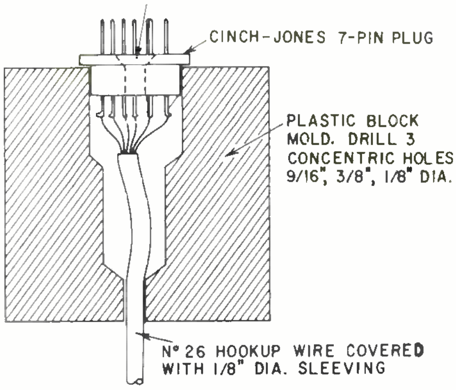
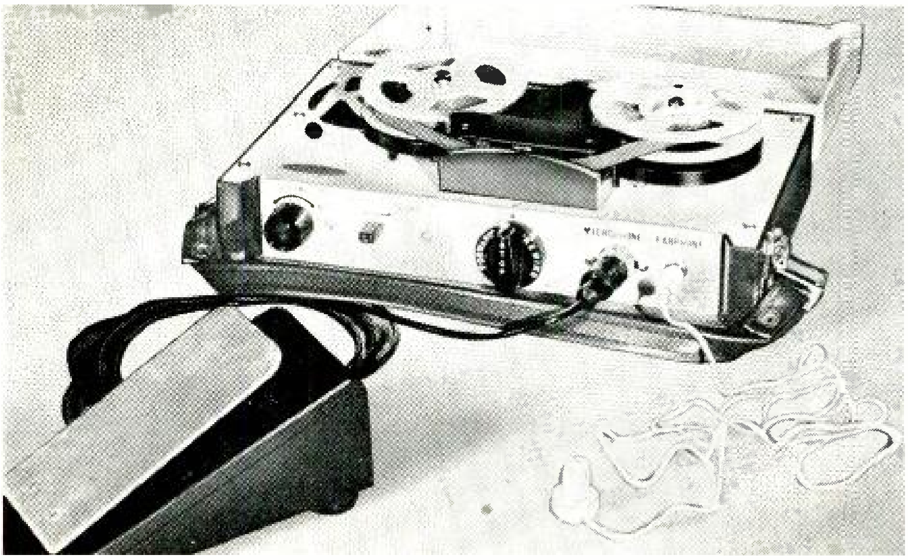


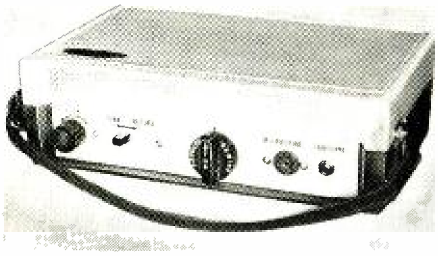
*Fig. 4—Author's mold for plug "handle". Wide sleeve from phone jacks like Mallory 75 or 76 can also be adapted.*

If it seems like too much trouble to mold plugs and microphone housings, a different type of connector on the recorder will do every bit as well. For instance, a six-terminal Jones connector (type S306AB and two mating plugs (Jones P306CCT) will solve the cable problem adequately. You can mount the slide switch on the microphone in other ways, too.

### Using the Little Dictator

To use the dictating machine, simply plug in the microphone unit, turn the function switch of the recorder to FORWARD and the PLAY–RECORD switch to RECORD. Turn the mike switch ON to dictate, OFF when not talking. One precaution: if you wish to back up and review what you have said, be sure the PLAY–RECORD switch is in the PLAY position before rewinding the tape. If you don't do this, all that you have recorded will


*The Little Dictator set up for transcribing a recorded tape. Earpiece facilitates transcription in noisy locations.*



*Converted recorder is no bigger than original machine: foot switch doesn't have to go along, since transcription will be done at home or office. Machine carries easily in briefcase or suitcase.*

be erased.

When transcribing, the typist disconnects the microphone and connects the foot switch. The foot switch is then depressed and released alternately, allowing the information on tape to be transcribed a few words at a time until the entire tape has been reproduced. No unusual talents other than the ability to type are required of the person doing the transcribing. It is convenient for the transcriber to use the ear plug rather than to listen to the tape via the speaker; surrounding noises are less distracting.

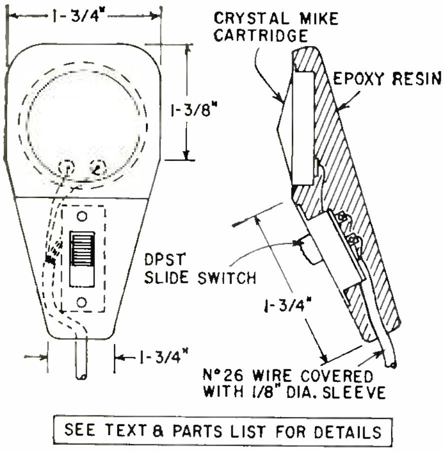


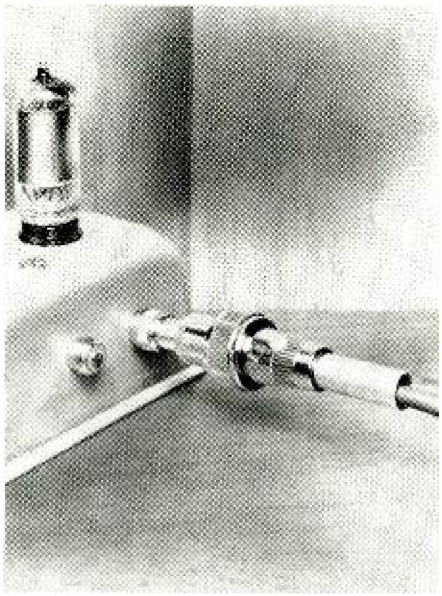

*Fig. 5—Microphone unit is inexpensive crystal mike element with dpst switch, molded (or otherwise fastened) together. Depending on input impedance of recorder's amplifier, crystal mike cartridge may have to be wired with single-conductor flexible shielded cable.*

Tape recorder
1 dpst pushbutton switch
1 dpst slide switch
1 crystal microphone cartridge (Burstein-Applebee 17B265 or equivalent)
Connectors (see text)
Mountings and hardware (see text)

Because tape speeds are not closely controlled on these little machines, you must usually play a tape on the same machine you recorded it on. Sometimes you can play a tape on another machine of the same make and model.

Once you overcome a natural shyness toward writing letters or reports by microphone rather than with a pencil or pen, the dictating machine becomes a valuable time-saver, and you will find yourself using it everywhere! END

# Adapter For Mike Connectors

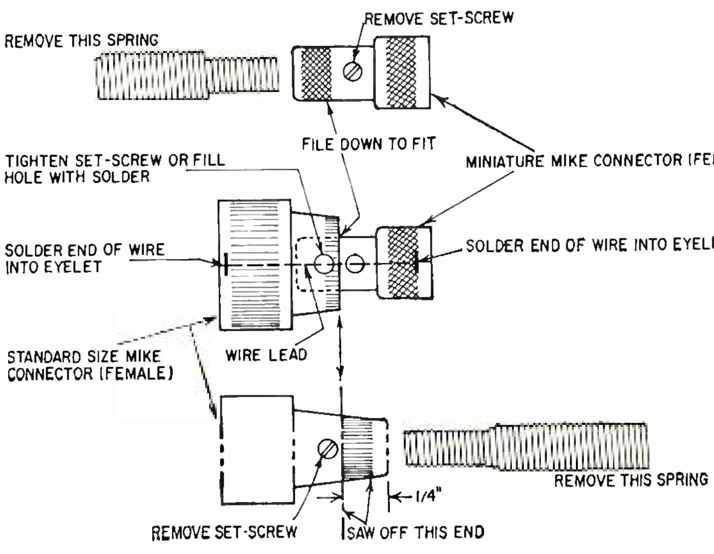


For many years, the well known Amphenol type mike connectors have been standard equipment on mike cables and audio amplifiers. Nowadays the miniature mike connectors promise to become just as popular for all kinds of transistor and miniature electronic apparatus. With both sizes of mike connectors in use, experimenters, audiophiles, service technicians and research labs need an adapter that will quickly and easily join the standard and miniature mike connectors.

To make such an adapter, you will need one Amphenol 75-MC1F mike connector or equivalent, one Switchcraft 5501F Mini-Con miniature mike connector and a short length of insulated hookup wire.

The diagram illustrates the simple construction of the adapter very clearly. Remove the setscrews and pull out the cord-protecting springs in both connectors. Saw a piece about ¼ inch long off the end of the large connector, then file down the barrel of the miniature connector so it is a snug fit inside the large connector. A short length of hookup wire, running lengthwise inside the adapter, connects the center eyelets of both connectors. Now sweat-solder the barrels of both connectors together so they can't slip or turn.

The adapter is is easy to use. Take the case of a mike cable with an Amphenol 75-MC1F or equivalent standard female connector and an amplifier with a miniature mike connector. Simply screw the small end of the adapter onto the panel connector. To couple the female connectors, unscrew the coupling ring from the connector on the cable and slide it back out of the way. Screw the cable connector onto the large end of the adapter to complete the hook-up. —*Art Trauffer*



# Watch Those Shifty Resistors!

**Most resistors hold their values over a wide range of circumstances. But some are designed to change resistance**

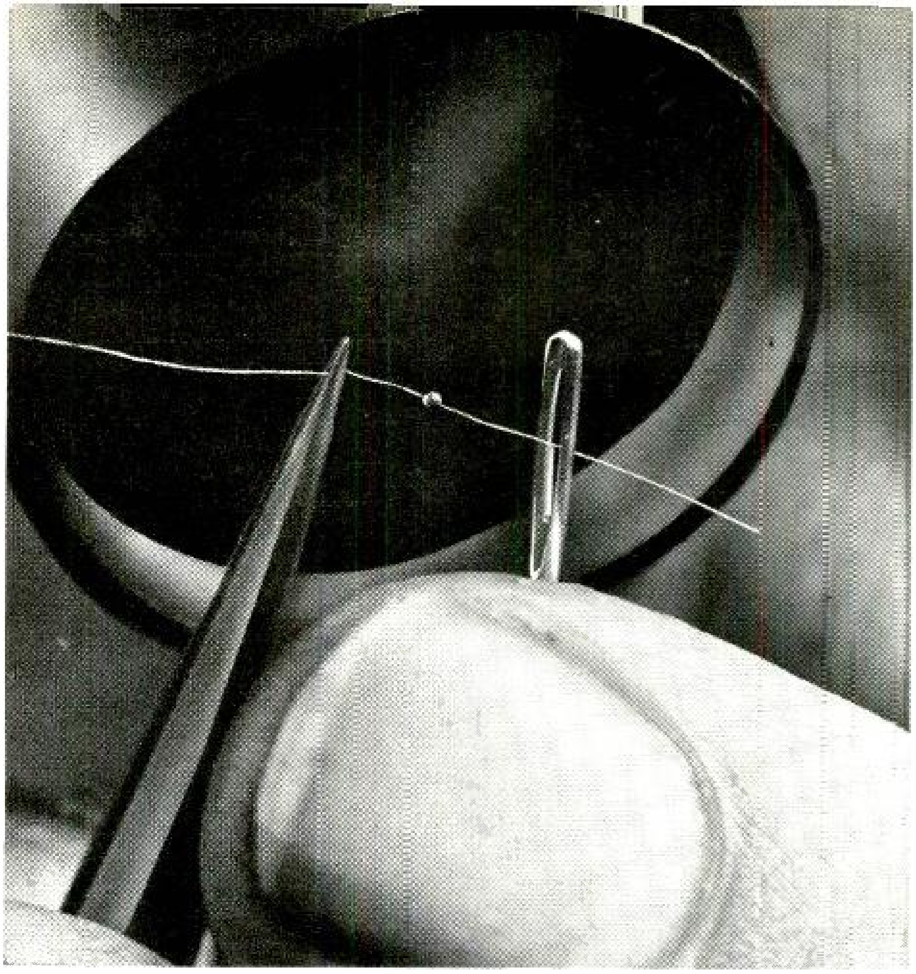
**By CARL HENRY**

THOSE STAR ACTORS LIKE THE TRANSISTOR and crystal diode usually hog the spotlight among the semiconductors. But several less publicized semiconductor devices are important in electronics today. Perhaps the oldest in common use is the thermistor, developed in its present form by Bell Telephone Labs in the early 1940s. Thermistors, made by sintering a ceramic material with a metallic oxide, can have a resistance variation with temperature of over ten million to one.

Why are thermistors important? Most items used in electronics have a positive temperature coefficient (their resistance increases with temperature). Since thermistors have a *negative* coefficient, they are widely used to compensate for the effects of temperature changes in circuitry. The photographs illustrate several types of thermistors. The wafers, discs and washers are usable to about 300°F., while the bead types can be used to above 600°.

Thermistors can be used in two ways. First, they can be placed in an ohmmeter circuit. The temperature of the thermistor's surroundings will determine its resistance. Fig. 1-a shows this type of circuit, which can be used to measure temperature. In a more sophisticated version (Fig. 1-b), a bridge is used to indicate temperature more accurately. Figs. 1-c and 1-d illustrate applications of these circuits. Fig. 1-c is a crude control circuit to keep the temperature of an electric heater within a certain range. More accurate than a thermostat type of control, it is not as accurate as the circuit in 1-d, which will keep a chemical solution at a precise temperature.

In the second type of circuit, the thermistor is allowed to draw enough current to raise its internal temperature to 200° or 300°F. It is then placed in contact with the variable to be controlled



*Gulton Industries*

*Tiny bead thermistor is .01 inch in diameter.*

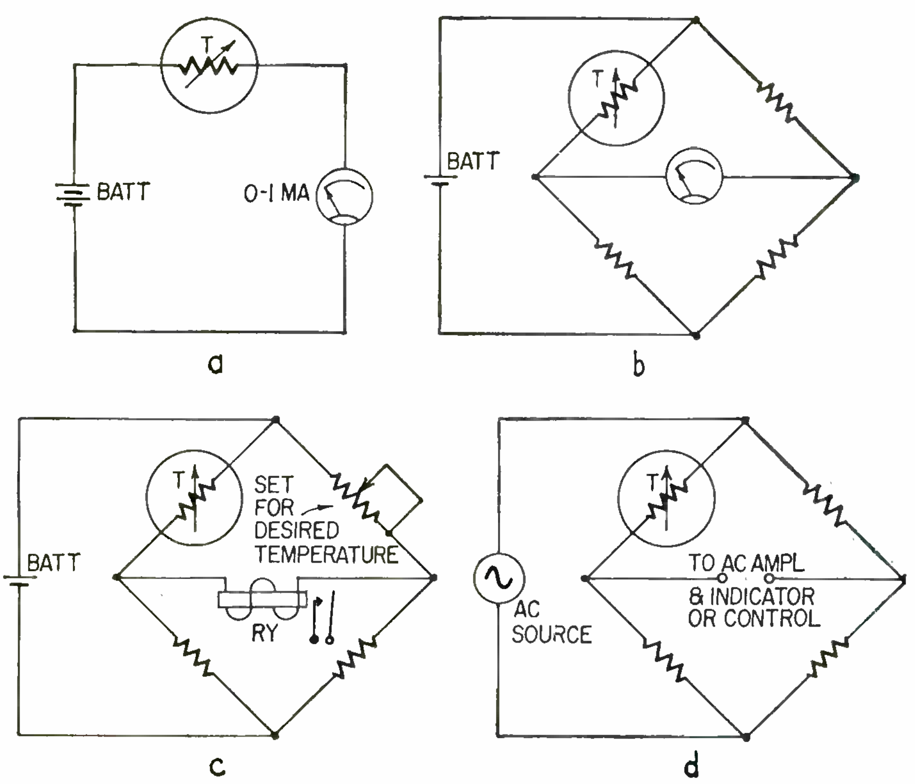



*Fig. 1—Thermistor applications. In Fig. 1-a, direct temperature measurement; 1-b shows a bridge circuit with increased sensitivity. In (c), a control circuit for heaters, fans, etc. Thermistor is mounted near heating or cooling element. Fig. 1-d shows a potentially very sensitive temperature-change detector.*

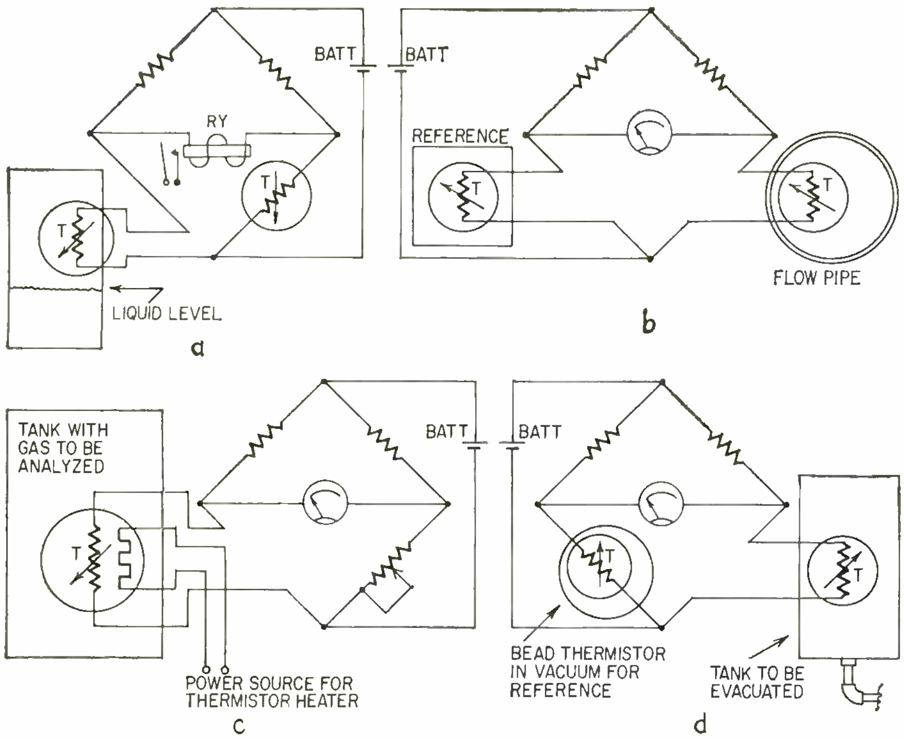



*Fig. 2-a—Liquid-level control with thermistor. Relay controls tank valve. (b)—Thermistor flow meter. Reference is mounted in brass block. System detects flow rates as low as .001 ml/minute. (c)—gas analysis by registering change in specific heat of gas. (d)—Measuring vacuum; rate of heating and cooling will be different for the two thermistors until surrounding gas densities (degrees of vacuum) are equal.*

or measured. In this manner it is possible to measure the liquid level in a tank, as in Fig. 2-a. The thermistor is placed at the point in the tank where the level is to be maintained. Since its internal temperature is high, its resistance is low. If the liquid in the tank rises, covering and cooling the thermistor, the resistance will increase. This increase can turn off a relay or move an indicator. We can analyze the content of a gas, measure the flow of a liquid or a gas, and measure the degree of a vacuum, even down to 50 microns, in the same way. Fig. 2 illustrates the methods schematically.

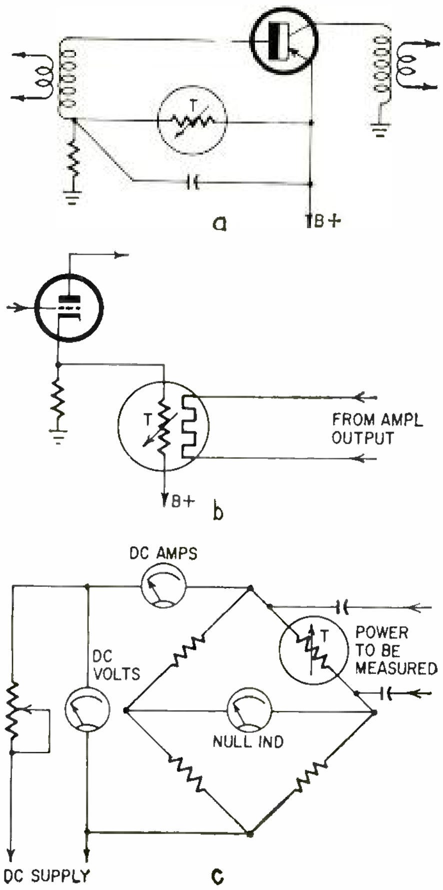



*Fig. 3—Electronic applications for thermistors. In Fig. 3-a, thermistor "holds down" transistor stage with changes in temperature. As temperature rises, transistor tends to conduct more heavily, but thermistor, whose resistance drops with increasing temperature, tends to shunt away more and more bias, maintaining transistor's conduction at lower value. In (b), heating effect of audio amplifier output through thermistor controls bias on voltage amplifier, holding output approximately constant (volume compression). Expansion is also possible. In (c), thermistor bridge measures even high-frequency rf with noncritical dc instruments. Dc is applied, lowering thermistor's resistance enough to balance bridge (normaly unbalanced). Applied ac unbalances bridge; dc power is then reduced to rebalance it. Difference in dc power (as read on meters) is equal to applied ac power.*

The thermistor can also be used to give time delays of up to several minutes. For instance, a thermistor in series with a relay will not allow the relay to draw enough current to close until the thermistor has heated enough for its resistance to drop. The delay can be controlled by choosing thermistors of different characteristics.

Surge suppression is also possible with the proper thermistor. Also, several bulbs can be operated in series and when one bulb burns out, the others can continue at normal brightness. Merely put the proper thermistor across each bulb. When the bulb filament opens, the thermistor heats, its resistance drops and the circuit functions normally again.

Some bead thermistors have an external heater attached. By placing such a thermistor in the grid circuit of a vacuum tube, the gain of the tube may be varied

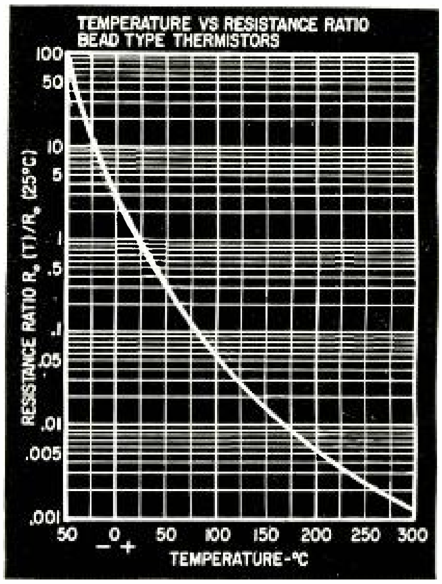



*Fig. 4—Temperature/resistance characteristic of typical bead thermistor.*

remotely simply by controlling the current in the external heater. The control carries only dc and is not critical; it can be located miles away without affecting the amplifier.

**How is it used?**

Fig. 3 shows several typical electronic applications. In 3-a, the thermistor is used to temperature-compensate a type of electronic circuit that is especially important in dc amplifiers and in oscillators. Transistors, in particular power transistors, change operating characteristics with changes in ambient temperature. Thermistors can be used to bias such circuits. With careful design, the same operating point can be maintained through a wide variation of ambient temperatures.

Fig. 3-b illustrates a method of stabilizing the output of an amplifier with a thermistor. Its resistance can be made to vary with the output in such a way as

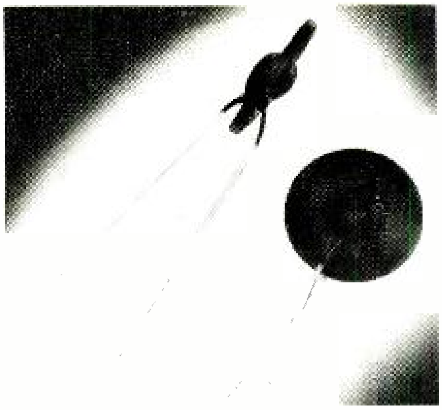
to increase the bias or reduce the feedback if the output increases. Either a bead thermistor or an external-heater type is suitable. The major advantage of this kind of control is the wide range of frequency and amplitude it covers.

Since the thermistor decreases in resistance with heat, which in turn depends on the current through it, it can be used as a voltage regulator. Connect the same as a Zener diode or gas regulator—in parallel with the load. As voltage increases, the thermistor's resistance decreases and the current through it increases, restoring the original voltage. The main difference between this circuit and a conventional regulator is the time lag in the resistance change.

This is true of all the circuits mentioned so far. The resistance change of a thermistor is caused by a heating effect, which of course takes time. This may be unimportant in dc control and audio circuits, but severely limits the use of thermistors as control elements as the frequency increases. In general, the smaller the thermistor, the faster the response time.

Thermistors can be used in some circuits at higher frequencies, however. Fig. 3-c shows one such circuit. Here it is being used to measure power. The frequency can be anything from low ac to microwaves. This is because we are measuring the *heating effect* of the power, and not the power itself. We can compare the heating effect of this power with the heating effect of dc, or as in 3-c we can use dc to rebalance the bridge that the high-frequency power has unbalanced.

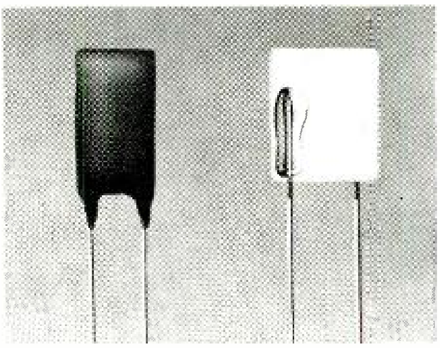
Using thermistors at audio frequencies makes possible the simplest volume compressor-expander circuit. By operating the thermistor on the negative-temperature-coefficient section of its characteristic curve (Fig. 4), it acts as a limiter. If the circuit is properly designed, there will be no waveform distortion.



*Disc wafer thermistors.*

### Varistors

Running thermistors a close second in importance is a component used in telephone circuits for years and years, but only now becoming widely used in electronics: the *varistor*, a resistor whose value varies with voltage. Fig. 5 illustrates two typical telephone type varistors. As the voltage across one increases, its resistance decreases. Fig. 5 also shows a typical varistor application, an intercom speaker circuit sometimes known as a "talkback" speaker. It is desirable in this type of circuit not to attenuate the low-level signal from the speaker to the amplifier. However, the high-level signal from the amplifier to the speaker must be controlled, especially if the speaker is used in an office.



*Gulton Industries*

*Rectangular wafer thermistors.*

This paradox is resolved by using a varistor. When the transmission is from the speaker to the input of the amplifier, the voltage is very low, and the varistor acts as a high resistance. This effectively removes the T-pad from the circuit. When the transmission is from the output of the amplifier to the speaker, the voltage is high, the resistance of the varistor is low, and the T-pad controls the volume of the speaker.

From this you can see that the varistor will function as an audio limiter. It operates much faster than a thermistor and, with the proper circuit design, the output is undistorted.

A second type of varistor is shown in Fig. 6. Commercially this is known as a contact protector. Fig. 6 also shows a typical circuit, with the varistors protecting the contacts on a relay. The theory is that the high voltage generated at the relay contacts causes the varistors to conduct and prevent arcing. Normally the voltage across the contacts is not great enough to cause the varistor to conduct. You can visualize this better if you think of the varistor as two silicon rectifiers back to back. Ordinarily they will not conduct, because the voltage across them is too low. When a high voltage is generated by the relay contacts, the inverse voltage of the diodes is exceeded, and they short out the spark.

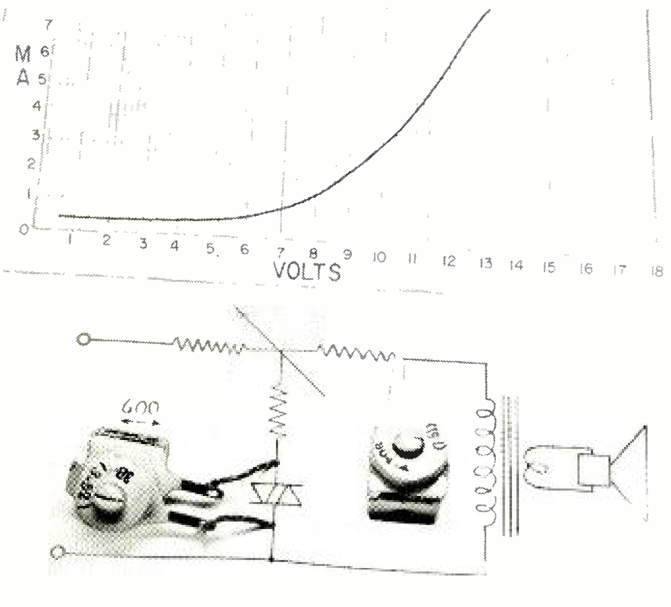



*Fig. 5—Two Western Electric telephone type varistors, one of them "connected" to a diagram showing a typical application (see text). Above, general voltage characteristic of varistors.*

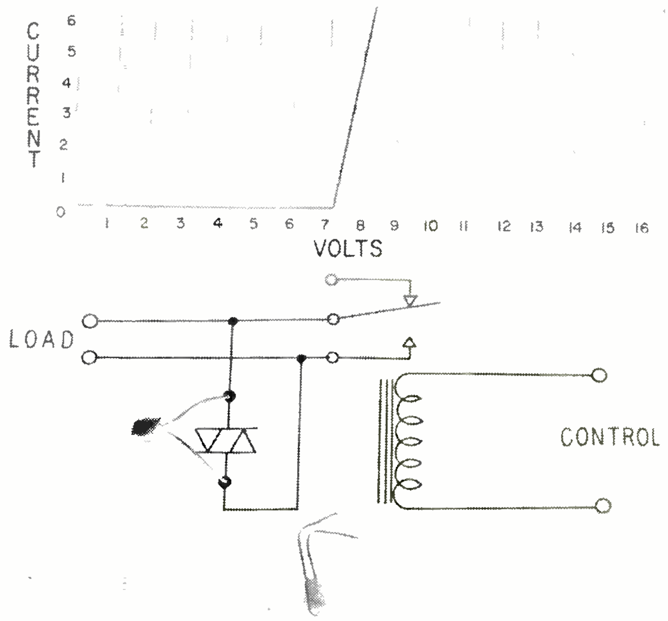
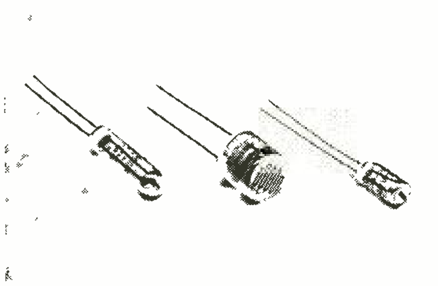



*Fig. 6—Varistor as contact protector, with circuit and characteristic curve.*



*Clairex Corp.*

*Three typical photoconductive cells.*

**Photoconductive cells**

The last of our "shifty" resistors is the photoconductive cell—a resistor that varies with light.

Two types of cells are in production now, cadmium sulfide and cadmium selenide. The selenide cell is faster-operating, peaks in the near infrared (690 millimicrons) and has a greater light-to-dark resistance ratio. The sulfide cell peaks near the same point as the human eye (520 mμ) and has a better temperature characteristic. Two other types, the cadmium telluride cell, which peaks around 800 mμ, and the zinc sulfide cell, which peaks at about 400 mμ, will extend the use of the cell into the ultraviolet.

Both the cadmium sulfide and cadmium selenide are about 1,000 times more sensitive than the older selenium photovoltaic cells. It is also claimed that the photoconductive cell is 1,000,000 times more sensitive than the photoemissive cell (phototube). Photoelectric exposure meters for photographers, auto headlight dimmers (doing away with the complicated photomultiplier circuits) and anemometers are but a few of the applications of these cells.

Fig. 7 illustrates some of the simpler applications. The photoconductive cell is exactly what the name implies, a resistor that shifts or decreases in value with light level. Fig. 7-a shows a simple circuit to measure light. A similar circuit is being used in several new photographic exposure meters on the market. A battery, the photocell and a meter are connected in series. As the light level increases, the resistance of the cell decreases, and the meter indicates more current. This type of circuit can be made so sensitive that you have to carry a flashlight to read the meter!

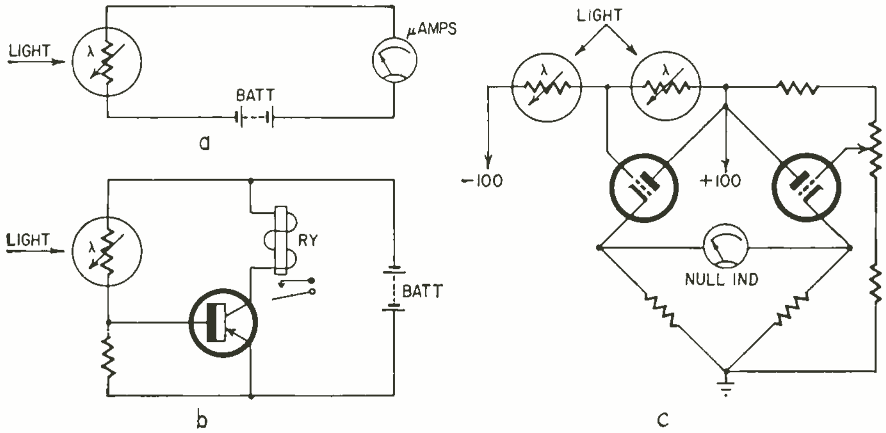



*Fig. 7-a—Direct measurement of light—circuit used in many photographic exposure meters. (b) Greater sensitivity is possible with stage of amplification: cell controls transistor's bias. (c)—A comparison photometer, to compare brightness or luminosity of two objects or sources.*

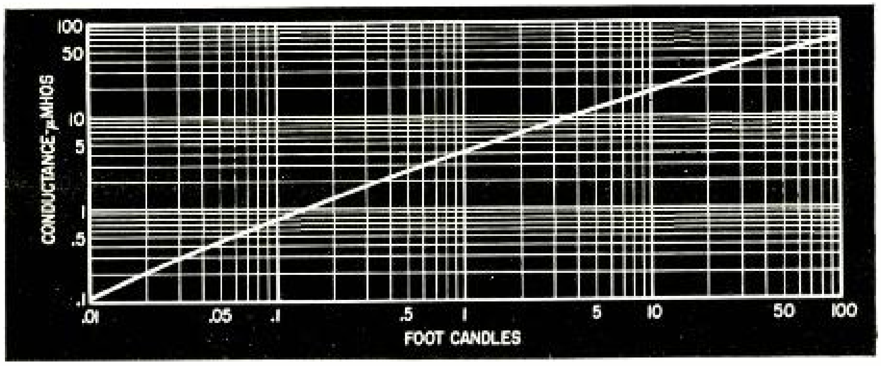



*Fig. 8—Typical photoconductive cell characteristic.*

**Thyrite resistors**

A rather sophisticated type of varistor is the *thyrite* resistor. It is constructed of silicon carbide, sintered in a ceramic material. Thyrite is a kind of super varistor. Its resistance changes over a range in the order of 100,000 to 1 for voltage changes of 1,000 to 1. A typical use for this "shifty" resistor would be in a pulsed sounding or echo circuit. In some of these circuits a pulse of 1,000 volts is transmitted to a transducer. The echo receiver must be connected to the transducer. A thyrite resistor across the receiver input prevents the transmitted pulse from damaging the sensitive receiver.

**Lunar cells?**

Fig. 7-b shows an extremely sensitive relay control circuit. With the transistor to amplify the already high sensitivity of the photocell, it is possible to operate the relay on moonlight. The photocell supplies a biasing current to the transistor. With an increase in light, the biasing current increases to the point where the collector current operates the relay.

Fig. 7-c shows the simple circuit needed to use these photocells for photometry. Such a circuit is accurate and sensitive enough to measure the blood pressure change of animals or humans by light transmitted through the finger or ear lobe. It may make the conventional sphygmomanometer obsolete.

Fig. 8 illustrates a typical conductive cell characteristic.

At this writing there are no accepted standards on photoconductors, but with increasing use this will undoubtedly be corrected. END

## Computer Solves Problem With 13,542 Variables

A record is claimed by Simeon E. Gordon, mathematician at ITT Communications Systems, Inc., Paramus, N. J., for the solution of a problem that consisted of finding the shortest message route to be followed through a network of 62 switching points.

The difficulty was that the messages had to be routed over the network without interference. The problem, Gordon explained, was similar to determining the shortest route a motorist could follow over a road network to avoid traffic delays at 62 intersections.

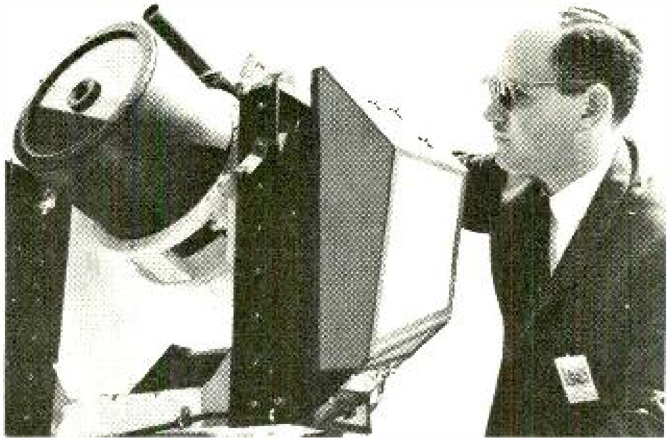
The problem, which involved 2,002 mathematical equations, as well as more than 13,000 variables, required approximately 6½ hours on the computer, and involved a technique known to computer mathematicians as linear programming.

It took Gordon more than a year of spare-time work to develop the program which made it possible for the computer to solve the record problem. It is the first time, Gordon believes, that a computer has been utilized to solve a problem of more than 1,023 equations.

# WHAT'S NEW

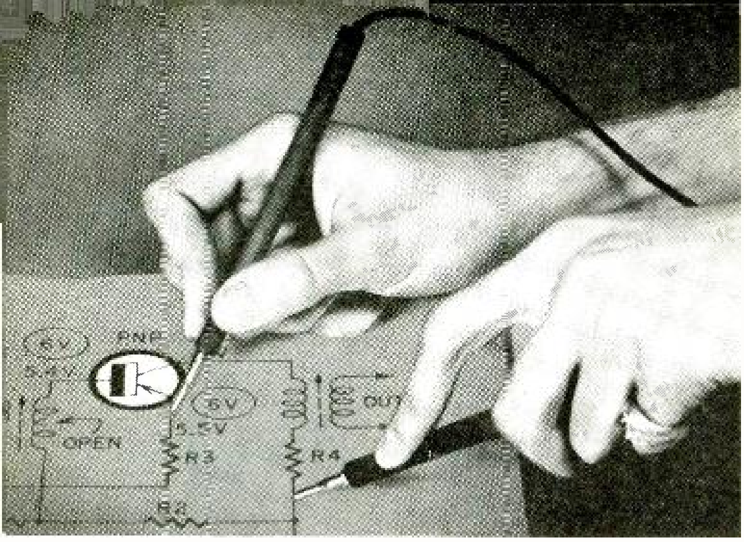
MAGNETIC-FIELD-FREE ROOM was built to test space-bound instruments. Earth's magnetic field and other stray fields played havoc in adjusting delicate instruments for work in outer space. Marshall Laboratories, Torrance, Calif., manufactures the enclosures from Allegheny Ludlum's Mumetal and Moly Permalloy alloys, both high-permeability metals. The "fluxroom" must be heat-treated for maximum effectiveness only after assembly, since alloys are strain-sensitive and lose their properties under mechanical stress. Room is approximately 8 feet each way, and mounted on turntable so it can rotate 360°.

EDUCATIONAL TALKING TYPEWRITER teaches 3- to 8-year-olds to read and type. Dubbed "SLATE" (Stimulated Learning by Automated Typewriter Environment), Westinghouse-developed system lets child hear what he types. In "letter mode", pupil strikes key, sees letter printed and immediately hears it spoken. This teaches letter and punctuation-mark recognition. In "word mode", all keys are inactive except those that spell out words chosen by teacher. Machine responds to those only when pressed in correct sequence to spell word. Letters are pronounced one by one, then whole word is spoken. "Sentence mode" requires correct spelling of entire sentence. Unit can be programmed to work in any language.



INFRARED-AIMED LASER RADAR tracks and ranges noncooperative airborne targets with terrific accuracy, according to Electro-Optics Group of Sperry Rand Corp. System consists of passive infrared tracker, laser transmitter and photomultiplier receiver. It can put laser beam on target to within .01°. Transmitter is pulsed ruby laser with 375-kw peak output; tracker is indium antimonide photodiode cooled in liquid nitrogen. System, hailed as 10 times as accurate as microwave trackers, permits narrower, more intense laser beams for higher signal-to-noise ratios.

A LAMP? YES. A LOUDSPEAKER? YES. Decorative lampshade is 360° cylindrical electrostatic speaker for frequencies above about 400 cycles. Bass is reproduced by front-loaded cone type electrodynamic speaker in base. Acoustica Associates, Inc., manufacturer, quotes total frequency range as better than 40 to 25,000 cycles. Lampshade is translucent; less than 1/4 inch thick. System connects to ac wall outlet and to any hi-fi amplifier.




# TRANSISTORS & VOLTAGE MEASUREMENTS

Wrong voltages are good clues to transistor and circuit defects. Not the same as tubes, though

By DAVID R. ANDERSON

HOW DOES AN OPEN BASE RESISTOR affect collector voltage? Can you tell what's open in a transistor circuit by what's happened to the element voltages?

When you work with tubes, you know that, if the plate voltage is the same as the supply voltage, the cathode resistor is almost certainly open. Why not learn the same diagnostics for transistors?

Look at Fig. 1, a basic n-p-n transistor circuit. Here, the collector voltage will always be the most *positive*, while the emitter voltage will be the most *negative*. The base will be biased so that it is slightly *positive* with respect to the emitter, and *negative* with respect to the collector.

The same relationship will hold true for the p-n-p transistor except that the polarity of the voltages will be reversed.

### One battery supply

For simplicity, two batteries are shown in Fig. 1. Most practical circuits use an arrangement like that in Fig. 2 to obtain the operating voltages from a single battery.

In this arrangement, the collector is connected to one end of the battery and the emitter to the other end. The base is forward-biased with respect to the emitter by tapping off a part of the battery voltage via R1 and R2. Polarity depends on whether an n-p-n or p-n-p transistor is being used.

Most technicians find it easiest to measure voltages from ground to the various transistor elements. This is quite acceptable. However, when a power supply like the one in Fig. 2 is used, either end of the battery may be grounded.

Fig. 3-a shows an n-p-n transistor circuit with the negative side of the battery grounded. Fig. 3-b shows the same circuit with the positive side grounded. The voltages measured at the various elements differ not only in value, but also in polarity, depending on which end of the battery is grounded.

For instance, the collector voltage in Fig. 3-a measures +5.5 from ground. The collector voltage in Fig. 3-b measures −0.5 from ground. So be sure to note which end of the battery is grounded before you begin measuring.

### Open base circuit

Fig. 4-a shows the effect an open base circuit has on the operating voltages of an n-p-n transistor. The uncircled values show the normal operating voltages, while the circled values show the voltages measured from ground with the defect.

The collector voltage has increased. This happens because, with the base circuit open, the base-to-emitter bias disappears and the collector circuit stops conducting. When the collector is not conducting, no current flows through R4 and there is no voltage drop across it. As a result, the collector voltage rises to the battery voltage.

Since the collector has stopped conducting, there is no appreciable current flow through R3 and no voltage drop across it, either. Thus, the emitter voltage falls to zero.

The base voltage becomes zero because it is no longer connected to its operating voltage.

In the p-n-p circuit of Fig. 4-b, an open base resistor has quite a different effect on the operating voltages. The collector voltage has dropped to zero, and the base and emitter voltages have risen to the full battery voltage.

This is because the battery polarity has been reversed, compared to the n-p-n circuit of Fig. 4-a, to supply the proper operating voltages for a p-n-p transistor. As a result, when you measure between collector and ground, you are reading the drop across R4. With the base circuit open, there is no drop across this resistor because there is no collector current, and you measure zero voltage.

When you put the probes from ground to emitter, the battery voltage,

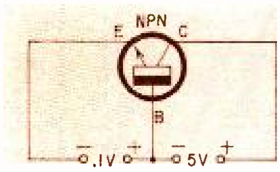



*Fig. 1—Voltage relationships in an n-p-n transistor. With p-n-p types, polarity is just reversed.*

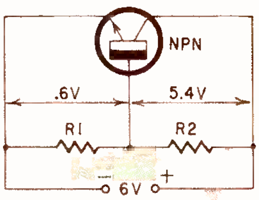



*Fig. 2—Most practical circuits use single battery for all biasing.*

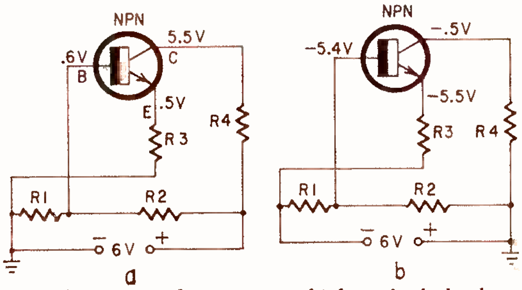



*Fig. 3—Watch first to see which end of the battery is up! Magnitude and polarity of readings depend on where ground is.*

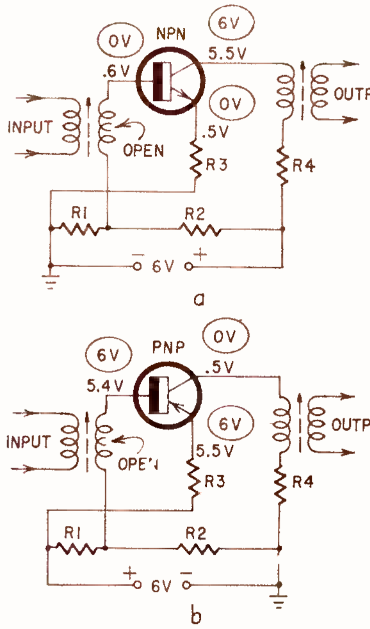



*Fig. 4—Open base circuit with (a) n-p-n transistor; (b) p-n-p. Circled voltages are "defective". Voltages here are just examples; exact values depend on battery, transistor type and operation.*

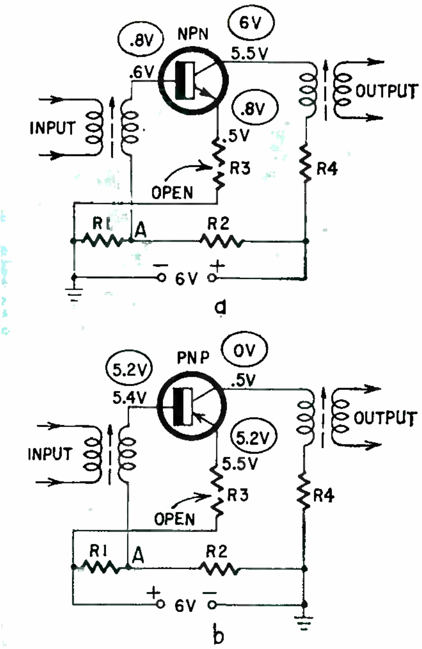



*Fig. 5—Open emitter in (a) n-p-n circuit; (b) p-n-p*

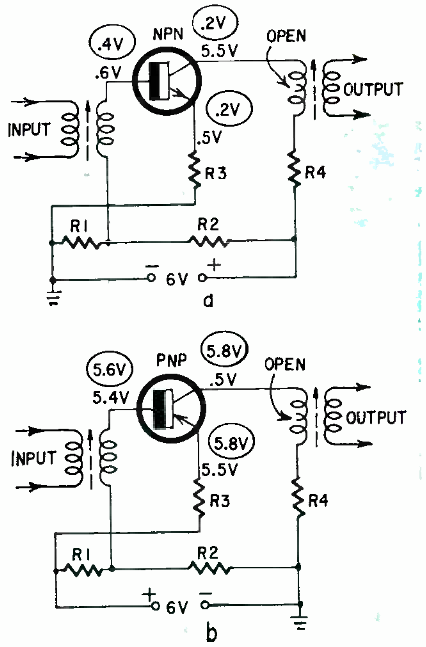



*Fig. 6—Open collector circuit with (a) n-p-n transistor; (b) p-n-p.*

less the drop across R3, is being measured. But since the collector circuit has stopped conducting, there is no drop across R3. As a result, you find the full battery voltage at the emitter.

The base circuit is open and no longer connected to its operating voltage, yet it measures the same voltage as the emitter voltage. This happens because a transistor has a low internal resistance between base and emitter, so the base rises to the emitter voltage.

### Open emitter circuit

Fig. 5-a shows the effect of an open emitter circuit. The collector stops conducting and there is no current in the collector circuit. This results in no voltage drop across R4. With no drop across R4, the full battery voltage appears at the collector.

The open emitter circuit also stops the slight current flow in the base-emitter circuit. When this current flow is stopped, the voltage at point A rises slightly, causing the base voltage to rise also (go more positive).

The open emitter, because of the low internal resistance of the transistor, then assumes the base voltage.

In Fig. 5-b a p-n-p transistor with an open emitter circuit is shown. Here, the collector voltage is zero because there is no current flow in the collector circuit, and no voltage drop across R4.

The base voltage in this case has *dropped* slightly. As with the n-p-n transistor, a slight base-to-emitter current flows through R1. When the emitter-base circuit is open, this current flow stops and the voltage at point A drops slightly (goes less positive). This causes the base voltage to drop. The open emitter then assumes the base voltage.

### Open collector circuit

Fig. 6 shows the effect an open collector circuit will have on the normal operating voltages of a transistor. In both the n-p-n and the p-n-p circuits, the emitter and collector voltages have become equal. The base voltage has changed very little.

Since the collector circuit is open, no current flows through it and the collector voltage rises or drops to the same voltage as the emitter.

Because of the large change in the collector voltage, and only a small change in emitter and base voltages, the defect is clearly in the collector circuit. END

### WHAT HAPPENS TO VOLTAGES WHEN ELEMENTS ARE OPEN

| transistor type | open emitter | | open base | | open collector | |
|---|---|---|---|---|---|---|
| n-p-n | emitter | ↑ | emitter | 0 | emitter | ↓ |
| | base | ↑ | base | 0 | base | ↓ |
| | collector | ↑ | collector | ↑ | collector | ↓ |
| p-n-p | emitter | ↓ | emitter | ↑ | emitter | ↑ |
| | base | ↓ | base | ↑ | base | ↑ |
| | collector | 0 | collector | 0 | collector | ↑ |

↑ = higher-than-normal voltage ↓ = lower-than-normal voltage 0 = zero voltage

*"Higher-than-normal" means voltage has risen toward potential of ungrounded battery terminal; "Lower-than-normal", voltage has fallen toward 0 (potential of grounded battery terminal with respect to ground).*

## Making Estimates Worries Many Servicers

"I ONLY WANT YOU TO LOOK AT MY SET and tell me what it will cost to fix it. I think it's just a tube."

So begins a thoughtful article in the Seattle TSA *Service News*. "If you give the customer an off-hand guesstimate," continues the article, "too often you find that the customer thinks you have given him a firm bid for a complete overhaul with an unlimited guarantee."

On the other hand, writes the author, if you take the time to pull the set apart, troubleshoot it and ultimately come up with some genuine but not obvious troubles, the customer may very well take his work elsewhere, and tell you that it's outrageous to charge him "just to look at it."

One suggested way out is that the customer isn't really interested, often, in knowing *exactly* what the charge will be. More likely, he wants to know whether it is going to $10 or $50 or $100, so he can budget the coming weeks accordingly.

Tell the customer that you're more interested in getting the set fixed *right* than in giving him an exact figure in advance, one you'll feel bound to meet even at the sacrifice of some necessary work to the set.

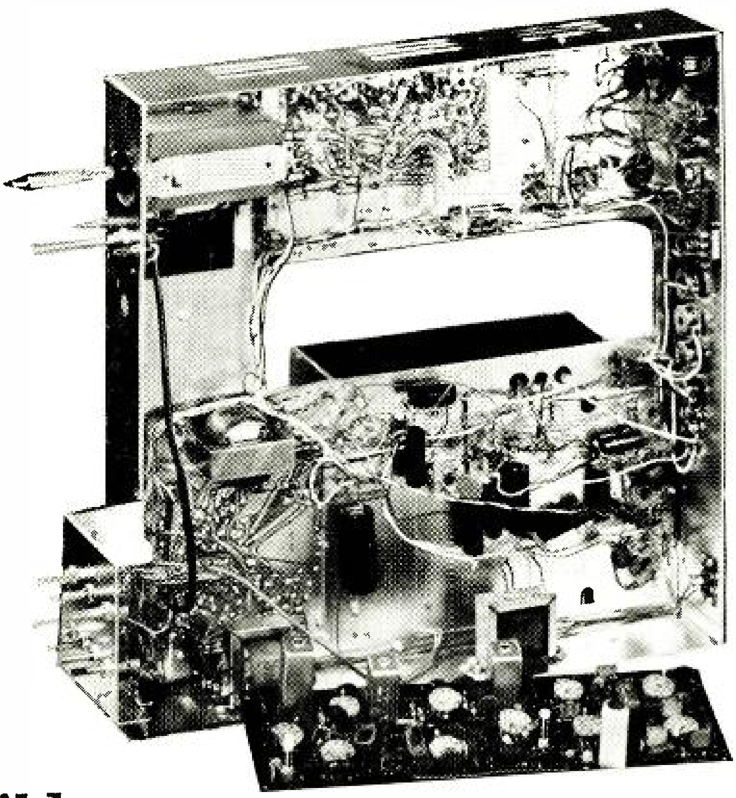
If the set isn't worth repairing, in your opinion, tell the customer so. If you realize it needs a new picture tube, tell him. Remember, too, that recent sets usually develop just one trouble at a time. Older sets are likely to give way in several spots, and to have some weak or about-to-break-down parts as well.

If the customer wants a rockbottom price just to get the set going, make him understand that you will not guarantee it. The author advises staying away from that kind of repair altogether.

The writer, with a deliciously nervy sense of humor, has decided to fight back. A customer came in with a set, requesting the technician to "just look at it." The technician did—just that. Just looked at it.

"Or take the customer with the little $9.95 squawker box. He wants an estimate because he doesn't want to spend very much. Try smiling and saying, 'Well, now, these seldom run over $40 for a good repair.' You will certainly get his attention." END

**Cover Story**



OUR EDITORIAL REVIEWER FINDS THIS SET A TERRIFIC IMPROVEMENT OVER OLDER ONES. FUN TO BUILD AND EASY TO ADJUST, TOO.

## Field-Day For Kit Builders:

# DO-IT-YOURSELF COLOR TV

HAVING BEEN THE OWNER OF ONE OF the first 21-inch color TV sets since 1956, I was curious when Heath announced their color TV kit. I decided that putting one together would make an interesting story, particularly since I had a basis of comparison in the 1956 receiver.

Assembly was no more difficult than any other kit—just more of it. The instruction book is a story in itself—all 16 ounces of it. Not content with giving step-by-step assembly, adjustment, operating and service instructions, Heath included 16 pages on the fundamentals of TV theory—both black-and-white and color. And there are eight pages of full-color photos of the picture-tube screen showing correct and incorrect color purity, convergence and color adjustments, as well as various defects, to aid in troubleshooting.

A considerable part of the kit is supplied preassembled. The front end and the video i.f. strip are factory-wired and aligned, with tubes already installed. The horizontal output stage and associated high-voltage rectifiers are prewired and assembled in a cage; the dynamic convergence control board is also furnished preassembled.

The builder must assemble two printed board assemblies: the sound–sync board and the color circuit board (the most complex). Then he must mount all circuit boards, miscellaneous transformers, chokes, controls and other parts on the chassis and interconnect them. A preformed and precut cable assembly is furnished which takes care of a large part of the interconnecting of circuit boards. I had a moment's difficulty figuring out which end of the cable assembly went where. But careful study of one of the many pictorials solved the problem.

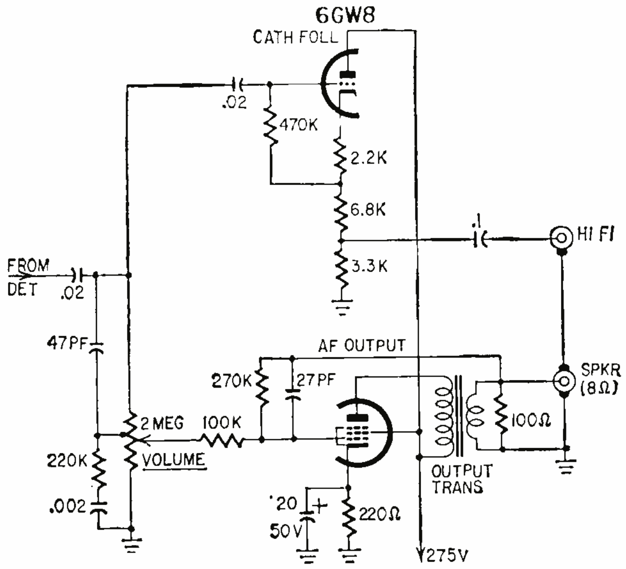



*Fig. 1—Unusual audio circuit in Heath GR-53 has two independent outputs. One is medium-impedance cathode follower for feeding hi-fi system; other output supplies up to 2 watts to 8-ohm speaker at low distortion. Note loudness compensation on volume control. Control does not affect hi-fi output—it works only on speaker portion. Treble-cut tone control circuit is omitted from this figure.*

The step-by-step instructions were most complete and precise. Finally, after 34 hours (the instruction book says it can be done in 25 hours, but I took my time) I had all wiring completed, the chassis and picture tube degaussed. (A degaussing coil is furnished—it gets its power from the 6.3-volt heater winding on the power transformer.) I made the few precautionary checks suggested in the manual and turned the set on expectantly.

No sound, no raster! Then I noticed that the horizontal output tube's plate was cherry-red. No drive on the grid! A voltage check showed no B-plus on the horizontal oscillator tube. Tracing back from the rectifier to the horizontal oscillator, I found the trouble: the B-plus lead to the sound sync board was loose. A cold-soldered joint (sob)! After re-soldering, I turned on the set again. This time picture and sound came forth. I was ready for the adjustments for color purity and convergence.

The purity adjustments proved to be quite simple. The next step was *static* convergence (at the center of the raster). This, too, was not a very difficult operation. Heath thoughtfully built into the set its own dot generator! A slide switch on the color circuit board puts it into operation. In addition, two clip leads soldered to the chassis make it a cinch to blank out one of the color beams to check convergence of any two guns.

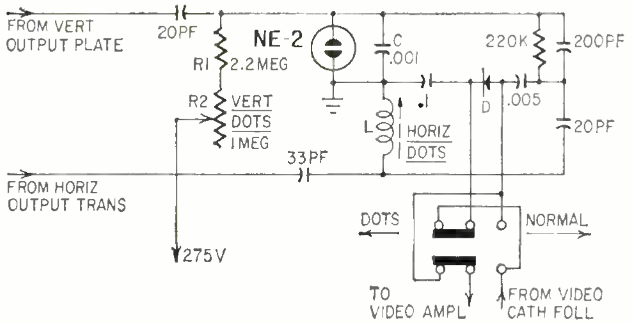
After completing the static convergence I paused to admire my handiwork. I was startled to note that although I hadn't started the *dynamic* convergence adjustments, convergence across the whole face of the tube was far better than our 8-year-old factory-built color set had ever been capable of, even after several hours of static *and* dynamic convergence adjustments!

Next, I tackled dynamic convergence. This was more involved, but again the instructions were so simple that the job was not too difficult. The final result was excellent convergence except at the extreme edges of the picture. At normal viewing distance even this slight misconvergence disappears and there is no evidence of color fringing (an annoying feature of the 1956 set). Purity and convergence adjustments took 3 hours and 20 minutes. (A repeat performance several weeks later took only about an hour because of familiarity with the adjustments.)

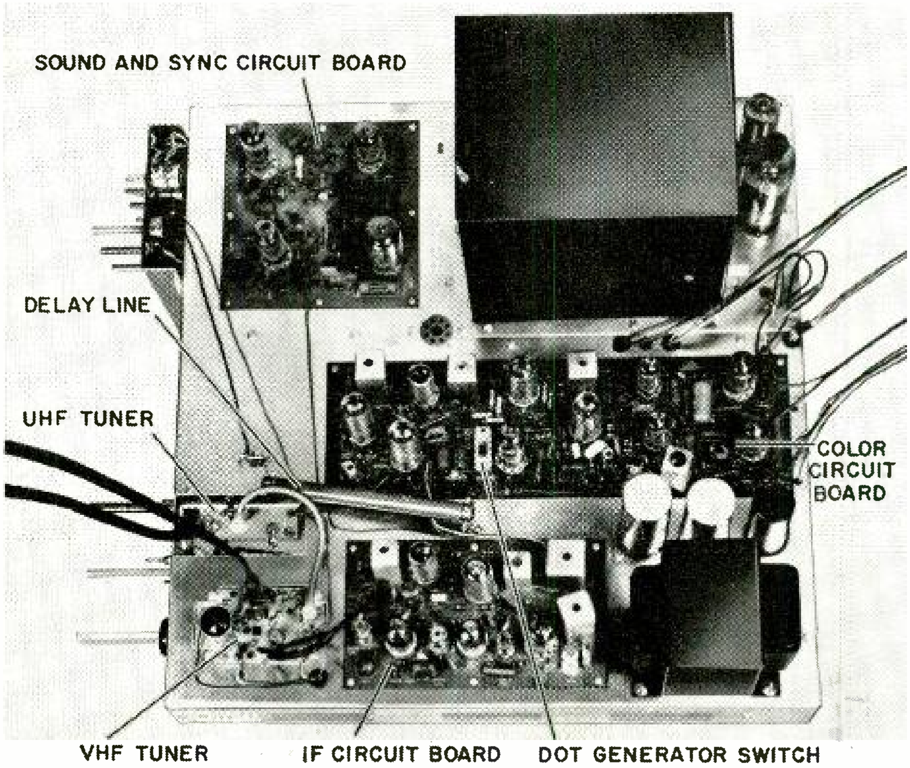
Expectantly, I tuned in a color program. No color! Acting on a hunch (and experience with the old color set) I replaced the 3.58-mc color oscillator tube (a 6GH8). That did it. The color came in. Next I touched up the color sync adjustment, following the service instructions in the book. (It can be done without instruments.) This done, color sync was stable as a rock, whether the receiver was just turned on or after several hours of operation.

Heath says that if width is insufficient (I didn't have this trouble), usually if line voltage is low, adding a 130-pf 6-kv ceramic capacitor across the horizontal yoke will give an inch more width. The capacitor can be mounted above or below the chassis.

*Fig. 2—Circuit of built-in dot generator for convergence adjustments is described in detail in article. It can be switched in at any time once set is in operation.*




*Completed Heath color TV chassis ready for connection to 21FJP22 picture tube and installation in cabinet or custom mounting.*




**The circuit**

The set uses RCA's high-voltage and sweep-convergence circuits as well as their color demodulator. Other circuits are Heath-designed but similar to those in the de luxe models of other set manufacturers. The vhf front end uses a turret tuner with a neutralized triode (nuvistor) rf stage. (Sets made after April 30 include an all-transistor uhf tuner as well.) The video i.f. amplifier has 3 stages. Video detector is a 1N295. A separate 1N295 serves as sync and sound detector followed by a combined sound i.f. and sync amplifier. A second sound i.f. feeds a locked-oscillator FM detector.

The audio system (Fig. 1) has two separate outputs. The first uses the triode half of a 6GW8 as a cathode follower. The output of this stage goes to a phono jack on the rear of the chassis for connection to your high-fidelity system. Output level is 2 volts maximum with less than 1% harmonic distortion and ±1 db response from 50 to 15,000 cycles. Output impedance is 3,000 ohms.

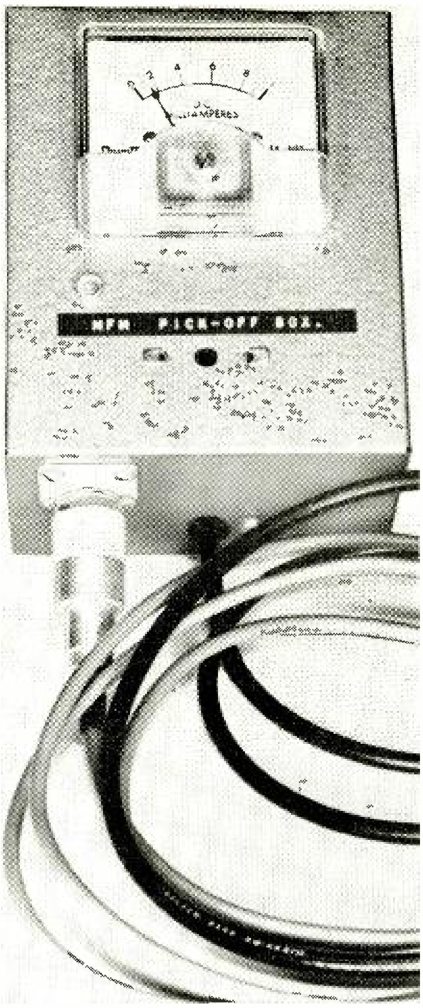
The pentode half of the 6GW8 is used as a conventional sound output stage. About 10 db of negative feedback from plate to grid reduces distortion and flattens frequency response. The stage supplies 2 watts into 8 ohms at less than 3% harmonic distortion. Response is ±2 db from 50 to 15,000 cycles. Using the oval speaker supplied with the console cabinet sound is vastly better than in most console TV's. With an external hi-fi system sound is limited only by the quality of the broadcast or the hi-fi system.

An extra stage of color amplification is provided. This stage has an agc voltage applied to it (derived from the color burst) for automatic color control.

### Color dot generator

The built-in dot generator circuit is shown in Fig. 2. R1 and R2 together, C and the NE-2 form a relaxation oscillator. R2, the VERTICAL DOTS control, varies the voltage applied to C as a way of controlling frequency. Oscillations are synced to a multiple of the vertical sweep frequency and applied to diode D. Coil L, the HORIZONTAL DOTS coil, is tuned to a multiple of the 15,750-cycle horizontal retrace frequency. It generates a chain of pulses when the retrace pulse shock-excites it. The pulses are mixed with the relaxation oscillator pulses and applied to D, which is biased so that only pulse tips are passed to the grid of the video amplifier. The VERTICAL DOTS control varies the number of *horizontal rows* of dots displayed on the picture tube. Changing the inductance of the HORIZONTAL DOTS coil L varies the number of *vertical columns* of dots. The dot generator output is fed to the grid of the video amplifier through a dpdt slide switch.

After using the set for several weeks, I can report that color and black-and-white reception is excellent, and tuning for color is noncritical. Convergence and color balance do not drift—in marked contrast to the 8-year old color set. Color TV has come a long way in those 8 years. The only remaining problem is the variable quality of the transmission from some stations. But then, we've had that trouble with black-and-white TV (and with radio, too) all these years! END




# PICK-OFF BOX & WATTMETER FOR CB

**Make transceiver power and frequency checks without creating interference**

BY LYMAN E. GREENLEE

**Servicing CB transceivers is now important business. But to make the frequency and power checks the FCC requires, you need specialized equipment. As channels become more and more crowded, you must limit on-the-air checks to an absolute minimum. Throwing a carrier on the air for frequency or power measurements is extremely annoying to all stations in the vicinity. The Pick-Off Box was designed to let you pick off a signal for frequency measurement or receiver checking without putting a carrier on the air. The cost of the Pick-Off Box and Wattmeter is so little in time and materials that no one who services any CB equipment can afford to be without it.**

It was designed primarily to feed a signal to a frequency meter such as the Lampkin MFM (Micrometer Frequency Meter). About 3.5 watts rf input is required for a full-scale meter reading, and the Pick-Off provides just the right amount of output to beat with the MFM for an accurate frequency check.

If an accurate rf wattmeter is handy, you can set the 0–1 milliammeter for 3.5 watts rf full scale by adjusting the 5,000-ohm pot, R3. Otherwise, simply set R3 at half scale (2,500 ohms). The meter indication is useful for checking transmitter tuning and crystal activity as you make frequency measurements for the various channels, regardless of whether it is accurately calibrated in rf watts.

Radiation is so low that interference with other CB equipment on the same channel is negligible.

The block diagram (Fig. 1) shows the setup for making frequency measurements. The transceiver under test is coupled to the box through a short length of coaxial cable terminated with a standard Amphenol connector. For the pickoff for the MFM, a length of shielded microphone cable is terminated in a phone tip at one end and an Amphenol connector at the other.

Besides the MFM and Pick-Off Box, you will need an all-wave receiver that will tune to WWV. The antenna may be coupled direct to the MFM, using a small capacitor ($C_x$) of around 10 pf. $C_x$ should be chosen to give a clear zero beat with the micrometer frequency meter without overloading the receiver's avc system.

After the equipment has warmed up thoroughly, set the MFM trimmer to zero-beat with WWV, and return the all-wave receiver to standby. Key the CB transceiver, note the power output

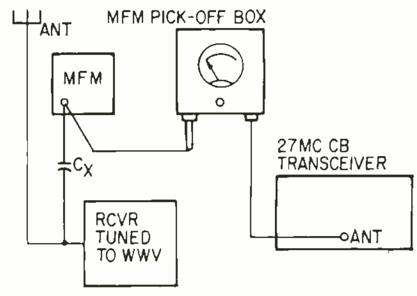



*Fig. 1—Setup for measuring frequency with Lampkin MFM and Pick-Off Box.*

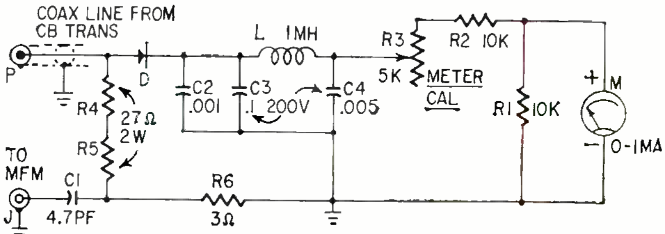



*Fig. 2—Circuit of the Pick-Off Box.*

and tune each channel to zero-beat with the MFM, noting the dial reading for each crystal. Calculate deviation from the chart supplied with the MFM for each channel. A weak crystal will show up immediately because the rf output read on the meter will be noticeably lower than on other channels.

Using a transmitter for receiver alignment is easy with the Pick-Off Box. Couple the transceiver being aligned through the box to another transceiver. The Pick-Off will provide an attenuated signal to the receiver, which can then be aligned to exactly the frequency of the transmitter. This type of alignment is important with fixed-tuned units. Each channel can be adjusted precisely to the frequency of the transmitter it is to receive, rather than to that of a test oscillator or frequency meter, which might be off-frequency compared to the transmitter. This alignment will insure maximum signal transfer between two units.

After one receiver is aligned for all channels for which crystals are available, reverse the procedure and align the other receiver by using the transmitter (of the transceiver already aligned) as a signal source. One of the biggest headaches with fixed-tuned transceivers is that they must be precisely tuned, and good reception is impossible if either the transmitter or receiver is off frequency.

Obviously, it's better to tune the receiver exactly to the transmitter frequency than to set it precisely on the correct channel frequency, since the transmitter crystal may be either plus or minus as much as .005% and still be within FCC tolerances. If we had a transmitter operating at plus .005% and we happened to tune the receiver to minus .005%, the total error would be .01% between the two units, and reception would be very poor if the receiver had a crystal filter. It always pays to check frequencies carefully if there is a complaint of poor, garbled, mushy reception between two fixed-tuned units. Most fixed-tuned receivers can be adjusted on each channel. If there is no such adjustment, change crystals in the receiver to match the transmitter frequency. Receiver crystals are often made to much broader tolerances than transmitting crystals, and it is usually possible to get the right one by careful selection.

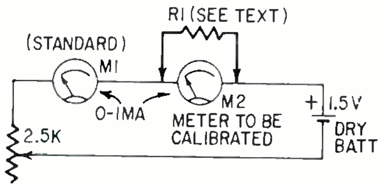
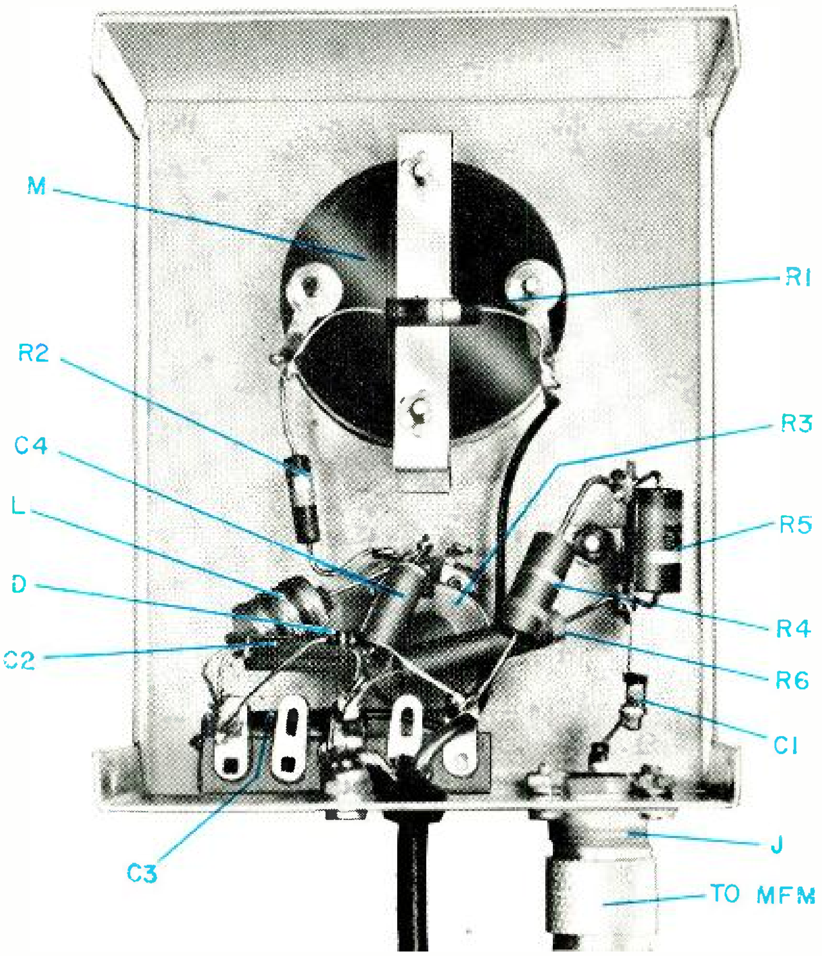



*Fig. 3—Meter calibrating circuit.*

*Wiring the Pick-Off Box is a quick job.*

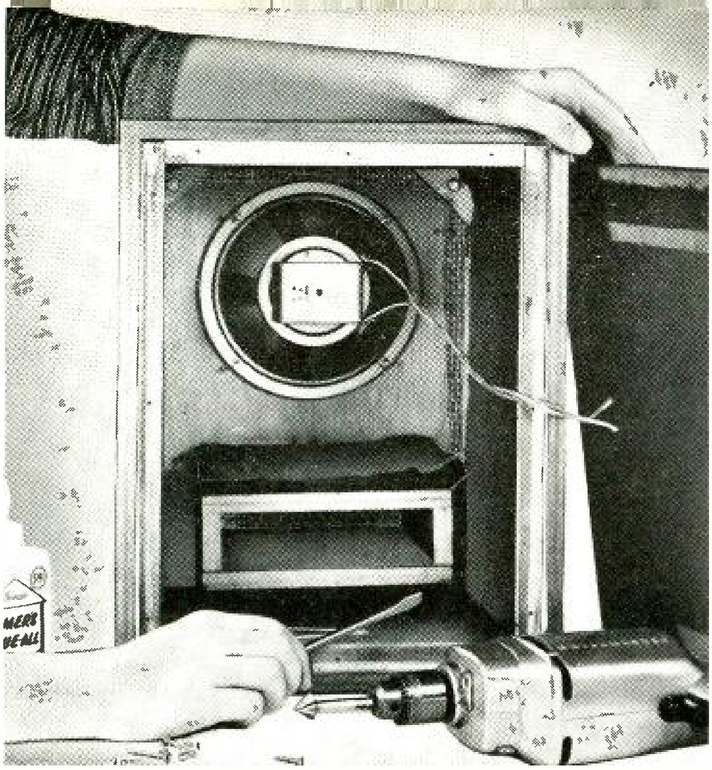



### Construction notes

Fig. 2 shows the wiring diagram of the Wattmeter and Pick-Off. R1 is used to make the Shurite meter read 1 ma full scale (the one I used read high). A more expensive 0–1 ma meter could be used, but this one is cheap, rugged and accurate enough. Check the meter by connecting it in series with an accurate 0–1 ma meter, a flashlight cell and 2,000-ohm rheostat. Choose a value for R1 that makes both meters read the same. R2 and R3 serve as limiting and calibrating resistors so that the meter will read about 3.5 watts rf with R3 set at half scale or 2,500 ohms. R3 may be set at its halfway position or adjusted to give a full-scale meter reading with 3.5 watts rf input if an accurate rf wattmeter is available for comparison.

The rf signal from the CB transceiver is fed through a length of RG-58A/U cable to the load resistor, made up of R4, R5 and R6 in series. Total resistance of this combination will be 56 to 57 ohms. A small portion of the signal is picked off through C1 from the top end of R6 while diode D rectifies part of the remainder and feeds it through the filter, L, C2, C3 and C4.

Construction should pose no problems. Everything fits neatly into the aluminum box, with room to spare. Layout is not critical, but keep all leads short, return rf grounds to a common point, and follow as closely as possible the parts arrangement shown in the photo of the interior of the instrument. There will be some radiation from the box, but not enough to cause objectionable interference. Ordinary microphone cable is adequate for the pickoff lead to the frequency meter. Strip the shield back about ¾ inch from the phone tip used to connect to the MFM antenna jack. Cable length is not critical. END



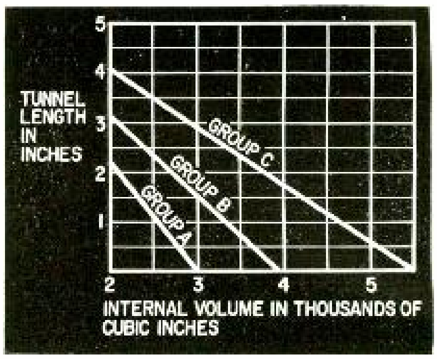



*FIG. 2—Tunnel (duct) length for small enclosures with 10-square-inch port opening. Lengths on chart are measured from back of baffleboard. Thus, with a ¾-inch front panel (baffle), actual duct length is ¾ inch longer than figure given. This has been allowed for in making chart. (Length shown does* not *include baffle thickness.)*

# DESIGN YOUR OWN SPEAKER ENCLOSURE

By GEORGE L. AUGSPURGER

FOLLOW THESE RULES AND YOU'RE SURE TO GET THE BEST FROM ANY HI-FI SPEAKER.

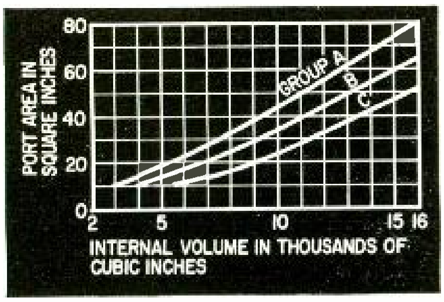
YOU HAVE A HALFWAY DECENT SPEAKER and want to build an enclosure for the basement playroom. So far as audio test equipment goes, you have an ordinary vom and that's about it. What do you do?

Naturally, if the speaker is made by a well known manufacturer, you will write direct to the company for its recommendations. If it is an obscure imported model, or if you don't know who made it, you can still go ahead.

### Find out what you can

What is the speaker diameter? Speaker diameter refers to overall frame size, not actual radiating area of the cone. If it is an oval speaker, assume it equivalent to the standard size which falls somewhere between the maximum and minimum diameters.

*Fig. 1—Port area vs enclosure volume for the three kinds of speakers described in the text.*




Second, determine the impedance. If it is not marked, measure the dc resistance with an ohmmeter and then double it for a rule-of-thumb impedance rating. There is very little chance that the figure will happen to be exactly 4, 8 or 16 ohms, but choose the one that comes closest as the nominal impedance of the speaker.

To make a reasonable estimate of what size enclosure will work best with a given speaker, we must place it in one of three groups:

(*a*) *Light cone/stiff suspension.* If the cone seems to be pretty thin and doesn't move easily when you touch it, the speaker probably belongs in this group. The great majority of PA speakers and auto speakers do.

(*b*) *Light cone/floppy suspension.* A good number of the bargain high-fidelity speakers, especially the imported units, have cones that move very easily. The outer edge of the cone may be treated with some kind of sticky substance to make it more flexible. If you hold the speaker up to a light. you may see that the outer edge of the cone is much thinner than the rest.

(*c*) *Heavy cone.* If the cone seems to be considerably thicker than a sheet of ordinary writing paper—more like a blotter. for example—and it is fairly soft, then the speaker is probably designed as a woofer.

In any case, hook the speaker up and listen to it before you start work. Without an enclosure, bass will be pretty weak, but you can get an idea of the mid-range and treble response. If highs are crisp and clean, there is no point in adding a tweeter unless you are willing to pay for a good unit. On the other hand, if the speaker sounds "mellow" and somewhat muffled, it won't be much good for anything but background music unless you add a tweeter. In this instance, a less expensive cone tweeter may be satisfactory.

### Enclosure volume and dimensions

The internal volume of the finished box is important. The table next to Fig. 5 at the bottom of page 46 gives the minimum volume needed if you expect to extend bass response to the limits of the speaker itself. If you want to make a smaller cabinet and are willing to sacrifice some bass efficiency, it also tells you the minimum volume that can be expected to give pleasing sound.

Although some engineers have certain proportions they like to use in designing enclosures, there is no one magic formula for superior results. The main idea is to keep the cabinet interior from setting up strong resonances at certain frequencies. *To be safe, no dimension should be more than three times any other dimension.*

At this point you run into the struggle between acoustics and decor. An enclosure with only 2 cubic feet of internal volume is still a sizable object, and you may find that it *must* be squashed into an awkward shape to get

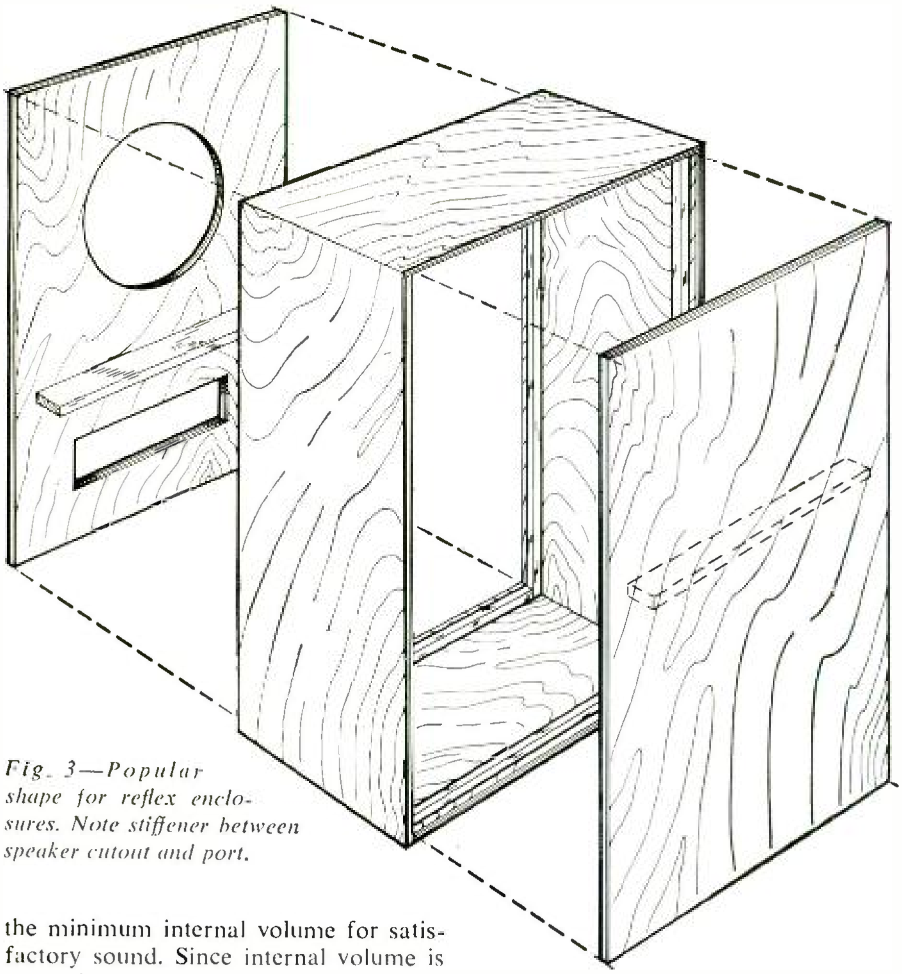


*Fig. 3—Popular shape for reflex enclosures. Note stiffener between speaker cutout and port.*

the minimum internal volume for satisfactory sound. Since internal volume is more important than proportions, go ahead anyway. A little farther on, we will take up these "problem cases" and show what can be done to make them perform almost as well as the more usual configurations.

You will have to juggle dimensions until you arrive at a set of figures to fit into the available space, yet allow adequate internal volume to work with the speaker you plan to install. Then lay out the baffleboard. A cutout must be provided for the speaker, for the tweeter (if you use one) and for the port.

### Port size

"Aha!" you say. "But suppose I don't want to build a ported enclosure?"

Well, if you want to follow my suggestions, you have no choice. I've probably played with as many wild enclosure designs as any other audio nut, and I am convinced that for safe, predictable results from a variety of speakers, the ported enclosure is the best bet.

"All right," you reply, "but then I will need to know the cone resonance of the speaker, and the radiating area of the cone, and the formula for critical damping, and how to tune the port, and all that."

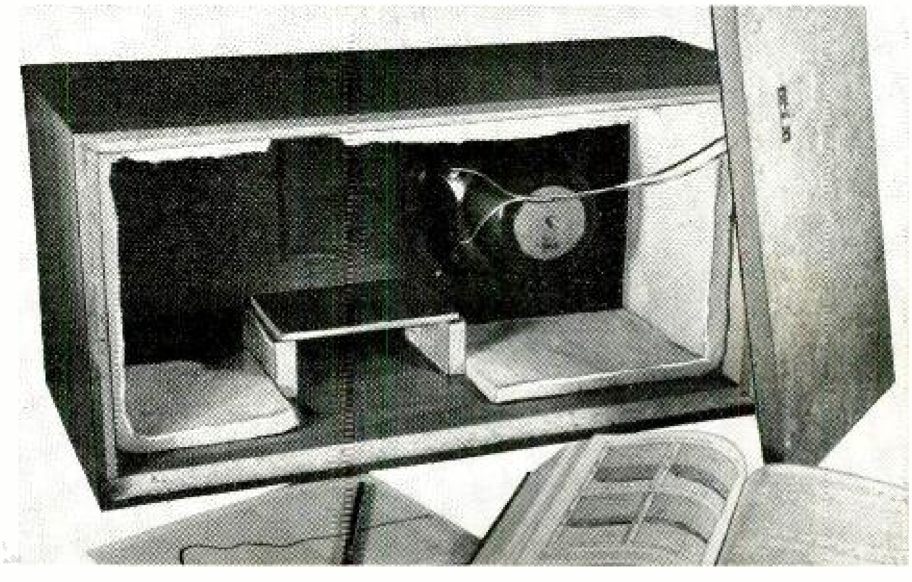
No, you will not. The term "reflex" has purposely been avoided since it implies a certain type of ported enclosure. But a lot of the bugaboos about "boom boxes" and tuning the system with clicks and bongs are pure mythology. So long as you observe the precautions sprinkled through this discussion, the completed project will work almost as well as if you had all sorts of professional test gear. Not quite as well, perhaps, but your chances are at least as good as if you spend a lot of time playing test recordings and blowing smoke into the port.

Refer to the three curves in Fig. 1. Find the recommended port size for the speaker you wish to use and the cabinet volume selected from the table. The shape and position of the port are not particularly important but, again, its dimensions should not exceed the 3-to-1 ratio. If the idea appeals to you, you may even make a "distributed port" by drilling a number of holes in the front panel so that their combined area adds up to the suggested value. The individual holes should be at least ¾ inch in diameter if the arrangement is to operate the same as a single large port opening.

If you are building a small bookshelf enclosure, the port area may become so small that it will not radiate sound effectively. The minimum area of a port is about 10 square inches. Rather than make the opening any smaller, we must add a tube or tunnel to the port to tune the enclosure properly. Fig. 2 suggests the best tunnel length. It is possible to use tunnels with larger ports, but this involves additional complications. For a nice, simple predictable design, the large ducted port offers no real advantage, so we will just ignore it.

### Baffleboard layout

Except for the problem cases to be mentioned later, the speaker will perform the same no matter where it is located on the front panel. It is a good idea to have the source of sound somewhere near ear level, so the speaker should be near the top of the panel if the cabinet is going to be set on the floor. If you plan to use a tweeter, this gets priority, and the main speaker is then



*This Lafayette "Mini-Duct" enclosure, used with a Lafayette SK-98 8-inch speaker, puts out some fine sound. Simple duct structure on floor of cabinet can be modified to suit various speaker resonant frequencies. Radiotron Designers Handbook (Fourth Edition, 1952) gives much valuable data, formulas, charts, etc., to assist you in designing or modifying an enclosure.*

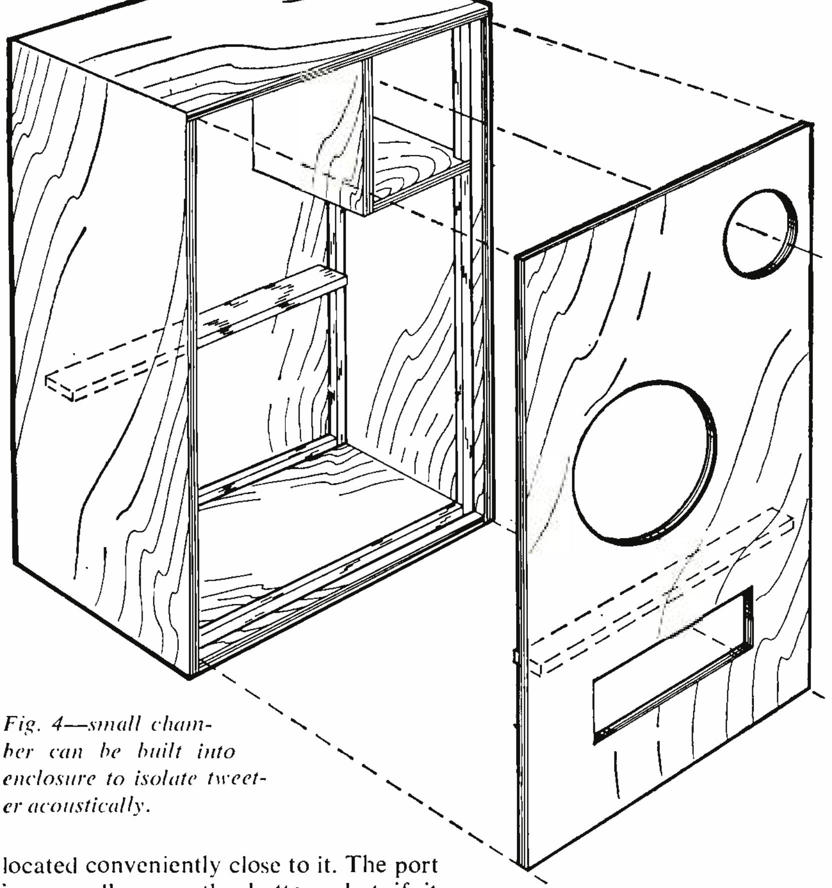


*Fig. 4—small chamber can be built into enclosure to isolate tweeter acoustically.*

located conveniently close to it. The port is generally near the bottom, but if it has to go somewhere else, don't worry about it.

Fig. 3 shows a popular configuration, established when the reflex enclosure came into general use. Symmetrical and easy to lay out, it works well. Note the stiffener across the baffleboard between speaker cutout and port. This braces the panel and at the same time gives a little acoustic isolation between the edge of the speaker cone and the port. If you can incorporate such a stiffener into your design, it is a good idea. Whether it is there or not, the port and the speaker should be no closer than 2 inches, and no more than 6 inches apart, approximately.

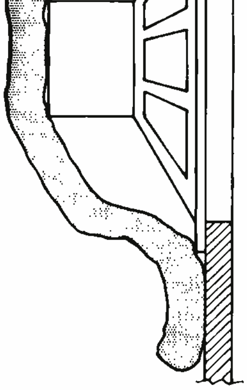


*Fig. 5—Layer of absorptive material across back of speaker sometimes controls "boom".*

A brief warning about the tweeter: You cannot take an ordinary 4-inch speaker and mount it in the same chamber with the main speaker. The two cones will be pneumatically short-circuited. Many small units designed specifically as tweeters are completely sealed, and in this case there is no problem. But if the one you choose is not, it must be installed in a separate little chamber within the main enclosure, as in Fig. 4. It should be completely lined with absorptive material, and the volume occupied by this little isolation chamber must be subtracted from the total cabinet volume when working out the port size.

### Bracing

A good loudspeaker enclosure *must* be as rigid as possible. Enclosures with thin unbraced panels may sound quite distinctive, perhaps even pleasing. But, unless you are a gifted craftsman, willing to spend as much time on a speaker cabinet as you would in building a violin, it is much better to make sure that the enclosure does not add distinctive coloration to reproduced sound.

You can sometimes get by with little internal bracing if you use thick panels. But to be on the safe side, a brace should be added to any surface larger than 18 inches square. The easiest way to brace a panel is to glue and screw a piece of 1 x 3 on edge across the narrow dimension of the panel. The enclosure in Fig. 3, for example, has braces across the front and back panels. Since the cabinet is assumed to be less than 18 inches deep, no bracing is required on the remaining four surfaces.

As a final test, check the panels for rigidity when the enclosure is finished. Pound on them with the heel of your hand. If there is a strong "kettledrum" sound, better add another interior brace or two. The more solid the enclosure, the firmer and crisper the bass response will be.

### Padding

The only thing padding does is to absorb mid-range sound that would otherwise bounce around inside the enclosure and finally be reflected out through the port opening or the speaker cone itself.

The padding material should be at least ¾ inch thick, reasonably soft and fluffy. Several products available from most hi-fi dealers are specially formulated and packaged for this purpose. Scraps of ordinary felt rug padding are often used and work very well.

Padding does not have to be neat, it does not have to be fastened tightly to the interior surfaces, it does not have to cover any specific areas. Generally, the less padding used, the more "live" the sound. An accepted rule is to pad about half the interior surface area and arrange to have an unpadded wall always face a padded wall. For example, a good starting point is to pad the back, bottom and one side of the enclosure. Padding can be loosely tacked to the enclosure walls with upholstery nails, staples or large carpet tacks. Insulated wiring staples are easy to use and do a good job.

Whatever you do, don't put a layer of padding across the port opening. Some sophisticated variations of the ported cabinet do use that kind of resistive loading across part of the opening, but they are designed for use with specific speak-

**MINIMUM ENCLOSURE VOLUME (IN CUBIC INCHES)**

| Speaker group | Speaker diameter (inches) 8 | 10 | 12 | 15 |
|---|---|---|---|---|
| A Light and Stiff | 4,300 | 6,000 | 8,200 | 10,100 |
| | 2,100 | 2,900 | 4,000 | 5,200 |
| B Light and Floppy | 4,100 | 5,700 | 7,600 | 9,500 |
| | 2,100 | 2,700 | 3,600 | 4,800 |
| C Heavy | 4,000 | 5,200 | 6,900 | 8,600 |
| | 2,100 | 2,600 | 3,300 | 4,300 |

Upper figure in each entry is minimum internal volume for optimum bass; lower figure is minimum for acceptable overall performance.

ers. From time to time, articles suggest that two or three layers of old cheesecloth across the port will damp out the "reflex boom". The only trouble with this idea is that it doesn't work, as can be demonstrated quite readily by blocking the port altogether. If the system boomed in the first place, chances are that the boom is still there when it is changed to a completely closed cabinet.

When such boominess does occur, it may be because of room acoustics, a cabinet too small or not sufficiently rigid, or a speaker which has a poor coupling coefficient. In some cases, the boom can be controlled by tacking a layer of padding across the back of the loudspeaker (Fig. 5).

### Installing speakers

Remember that you will have to make one panel of the enclosure demountable for installing speaker components. Usually the back panel is removable, but if the enclosure is to be permanently hung or built-in, then the front panel is a more practical choice. The demountable panel should be held in place by screws spaced every 4 or 5 inches around the perimeter and screwed into wood strips glued in place on the top, bottom and sides of the interior.

Although small speakers can be held in place with wood screws, machine screws make a neater job and simplify removing and reinstalling the speaker if this should ever be necessary. Machine screws can be used with matching nuts and washers, or screwed into T-nuts inserted from the opposite side of the panel. T-nuts can be purchased from most large hardware stores.

Connecting wires can be brought out through small holes in the back, or you can use screw terminals or a phone jack. A little extra time and thought here can save a lot of inconvenience when you hook up the system. Do *not* use ordinary ac connectors. If you do, sooner or later someone will plug the speaker into a wall outlet.

### Grille cloth

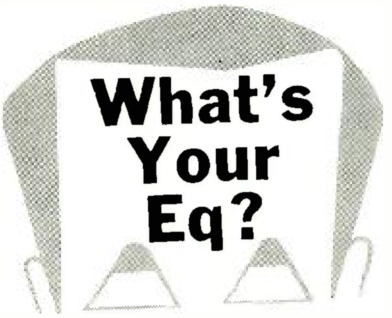
I have purposely avoided any suggestions of styling or furniture finishing because that would require a treatise in itself. If you want to do a complete construction and finishing job, see Jeff Markell's book *Designing and Building Hi-Fi Furniture*, Gernsback Library. A simple and attractive grille can be made by constructing a frame which comes flush with the edges of the cabinet, and stretching grille fabric over it. The frame can be held in place by decorative screws, dowel pins or friction catches.

As to the grille fabric, there are a number of colors and patterns available in synthetic materials made for this specific purpose. Most hi-fi dealers carry them. If you want something really distinctive, look for fabrics in the yard-goods department or the drapery counter of a department store. Choose a fairly hard (as opposed to fluffy), open-weave material (easy to blow through). Heavy upholstery fabrics or thick soft materials will absorb most of the high frequencies and make the system sound muffled.

The wooden panel behind the grille cloth should be painted a dull flat black so that it will not be visible. Fabric should be spaced 1/8 inch or so away from the panel to help keep the cutouts from showing through. If the material is so open that it is easy to see through, back it with a second layer of black sheer rayon or silk to make the grille opaque.

### Performance

Remember that room acoustics will affect the performance of the system almost as much as the speakers themselves. Don't place the speakers so that there are large pieces of furniture in the path of the sound. If you have two systems hooked up to a stereo source, place the cabinets so that a listener sees an angle of about 40° between the two sound sources. Don't be afraid to experiment with speaker placement for optimum results. END




**Conducted by**
**E. D. CLARK**

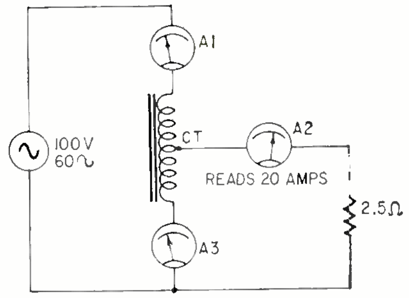
Two puzzlers for the students, theoretician and practical man. Simple? Double-check your answers before you say you've solved them. If you have an interesting or unusual puzzle (with an answer) send it to us. We will pay $10 for each one accepted. We're especially interested in service stinkers or engineering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

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

**Answers to this month's puzzles are on page 60.**

## Autotransformer

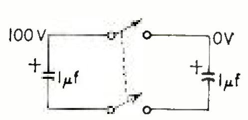
Can you determine the reading on ammeter A1 and ammeter A3?—*Kendall Collins*




## Case of the Lost Energy

Here's a capacitor problem to test your ability in analyzing "simple" circuits:

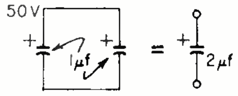
Two one-mike capacitors, and a switch connecting them. The left capacitor has been charged up to 100 volts; the right one is unchanged. The switch is then closed.




Since we have not changed the total amount of charge, and since the theory book tells us that:

Charge = Farads × Volts ($Q = CE$)

the left capacitor will lose half of its charge to the right one. The voltage will now be 50, since the capacitance has doubled. The circuit now consists of a 2-μf capacitor charged to a potential of 50 volts.




So far, so good. Now once again, we refer to our theory book and find the formula for the energy stored in a capacitor:

$$\text{Energy} = \tfrac{1}{2} \times \text{Farads} \times \text{Volts}^2$$

Let's try some numbers:

Originally,

$$\text{Energy} = \tfrac{1}{2} \times 1\ \mu f \times 100^2 + \tfrac{1}{2} \times 1\ \mu f \times 0^2 = 2{,}500\ \mu\text{Joules} = .005\ \text{Joule}$$

Finally,

$$\text{Energy} = \tfrac{1}{2} \times 2\ \mu f \times 50^2 = 2{,}500\ \mu\text{Joule} = .0025\ \text{Joule!}$$

We lost half the energy when we threw the switch! But a capacitor can only store energy, not dissipate it. Also, our theory book is a firm believer in conservation of energy.

Now then, simply, the problem: *Where did the energy go?*

(Assume that the switch is perfect.)
—*Donald E. Lancaster*

# MORE ON MULTIPLEX VIDEO

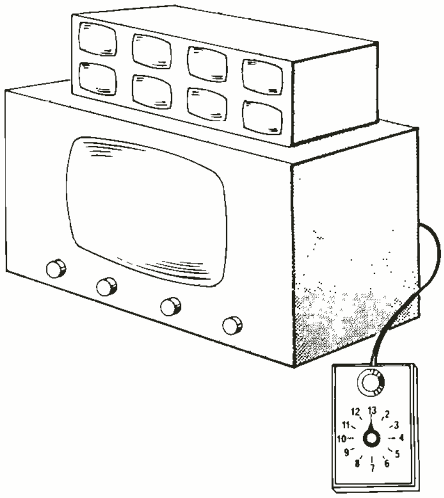
THE EDITORIAL "MULTIPLEX VIDEO" IN the March issue aroused considerable interest. One of the comments on it was simply a copy of Patent No. 3,079,462, issued to W. Rosenthal for a "Television Receiver with Picture Selector Device."

The patent, which was filed July 21, 1958, and issued February 26, 1963, showed a rather conventional-looking television set (see figure) with a box containing eight additional panels mounted on top of it, and what is obviously a control device on the end of a cable. The two parallel rows in the box above the set are small pilot cathode-ray picture tubes, with medium-persistence screens.

Pressing a button on the control starts a rotating switch which selects each channel's signal for a period of, say, ⅛ second. These signals are applied to the grids of video tubes in turn through a distributor. With a ⅛-second period for each tube, the tube would be scanned four times, and would receive an impression that would persist while the remaining screens were being scanned. Thus, four channels could be scanned in ½ second. If eight were scanned, the total period might be 1 second.

Circuitry is provided to transfer the picture on any one pilot screen to the main screen. This is one way of realizing the multiple video receiver described by Hugo Gernsback in the March editorial.

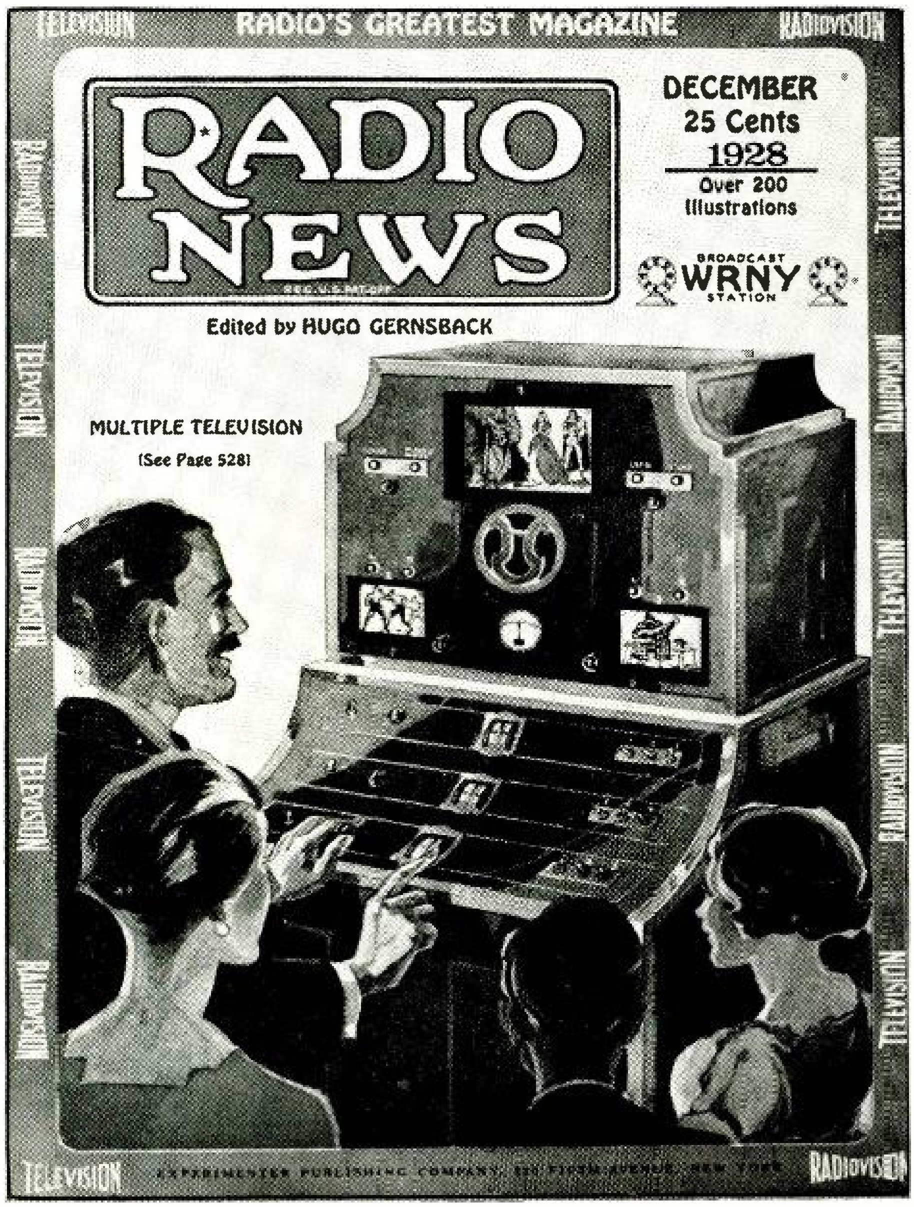
Two of the references cited by the Patent Office are "The Radio-Controlled Television Plane," *Television News*, March–April 1931, and "Multiple Television, a Forecast," *Radio News*, pp. 528–529, December 1928. Both of these references are to early articles by Gernsback.




*The set described in Pat. 3,079,462.*

The radio-controlled television plane (shown in the illustration opposite) was actually reprinted by *Television News* from Gernsback's publication, the *Experimenter* of November 1924, and was indeed a concept of multiple television equipment (probably the first such concept).

The plane would be unmanned and controlled completely with television cameras (called "electric eyes" in the article) pointing north, south, east,




*Set shown on the cover of Gernsback's* Radio News, *December 1928. The top screen is probably the first representation ever of a TV program in color.*

west, up and down. The signals from the unmanned plane would be transmitted to a ground station, where the control operator looking at the six screens would be able to observe the action around the plane and control it accordingly.

Thus, if the plane were equipped with guns, the control operator could maneuver it, as a fighter, to down an enemy plane, or, if supplied with bombs, to knock out a ground installation. With the six screens before his eyes at the same instant, the control operator would be able to see more than an aviator actually sitting in the cockpit.

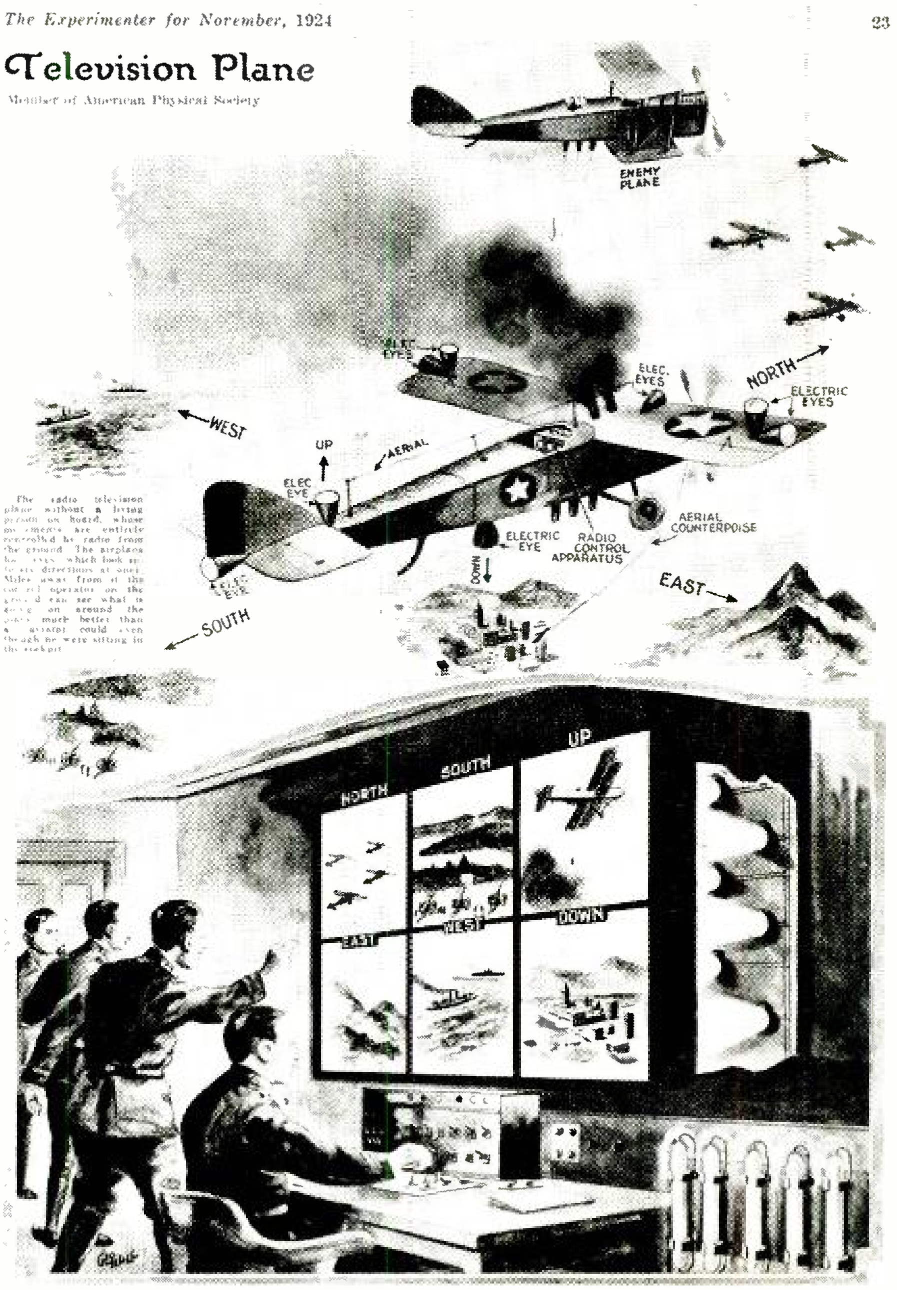
The second reference cited in the patent refers to an article printed in December 1928, after a few experimental television receivers had come into use. The reason for a multiple receiver was the same one given in the March 1964 "Multiple Video" editorial—the desirability of being able to see "what's doing" on several channels at a time.

The position of the screens on the multiple television receivers in the 1928 article is considerably different from that suggested in the 1964 editorial. The reason is that television in 1928 depended on a large rotating disc, perforated with a spiral of holes. Gernsback suggested that, instead of one spiral, the disc could have three sets: the large screen at the top would be scanned through one set of holes, and the two smaller ones at the base by two other sets, all at the same time. (This would be simultaneous, rather than sequential, television, as described in the more recent patent.)

Interestingly enough, the top screen in the set of the cover of *Radio News*, December 1928 (which was printed in four colors), is shown displaying its picture in full color. The smaller screens (labeled 2 and 3 on the cover) are in black-and-white.

Thus the wild dreams of the past come a little nearer to reality each time they are projected. The television plane of 1924 was described at a time when nothing existed that could really be described as television. The experiments of Francis Jenkins had succeeded in transmitting silhouettes, but there was no gradation of tone between black and white, and seldom were attempts at motion shown.

In 1928, TV sets of a type were in existence—the means for making a true television picture were known. In 1964, as Patent No. 3,079,462 and the "Multiple Video" editorial show, all the means for producing a true multiple television device are at hand. If a designer had a strong enough desire for such a TV receiver, he could have one in the time it would take to put it together. END



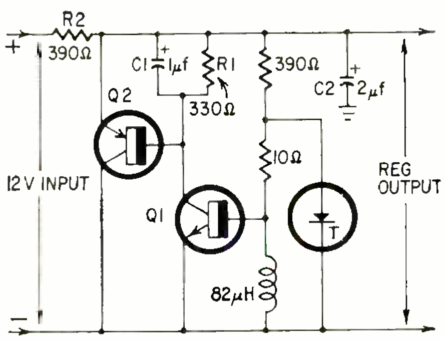

*The original multiple-screen television concept.*

## TUNNEL DIODE REGULATOR

HERE IS AN UNUSUAL APPLICATION FOR a tunnel diode. It regulates a dc supply and prevents the output from rising above a preset level, as disclosed in patent No. 3,108,218, assigned to International Business Machines Corp. Normally biased for positive resistance, the diode is stable. If the applied voltage rises for any reason, the bias is advanced to the region of negative resistance, and the diode oscillates.

During each positive alternation across the inductor, Q1 conducts. Its current flows through R1, C1, which smooth the pulses and deliver a forward bias to Q2 which also conducts.

A much larger current passes through Q2 than through Q1. In flowing through R2, it drops the voltage to normal and compensates for the undesirable increase.




C2 filters the regulated output. Suggested component values are for a 5-ma diode having a 5:1 peak-to-valley current ratio.—*I. Queen*

# SERVICING SPEEDLIGHTS

Their circuits have much in common; there's little to go wrong!

**By WAYNE LEMONS**

ELECTRONIC PHOTOFLASH UNITS HAVE been used by professional photographers for years, but when these units need service, nobody seems to want the job —sometimes not even the factory. *Yet almost any electronic technician is equipped to whip photoflash equipment back into shape and make himself a piece of change in the bargain.*

Nearly all speed lights (or strobe lights, as they are sometimes called) work on identical principles. A gas-filled flash tube has high voltage across it, but that alone does not fire the tube

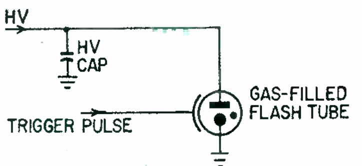



*Fig. 1—How a speedlight is fired. High voltage remains across tube at all times, but tube does not fire until triggered by pulse.*

until the tube is triggered with a voltage pulse. Fig. 1 shows the basic idea. The trigger pulse is fed to a small wire or clamp fastened around the outside of the flash tube. The trigger pulse momentarily ionizes the gas inside, just as rf ionizes the gas inside a small neon bulb held close to a strong rf source.

When the gas is triggered, the current from the high-voltage capacitor is discharged through the flash tube and a short, brilliant flash is produced. The light energy output is calculated by photographers in *watt-seconds*. The number of watt-seconds is determined by the capacitance of the high-voltage capacitor and by the amount of voltage used to charge it. The formula is $\frac{1}{2}CV^2$, where C is capacitance in microfarads and V is voltage in kilovolts. For example, if the high-voltage capacitor is 20 $\mu$f and the voltage across it is 2 kv (2,000 volts) we would have $\frac{1}{2}(20 \times 2^2)$ or $\frac{1}{2}(20 \times 4) = 40$ watt-seconds.

The size of the high-voltage capacitor determines the speed of the flash; smaller capacitors give shorter flashes. A 15-$\mu$f capacitor at 2,000 volts has a flash duration of only 1/10,000 second. The speed change is not linear with capacitance; it takes almost 4 times as much capacitance to increase the time to 1/5,000 second.

## The trigger circuitry

Nearly all studio speedlights are triggered by a scheme like that of Fig. 2. A pulse on the primary of the trigger transformer is stepped up in the secondary to a high enough voltage for triggering. A camera could be connected across the trigger button switch but the current in the primary circuit could easily damage the camera contacts. Some other arrangement is necessary. This is usually done with a thyratron trigger tube, occasionally with a relay, and in a few late models with a power transistor. Fig. 3 shows how a thyratron is connected as a trigger tube.

*Studio speedlight is mounted like photoflood. Power pack is behind reflector, not separate as in most units. Its circuit is in Fig. 4.*

The 0.5-$\mu$f capacitor (C2) in the trigger transformer primary is charged through the 100,000-ohm resistor. The charge is slow so that there is little output from the secondary. The thyratron is kept cut off by returning the grid resistor to −50 volts.

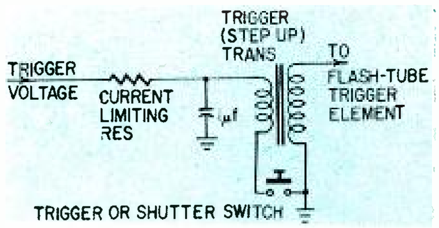



*Fig. 2—Most common triggering method uses transformer to step up pulse. Closing switch sends "kick" through transformer and sets off tube.*

When the points in the camera shutter close, the voltage on the grid goes to zero because of the charging current in C1. This drives the tube into conduction, ionizing the gas inside it, so that it has a very low resistance. C2 discharges through the trigger transformer primary and the thyratron and triggers the gas in the flash tube.

R1 discharges C1 so that it will be ready to drive the grid negative on the next shot. Even if the camera contacts remain together, the flash tube will not flash again until the contacts are opened and C1 is allowed to discharge.

## Complete circuits

Fig. 4 is a complete circuit of a popular speed light of a few years ago. It uses a "cold-cathode" 0A4-G thyratron—no heater. This tube needs a large positive voltage on the starter anode before it will fire. When the camera shutter contacts close, the voltage on the starter anode goes more positive and triggers the tube. R1 is used to adjust the tube for the most sensitive trigger point without the danger of self-firing.

The one big problem with these units is the 0A4-G tube. It is erratic unless specially aged. Just any tube picked off the shelf will not work. The factory supplies these special tubes but you can often age your own if you have a tube tester that will check thyratrons. Put the tube in the tester and fire it a number of times until it stabilizes. It will usually work OK after this treatment. A .25-μf capacitor across R2 will often help stop erratic firing also.

Fig. 5 is a former relay-triggered circuit that was modified for electronic triggering because the owner wanted to fire the unit with a phototube. If a photographer uses more than one speedlight, he need fire only one from his camera. The light from it will fire his other lights if they have phototube connections.

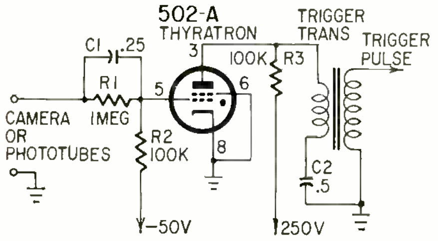



*Fig. 3—Thyratron trigger "amplifier" saves camera sync contacts from heavy surge currents.*

The original relay connections and the new circuitry are shown in Fig. 5. Starred parts (*) were added. Since the voltages on the bleeder were negative, the plate of the 502-A thyratron is grounded. A 47,000-ohm resistor (R) was added in series with the bleeder to make the voltage on the grid more negative than on the cathode so that the tube is kept cut off until triggered by the camera.

The circuit in Fig. 6 has some interesting features particularly important to the service technician. A safety switch shorts out the high-voltage capacitor when the lid is removed. *This is important. A speedlight can kill you!* It uses a brute-force power supply with a tremendous current potential. Never stick your hands in a speedlight circuit without making sure the capacitors are "dead." You can discharge them with a screwdriver or a piece of wire but, if the capacitor is fully charged, there will be a loud report that can make you a nervous wreck. I prefer to discharge the capacitors through a 10,000-ohm, 10-watt resistor for a few seconds and then short them out. This is less grating on the nervous system, and must be easier on the capacitors.

If the flashtube can be made to fire just as the unit is turned off, this will discharge the capacitors and lessen the danger of probing around inside. The "Photogenic" unit in Fig. 6 has an extra set of contacts on the off-on switch that does just that. Notice that it does so by grounding the plate of the trigger tube. This means that even if the trigger tube goes bad in service, the capacitors will still be discharged.


*Portable electronic flash. Power pack hangs on shoulder strap; flash tube and reflector assembly fits on camera.*

Another interesting feature of this unit is the flash indicator bulb. At first thought, it might seem foolish — you should certainly be able to tell whether there is a flash from the flash tube or not. This would be true if you were using only one unit but a professional photographer may fire several at the same time and he can't be sure that they have all fired. One misfire might ruin the effect he wants.

The flash indicator bulb lights bright after the unit flashes and slowly dims down and goes out when the unit is ready to fire again. It does this because it is wired in the primary circuit of the plate transformer. When the flash tube fires, the 80-μf high-voltage capacitor is short-circuited and discharged. The 2X2 rectifier starts drawing high current to recharge it. This high current is drawn from the primary and through the bulb. As the capacitor charges up, the current reduces and the flash indicator bulb dims and goes out.

A HIGH–LOW switch is also used on this unit to increase or decrease the watt-second rating. In the HIGH position the voltage is increased and the capacitor has more charge in it.

Some earlier models of the unit had the heater winding for the 502-A on T1. When the HIGH–LOW switch was on LOW, the heater voltage on the tube was

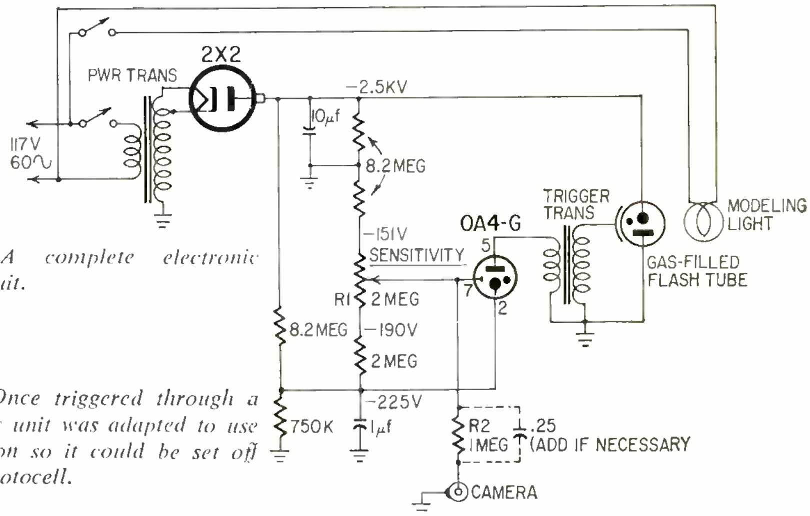
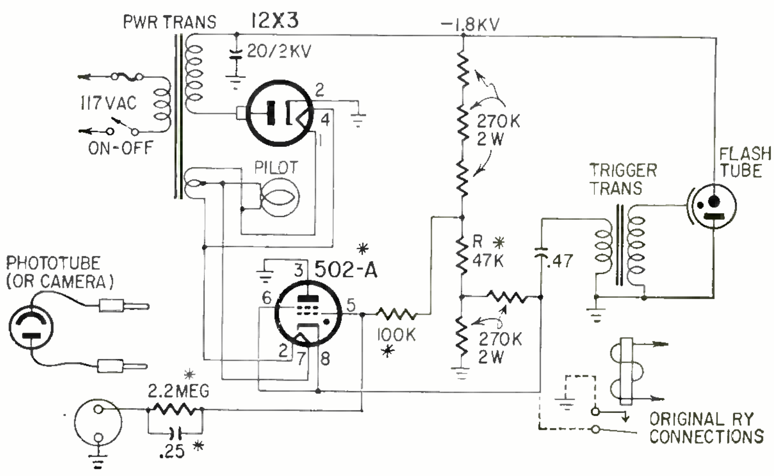



*Fig. 4—A complete electronic flash circuit.*

*Fig. 5—Once triggered through a relay, this unit was adapted to use a thyratron so it could be set off with a photocell.*



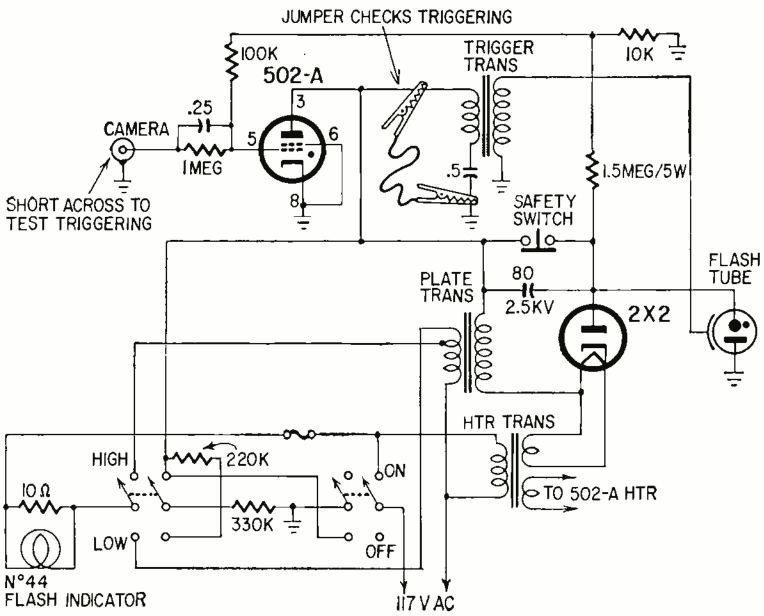



*Fig. 6 — "Photogenic" speedlight has worth-while features: automatic high-voltage shorting when lid is removed, indicator light to assure photog that light has flashed.*

reduced also. This causes trouble if the tube is a borderline case and will not trigger in the LOW position but works OK in HIGH.

**Troubleshooting**

Speedlights are usually well built. The greatest troubles are from tubes. They also develop open resistors, leaky capacitors, bad transformers, etc., but a vom or vtvm and knowledge of how the speedlight works should be all that is necessary to make fast repairs.

**Doesn't trigger.** This trouble is often found in the connecting cords from the camera to the unit. Remove the cord from the speedlight and short the terminals or touch them with your finger—this should fire the flash tube if the unit is OK. If this does not fire the flash, remove the unit from its case—*make sure you discharge the high-voltage capacitors!!!* — and try a new trigger tube. If this does not cure the trouble, check the voltages on the tube. If these are OK, check the triggering transformer by using a jumper (Fig. 6). This discharges the capacitor through the transformer. Of course, make sure you have high voltage. The high-voltage rectifier may be defective or sometimes the high-voltage capacitor may be shorted.

**Erratic triggering.** If the electronic flash doesn't always work when the photographer takes a picture, he'll be embarrassed. Again, this trouble is most likely to be found in the connecting cords; if it isn't, the next place to look is for a bad trigger tube.

Erratic triggering is sometimes caused by the flash tube itself. This can only be checked by substitution but many photographers have two or more identical units. In this event, you can try a tube that is operating normally in the defective unit and see if the trouble is cured.

Another possible trouble is a defect in the trigger transformer or an intermittently open trigger capacitor in the primary. In a few cases the trouble has been traced to too much ambient light falling on a phototube-fired unit. If this occurs with some circuits, it will drain off the bias so that the trigger tube will not always fire. Try placing a small hood of tape over the phototube to reduce its sensitivity.

Some circuits require additional light from the flash tube on the phototube before it will activate the slave flash unit. You can sometimes extend the phototube on a short cord so that it can be turned to catch more light from the master flash unit.

Low line voltage will cause erratic firing in some units. Measure the voltage. If it is below 105, connect a stepup transformer to increase it by about 10 volts. The "Up Ten–Down Ten" transformers sold for use with TV sets are ideal in this application. Some photographers prefer a metered variable-output transformer. They can set it for the same voltage every time so the light output will be consistent.

**Spasmodic or repeated flashing.** This may be caused by shorted or partially shorted connecting cables from the camera to the unit. If this is not the trouble (remove all connecting cords to test), the fault is likely to be in the trigger tube or an open bias resistor in its grid circuit. Sometimes, especially in areas of high humidity, the trigger transformer may break down between the primary and secondary winding, or leakage may develop across a connecting cable from the power unit to the speed lamp. Dirt around the plug can collect enough moisture to cause repeated flashing.

In units with sensitivity controls, it is best to adjust these at the highest expected voltage. Otherwise, the unit may self-flash if the line voltage surges upward. Too high a line voltage can cause spontaneous firing. A voltage adjusting transformer is the ideal remedy.

**Other troubles.** Repeated flashing or failure to flash may be caused by incorrect polarization of camera and speedlight cords. If either trouble occurs, reverse lead wires at the camera or at the unit—whichever is easier. Phototubes will not trigger the flash if they are reversed.

If there is an unduly long time between charging periods, check the rectifier tube. Long charge times can also be caused by low line voltage or, in the case of battery-operated portable units, by weak or discharged batteries. Fig. 7 is a battery-operated portable unit used by many professional photographers. This one uses two 225-volt batteries in series. Later models use a transistorized power supply with regular flashlight batteries as the power source. The 5823 is a small seven-pin miniature cold-cathode trigger tube.

All speed or strobe lights work on similar principles but every company has a different way of arriving at the same end result. If you encounter a strange unit and a schematic is not available, spend 30 minutes or so tracing out the circuit. You'll be surprised how this will help you service the unit, using the ideas set forth in this article. Keep the schematic. Once a photographer finds someone who will repair his speedlight, he'll keep coming back and he'll recommend you to his photographer friends. END

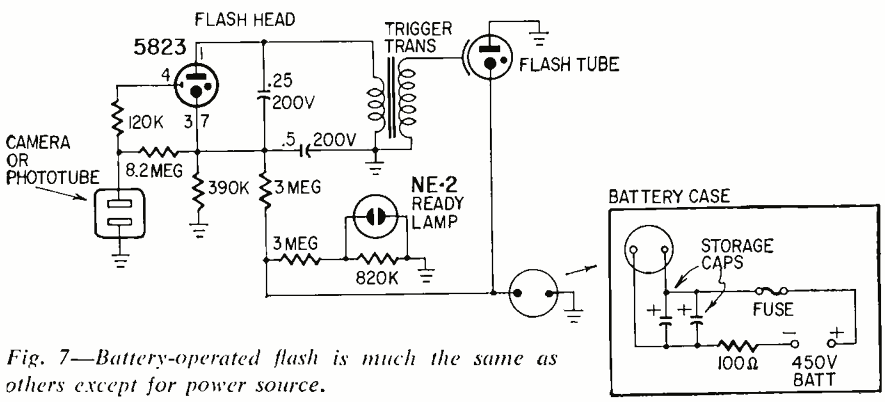
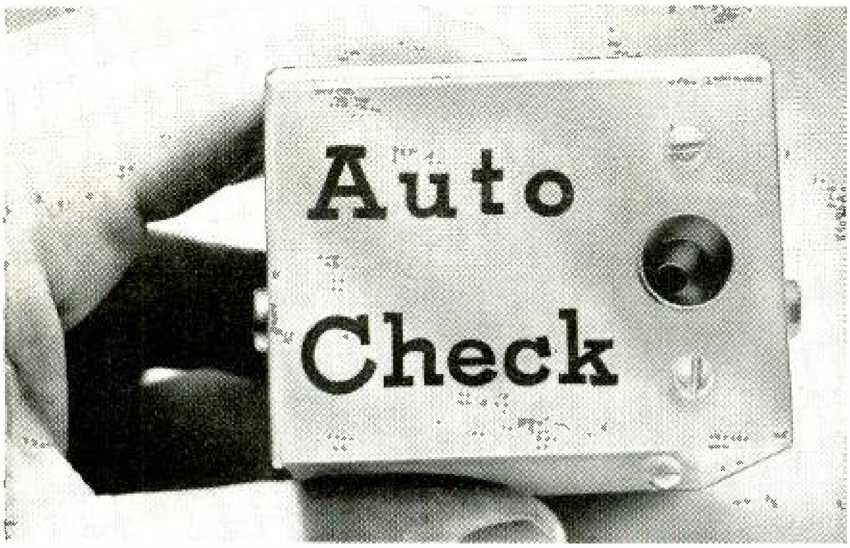



*Fig. 7—Battery-operated flash is much the same as others except for power source.*




*Author's car radio antenna checker, built into a small two-piece aluminum box.*

# Fixing Auto Antennas

## Knowing these tricks can bring you customers

By DAVID HELD

A TWO-TONED FORD STOPPED IN FRONT OF THE SHOP AND A well-dressed man opened the front door. "I have a car radio that quit about 10 miles outside of town. Could you look at it?"

This is the type of call we get several times a day; we're located at the edge of town on a busy highway. Auto and truck radio repair is good business, if you are prepared and equipped to do it. Of course it means climbing in and out of cars, standing on your head at times, letting dirt fall into your eyes and being smeared with oil and grease . . . so why go into it?

Several reasons. When you have a customer you've sold a TV set to, or one whose set you're servicing, you are giving him complete electronic service by fixing his car radio. That at times will help you keep him as a customer. Also, look at the customer's side of the picture. The car radio you repaired for him will lead him to call you again when his TV goes out or his kitchen radio quits.

Radio and TV business can be built up by doing car radio repair. Of course you may never again see the tourist who stops at your shop, but you have picked up a buck from outside your own community. *Don't nick him as he goes through!* Why? Down the road some 60 miles a gas station at a highway intersection recommends truck drivers to stop at your place for truck radio service. How come? Another truck driver's radio went out once and you fixed it. He told the filling station operator. Word of good service gets around.

Another reason why auto radio service is profitable is that it keeps enough work handy so your men will be busy at all times. Good service technicians are hard to find.

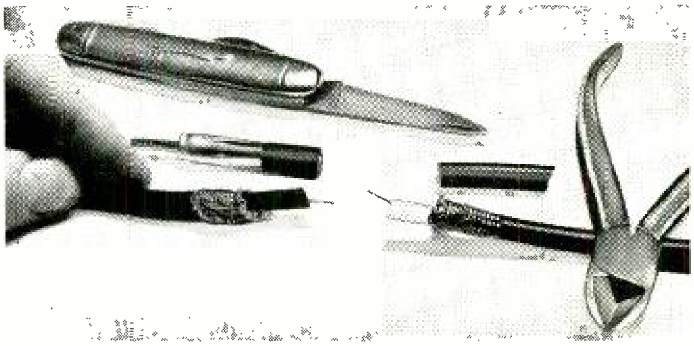
### The auto antenna

The car radio antenna has only a few working parts, but it is vital. Without it, the radio won't work at all. A *top-cowl* antenna has four basic parts: the antenna rod, an insulator, tightening nuts and a lead-in cable. Each part must do its job, or bad reception results. These are the troubles you're likely to find:

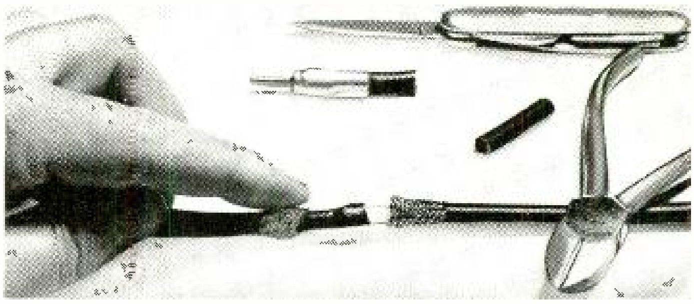
1. Bad lead-in
2. Broken antenna mast
3. Loose connections
4. Dirty contacts
5. Shorts
6. Water leakage

When the lead-in goes bad, two things happen: There's a lot of rushing noise at maximum volume, and weak sound even on local stations. Check lead-in continuity with an

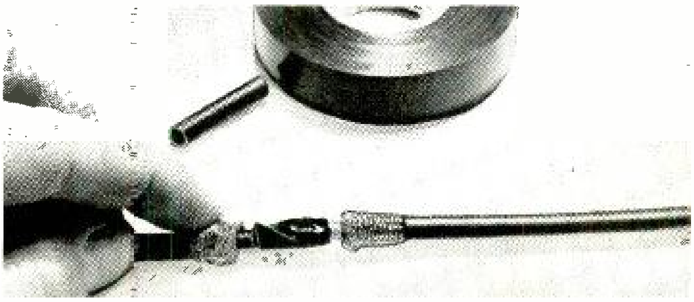
**A Neat, Tight Splice in 5 Easy Steps**



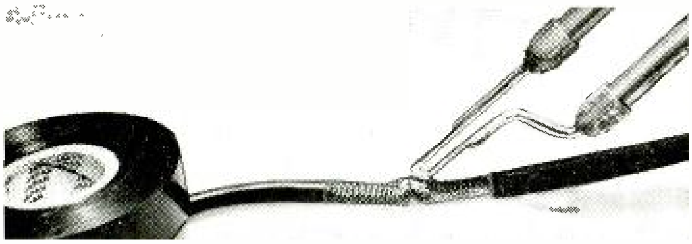
1. **Starting the splice.** Cut plug end off old cable, strip 1¼ inches of insulation off extension cable. Push braid back.



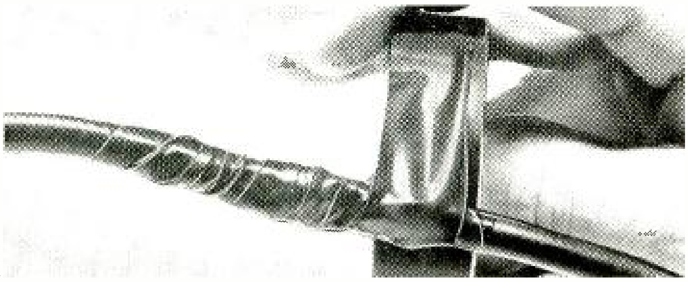
2. **Solder inner conductors** together. While joint is still hot, force soft plastic inner insulation over it.



3. **Wrap joint snugly** with plastic tape. Warming tape and splice slightly helps make a tight wrap.

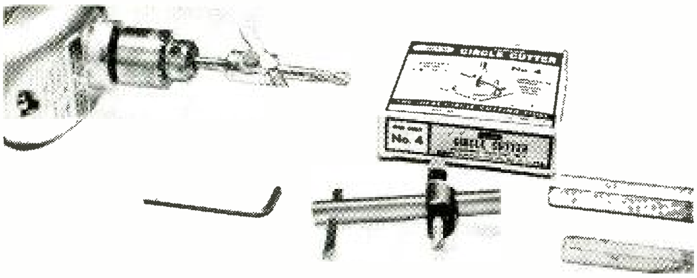


4. **Push metal braid ends together** over joint and solder. Do not heat splice any longer than necessary.

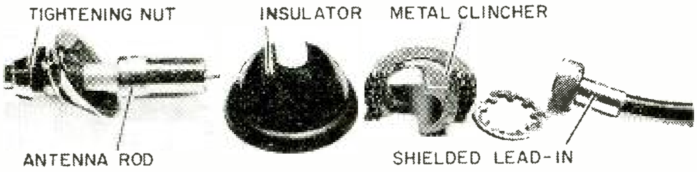


5. **Wrap completed splice** tightly with plastic tape. Begin and end wrap at least an inch beyond point where original cable insulation was cut.

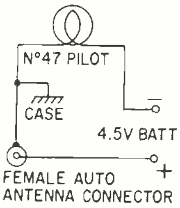
ohmmeter, or with a homemade gadget constructed as in the diagram below and the head photo on the first page. If the lead-in cable is open, it is probably open at the male plug that fits into the radio. Clip off the plug and tug on the insulated wire. If it is intact, make a continuity check. If continuity is good, replace the plug with a new one. Often the insulated wire is broken at the end where the antenna rod plugs into it. Replace the whole antenna in that case, since it is hard to match lead-ins to the many kinds of auto antennas.




*Hole-drilling tools. Left, electric drill with small circle cutter in chuck. Device at right is larger circle ("flybar") cutter, also designed to be chucked in electric drill. Be sure to make sharp, small dimple with center punch at point where you want hole to prevent drill from "walking" away.*




*Parts of auto antenna mounting assembly.*




*Circuit of the short-continuity tester. Plug lead-in cable into tester. If lamp lights, cable is shorted. If lamp does not light, cable is good—or open. Short far end of cable (braid to center conductor). If lamp lights, cable is neither shorted nor open. If lamp stays dark, replace the cable.*

When you install an auto radio that has been pulled from another car, the existing lead-in is often not long enough. Lead-in extensions are made for this purpose, and you should always keep a variety in stock. They come in assorted lengths. If you happen to be caught without one, the photos show how to make a good extension splice.

### Broken masts

If you're not sure that the car antenna is bad, plug a new antenna into the radio's antenna socket and hold it outside the automobile. Stations should come in all over the dial now if the old antenna was defective.

When the antenna mast itself is broken off, replace the whole antenna. These masts are often broken by mischievous kids, or sometimes by driving into the garage with the antenna extended. In many instances, the antenna can be replaced at no charge through the owner's insurance.

Antennas often loosen from the effects of wind and rough roads. A loose antenna assembly causes intermittent or noisy reception when the car is moving. Wiggle the antenna, with the car radio on, and this will show up at once.

When the antenna assemby becomes loose, motor noise will get into the radio reception. To determine what motor noise is being picked up by the auto antenna, unplug the antenna from the car radio. Start the motor and turn up the volume, listening for motor noise. (A little distributor noise is normal.) Plug the antenna back into the radio. If motor noise is now very loud and plain, the antenna system is picking it up. A bad lead-in, an ungrounded coax shield or a bad connection between shield bond and metal cowl can be at fault. Clean the spot where the antenna ground bites into the metal cowl of the automobile.

### Mounting the antenna

When you install a new car radio antenna, watch out for several things. Be sure there is clearance for the antenna mounting assembly, and that the antenna rod will clear the car hood when it is raised. (I once saw a top-cowl antenna newly installed on a truck. When the hood was raised, the antenna mast was snapped off completely.)

There are several tools on the market designed to drill antenna mounting holes. Many commercial antennas built specially for a certain make or model car come with a template for mounting the car antenna. Be sure the antenna stands up straight and does not block the driver's view.

To be sure that the antenna is snug and tight, wiggle the rod as you tighten it. Use a wrench to tighten the chrome nut; pliers will mar the surface. A dropcloth thrown over the car fender will protect the finish from tool and belt-buckle scars. Squirt plastic cement around the hole where the cable goes through the firewall. This keeps moisture, dirt and dust out of the car.

Select (or urge your customer to select) a good antenna, moderately priced. Cheap antennas will not stand up and are very difficult to mount.

Many new cars have rear-fender antennas installed and in some cases twin fender mounts. A few technicalities are involved in repairing or installing such antennas.

Their lead-ins are long and are actually part of the radio's tuned input circuit. A front-cowl antenna can be tuned easily to the radio circuit with the antenna trimmer—set the dial above 1400 kc on a weak station and adjust the trimmer for loudest volume. But with a back-fender antenna, the lead-in is longer, resulting in increased capacitance that cannot be compensated by the antenna trimmer. Simply connect a 100-pf capacitor in series with the antenna and lead-in. Most antenna manufacturers include one in rear-fender antenna kits.

Rear-fender antennas also loosen in their mounts, and trouble often develops at the T or Y section. The inside shielded wire is easily broken at that junction. If you are in a critical reception area, it is a good idea to use only one antenna hooked up to the radio. Use the other antenna only as a matched dummy, for looks. In some cases this may still not get enough signal to the car radio, so install a top cowl antenna on the front and leave the two rear fender-mounts for looks. It is always wise to readjust the trimmer on every auto radio as it (or a new antenna) is installed.

It is hard to match rear-fender twin antennas to the radio, because of their long cables. A "booster" helps, but to do a good job, I would rather install a universal top-cowl antenna.

**Power antennas**

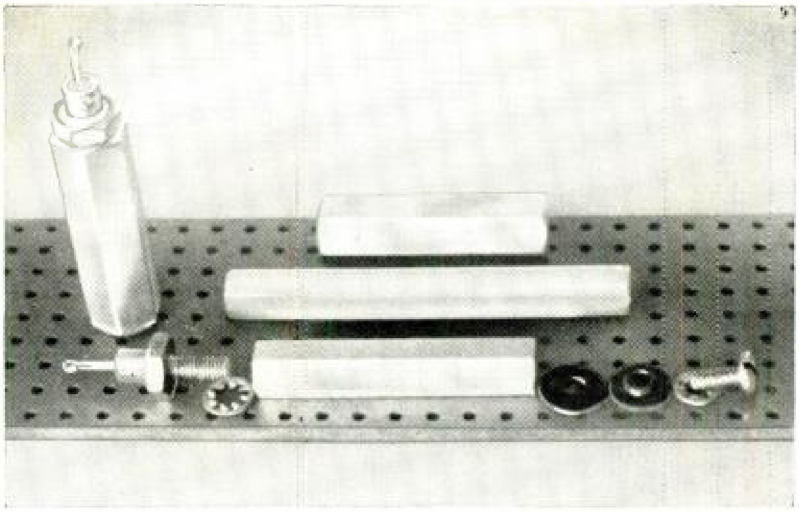
Some of the more expensive autos have motor-driven antennas. These are operated by a dc motor or by vacuum from the engine. When you remove an antenna of the vacuum-operated kind, mark the hose connections so that they will go back onto the correct nozzles. Sometimes mud hangs on the dc motor connections and pulls them off, making the antenna inoperative. The telescoping sections become worn and begin to "flap," making reception intermittent.

One of the biggest trouble spots in a power or "disappearing" fender antenna is the point where the lead-in enters the antenna assembly. This male plug rubs against the antenna rod and doesn't make a good connection, or the connection becomes dirty. On deep-well antennas, moisture gets in, causing noisy and weak reception. An ohmmeter will show this up. Be sure that this kind of antenna is bonded well at the top and bottom straps on the antenna assembly.

In some cases, motors in the electric-powered antennas burn out, and sometimes, surprisingly, this is the fault of weak or rundown batteries. The nylon strip that raises and lowers the telescoping antenna tends to stiffen, requiring more power to move it. A weak battery will make the motor run more slowly than normal, and the user's normal reaction is to hold the switch until the antenna is where he wants it. As a result, the motor overheats and sometimes burns out.

Parts for these antennas can be picked up at automobile parts houses or ordered through them.

Many antenna gadgets are on the market — boosters, replacement antenna staffs, false antennas. There are several types of antenna boosters, one for which you cut the mast in two and install with self-contained screws. Some other types plug between antenna and lead-in. These were designed for dual rear mounts to improve long-distance reception. Some dual types claim to double the volume of regular antennas, but even with boosters they do not match the gain of front-cowl mounts. END



# Quick and Dirty Heat Sink

**By ROY E. PAFENBERG**

MOUNTING TRANSISTORS AND SILICON rectifiers on aluminum or brass posts provides a neat, workmanlike method of installation and, at the same time, gives a bonus in the form of a remarkably effective heat sink.

The term "heat sink" is relatively new in the common vocabulary of electronics. Despite this, those who work with the various semiconductor devices must have a working knowledge of the subject. Semiconductors are physically small and all of them have a maximum operating temperature that may not be safely exceeded. Therefore, the power-handling capability of a transistor or diode is limited by the heat that can be radiated by the device and its heat sink.

The Sarkes Tarzian *Silicon Rectifier Handbook* states, as a rule of thumb, that each square inch of heat sink surface will radiate 8 mw of power per °C above the ambient temperature. The radiating capability of a heat sink may then be roughly approximated by:

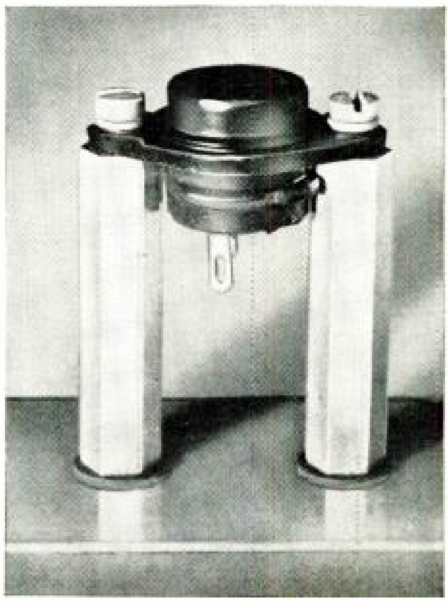
$$P_m = \text{Area (sq. in.)} \times .008 \times T_r$$

where $P_m$ is the maximum power radiated; $T_r$ the difference between the maximum operating temperature of the device and the ambient temperature in °C.

Aluminum or brass mounting posts offer several real advantages, particularly when an insulating chassis is used and the diode or transistor is operated somewhat short of the maximum rating, which might require a more elaborate heat sink. For example, calculation will show that the effective vertical surface area of a ½-inch diameter round post 2 inches high is 3.14 square inches. Applying the formula shows that for a maximum allowable temperature rise of 50°C, this post will radiate roughly 1.25 watts of power.

This method may be extended to supporting posts of any size and configuration. The silicon rectifiers shown in the photo mount by 10-32 threaded studs. The posts should be drilled and tapped to suit the device being mounted. A machine screw and lockwasher will secure the post to an insulated chassis. For a metal chassis, use conventional extruded insulating washers without regard for their thermal characteristics.

While these calculations of heat-sink efficiency are perhaps oversimplified, they do produce useful approximation. The mounting methods certainly do not meet all semiconductor device mounting requirements, but they do provide a simple, low-cost answer to many difficult installation problems. END




# Zener-Stabilized DC Amplifier

**Zener diodes and a power transistor clamp operating voltages in this stable general-purpose dc amplifier**

**By ALEX M. SCHOTZ***

INDUSTRY AND RESEARCH HAVE MANY practical uses for a stable, low-drift dc amplifier: extending the range of a dc scope, reading dc millivolts direct from a bridge circuit, or as a thermocouple.

With Zener diodes, there is now an excellent way to stabilize operating voltage and current, so important for dc amplifiers. By regulating the B-plus, bias and heater supplies, I built a fairly drift-free dc amplifier (Fig. 1). These are its specifications:

**1. Input impedance high, 2.5 megohms.**

**2. Output impedance low, 500 ohms.**

**3. Voltage gain minimum 50, actually over 60.**

**4. Direct readout for static measurements.** Meter used with this amplifier indicates ±5 volts full-scale output, with an input of 20 mv per volt output when the amplifier's gain is set at 50. Meter can be switched off for dynamic operation.

**5. Calibrated voltage source.** It can be used to check or adjust gain. The 100-mv source is brought out to terminal post in rear.

**6. Good regulation.** Power-line voltage can fluctuate from 90 to 135 without change in operation or calibration.

**7. Frequency response flat from 0 cycles (dc) to 30 kc;** down 5 db at 100 kc.

**8. Output voltage before clipping approximately ±12.**

**9. Signal-to-noise ratio at 10 vrms output better than 70 db down.**

**10. Common ground input and output (galvanic ground).** Polarity reverses from input to output, but can swing equally in either direction.

Construction is simple. The heater-regulating power transistor is mounted on a piece of aluminum 3 x 3 x ⅛ inch, painted black (except under the transistor) and "floated" above the chassis (electrically) on Lucite. Most of the small parts are placed on a terminal strip 5½ x 1⅝ x ⅛ inches (Fig. 2). Take normal precautions in wiring the input; the input impedance is high.

The circuit works this way: signal voltage, either dc or ac, is applied to the input terminal and reaches the control grid of the 6AN8 pentode section via the

**BENCH TESTED**

A RADIO-ELECTRONICS Editor who tested Mr. Schotz's amplifier reported that it "does exactly what the author says it will. After 10–15-minute warmup, unit does not drift more than 1 or 2 divisions on the meter, apparently because of line-voltage variations. (Each division is 10 μa.) Frequency response flat over entire audio range. When switched in and out between audio generator and scope, no apparent change in waveform. Maximum output voltage ranged between 10 and 12. Beyond that point, amplifier started to clip."

*Outboard Marine Research Center, Milwaukee, Wis.

# New 1964 Heathkit® All-Channel Color TV

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**Here's What The Experts Say! Popular Electronics**, May issue: "The GR-53A is not a skimpy receiver in which corners have been cut to keep costs down and still provide color TV. Instead, the GR-53A (on a comparison shopping basis) has the same color and sound fidelity, flexibility, and ease of handling as those manufactured receivers which sell for over $600."

**Radio-TV Experimenter**, June issue: "The repair cost savings during the Heath Color TV set's life compared to commercial units may be more than $200."

**Popular Mechanics**, February issue: "Mounted, prealigned critical circuits enable beginners to assemble. Picture quality is top-notch."

**Science & Mechanics**, April issue: "Built-in servicing circuits such as a dot generator are valuable aids in getting the set operating for the first time & eliminating expensive service calls & bills when realignment or part replacement is needed later on."

**Anyone Can Build It!** No special skills or knowledge required . . . all critical assemblies are factory-built & tested . . . simple check-by-step instructions take you from parts to picture in just 25 hours! Here's what one Heathkit Color TV owner, Mr. Thomas R. McMahan of Cincinnati, Ohio says about the GR-53A manual: "I would consider the manual to be equal to a lifetime of warranties with an ordinary television."

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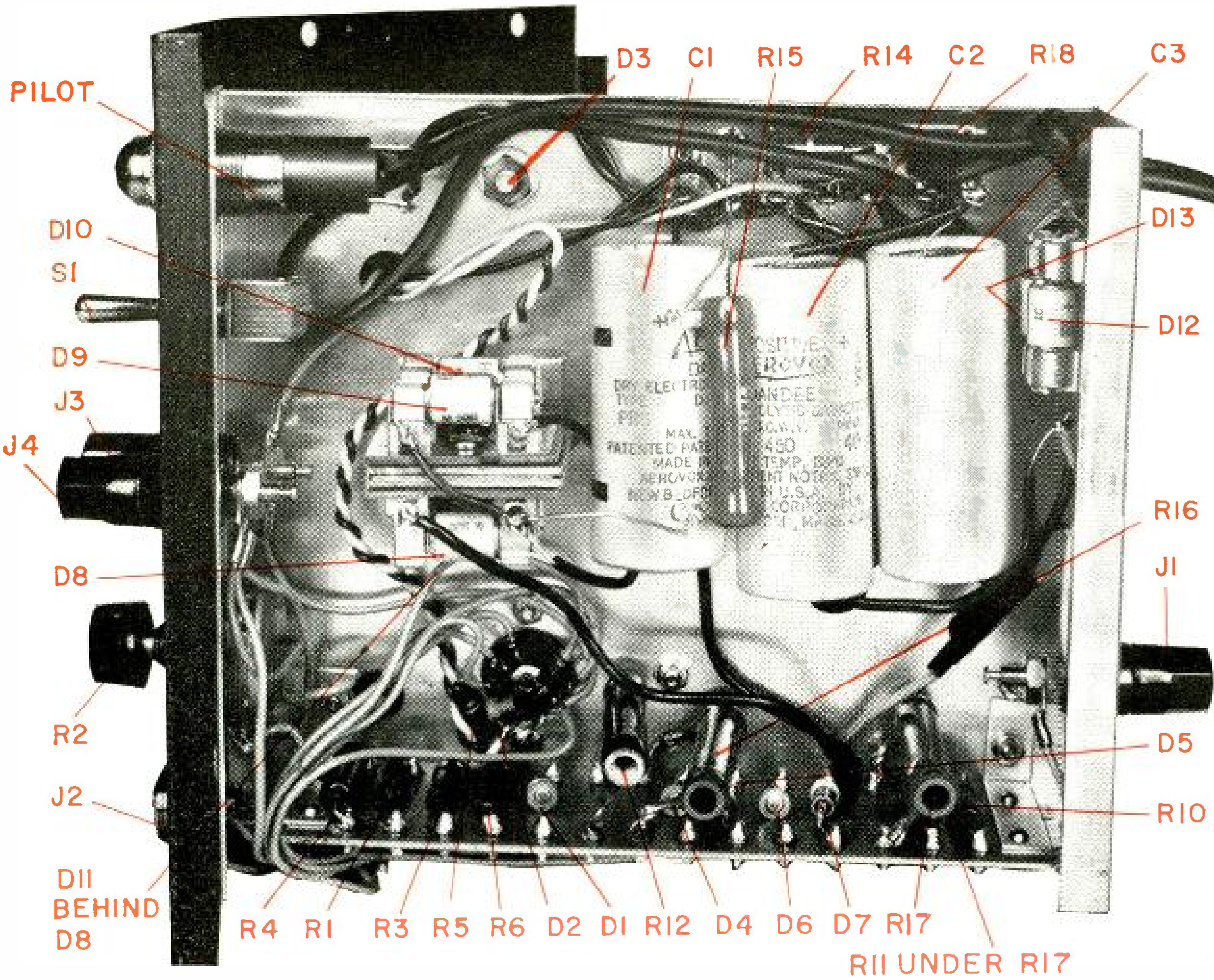



*A look at the amplifier's underside shows simple wiring. Most of it can be done on board before board is mounted.*

C1—500 µf, 25 volts, electrolytic
C2, C3—40 µf, 450 volts, electrolytic
D1—10-v Zener diode, ¾ watt (International Rectifier 1N1512)
D2, D4, D5, D6, D7—27-v Zener diodes, ¾-watt (International Rectifier 1N1517)
D3—5.6-v Zener diode, 3½-watt (International Rectifier 1N1590)
D8, D9, D10, D11—500-ma silicon rectifier (Sarkes Tarzian M500 or equivalent)
D12, D13—150-ma silicon rectifier (Sarkes Tarzian M150 or equivalent)
J1, J3, J4—5-way binding posts
J2—coaxial microphone connector
M—500–0–500-µa meter (Simpson 27, or equivalent)
Q—2N278 (Motorola)
R1, R9—100 ohms, ½ watt, 1%
R2—pot, 2.5 megohms, linear
R3—10,000 ohms, ½ watt, 1%
R4, R8—47 ohms, ½ watt, 1%
R5—150,000 ohms, ½ watt, 1%
R6—330 ohms, 1 watt
R7—pot, 50 ohms, linear
R10—2.2 megohms, ½ watt, 1%
R11—15,000 ohms, 1 watt
R12—5,000 ohms, 10 watts
R13—10,000 ohms, 1 watt
R14—75 ohms, 2 watts (or two 150-ohm 1-watt resistors in parallel)
R15—5 ohms, 10 watts
R16, R17—10,000 ohms, 10 watts
R18—10 ohms, 10 watts
*All 1% resistors low-noise types*
S1, S2—spst toggle switches
T1—power transformer, 135 v, 50 ma; 6.3 v, 1.5 a (Triad R-30X or equivalent)
T2—filament transformer, 12.6 v ct, 1.5 a (Triad F-25X or equivalent)
V1—6AN8
Chassis, 7 x 7 x 2 inches (Bud AC-405 or equivalent)
Cabinet to suit
Pilot-lamp assembly and No. 47 bulb
Heat sink
Miscellaneous hardware

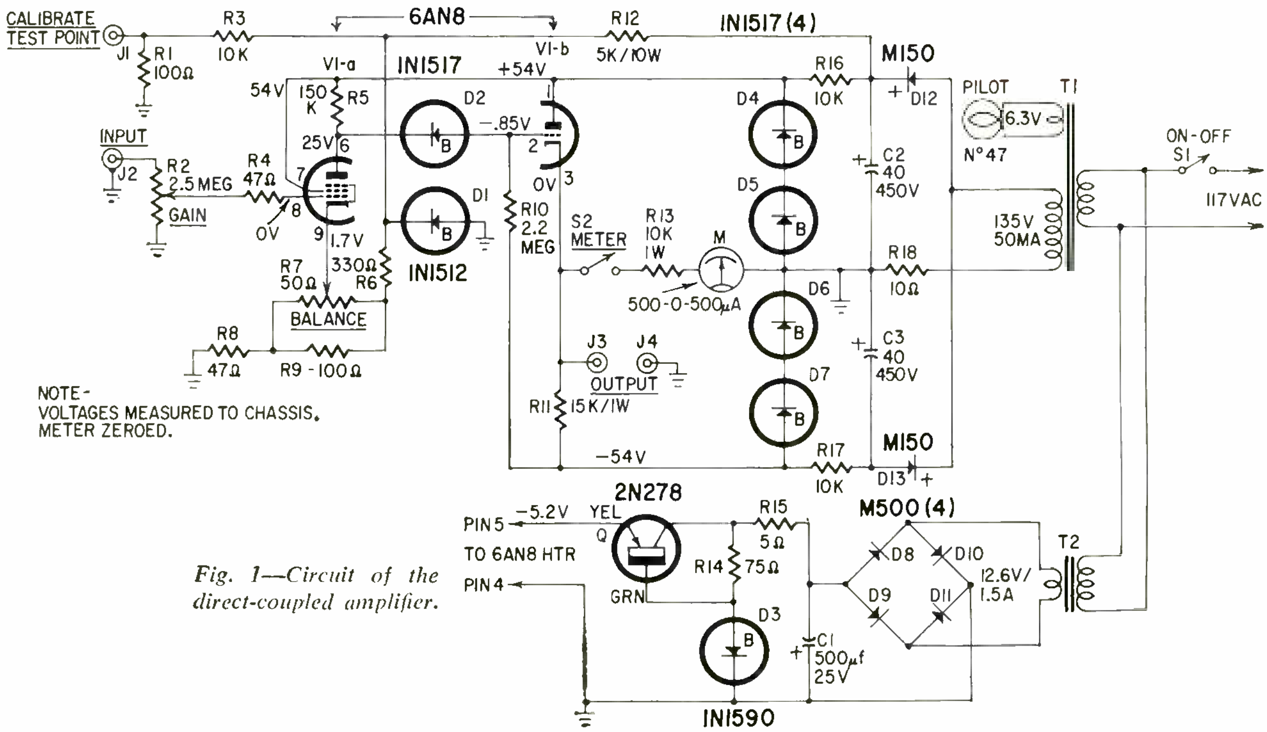
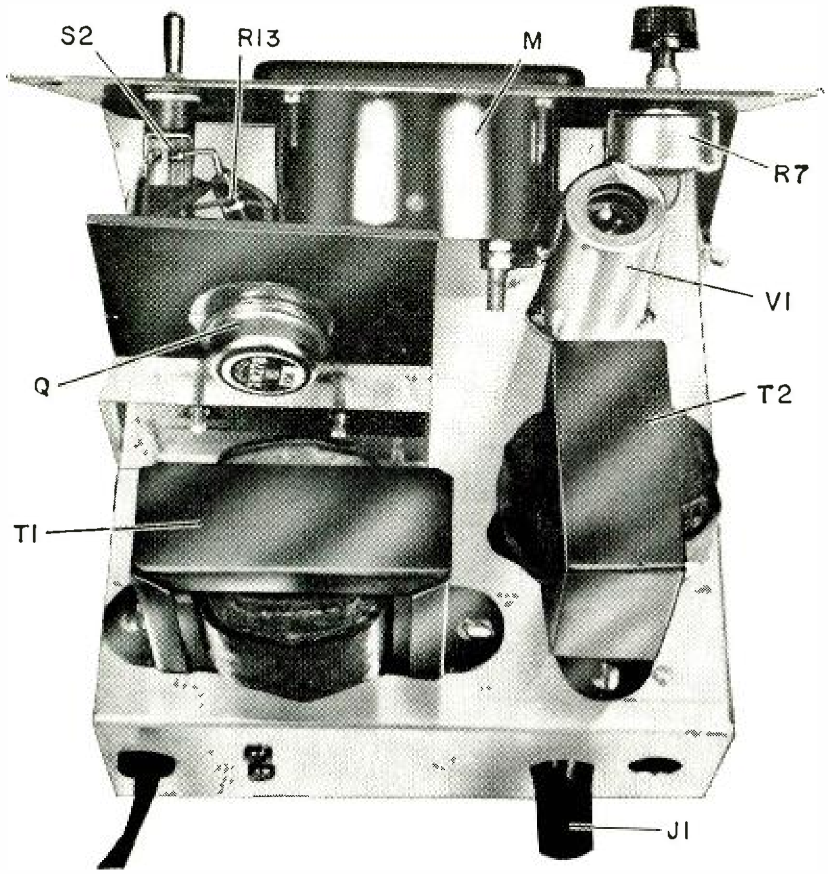



*Fig. 1—Circuit of the direct-coupled amplifier.*




*Heater-regulating transistor is mounted on sheet aluminum heat sink, insulated from chassis with clear plastic block.*

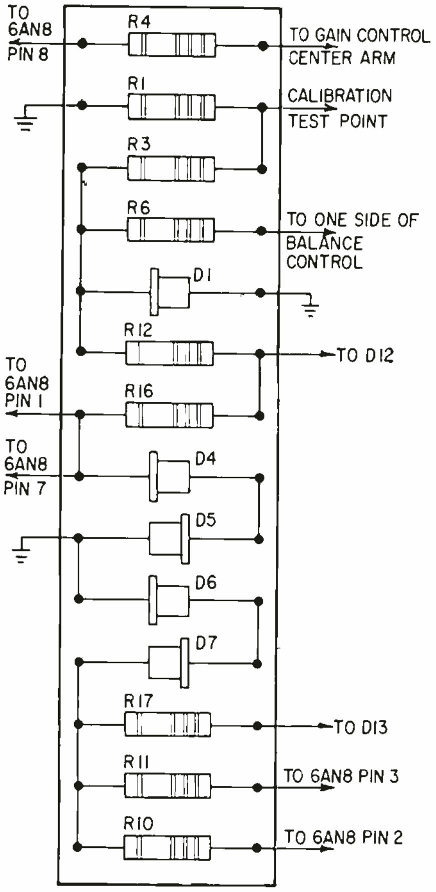



*Fig. 2—Terminal board carries most of the wiring. It's optional.*

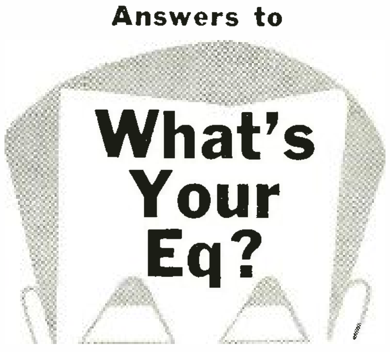
attenuation control. This signal voltage is then amplified and the output from the pentode plate coupled through a Zener diode to the grid of the 6AN8 triode section. Using the Zener diode (D2) and the negative supply, puts the output of the cathode-follower 6AN8 triode section at the proper level. When the circuit is properly balanced, this permits the signal voltage to swing in either direction from ground (zero reference). With the 6AN8 triode operated as a cathode follower, the output impedance is low.

To balance this amplifier, let it warm up 10 minutes and turn the gain control fully counterclockwise. Switch the meter on, and adjust the balance control so that it shows a null (zero-center).

For dynamic output (when the signal varies) the meter should be switched off and the output applied to an appropriate readout device, like a scope or counter.

The meter can indicate potential directly from a static potential source. You can measure voltage by comparing the output from the calibrated voltage source to that of the measured point.

By presetting the gain with the calibrated voltage, the amplifier can be used as a decade amplifier, or as a millivoltmeter with a high input impedance for static potentials. END




This month's puzzles are on page 47

### Autotransformer

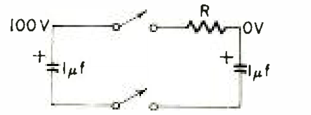
Ammeters A1 and A3 each read 10 amperes. The primary and secondary currents in an autotransformer are 180° out of phase (in phase opposition). They tend to cancel in the part of the primary winding which includes the secondary winding.

Taking into consideration a winding ratio of 2 to 1, and a secondary current of 20 amperes, the apparent primary current (and hence the apparent reading on A1 and A3) would be 10 amperes. Since the primary and secondary are 180° out of phase, the total primary current is the algebraic sum of the two, or 10 amperes.

Note: Core and winding losses are disregarded.

### Case of the lost energy

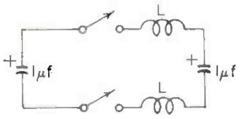
This is really not as simple a problem as it looks. Suppose our problem circuit looked like this instead.




Now, for a time after closing the switch, current will flow through the resistor until the capacitor charges have become equal. Here in this resistor is a good place to get rid of energy, turning it into heat. Since we must conserve energy, the heat energy produced by the resistor evidently *must* be equal to the energy lost by the capacitors. Now what if we change R to a different value? If R gets bigger, the current flows for a longer time, but is weaker. If R gets smaller, the current flows for a shorter time, but is stronger. The energy dissipated in the resistor is *independent* of the value of the resistance and exactly equal to the difference between the initial and final values of capacitor energy.

Because of this, if we have *any* resistance in the circuit at all, we have explained where the energy went. In any practical problem, the small circuit lead resistance would heat up and dissipate this energy. Since most energy values normally found in capacitor circuits are generally very small, this heating effect is not very noticeable. As an example, a 25-watt light bulb in 1 second dissipates or expends 25 joules of energy, or 10,000 times as much energy as that left in our capacitor problem!

This explains any practical problem. But what if there were absolutely no resistance in the circuit at all? Then there would be another way out of the problem. Near absolute zero (−460 F), we may have zero circuit resistance. But *always*, no matter what the temperature, we *must* have *some* lead inductance. Let's draw this into the circuit.




But this is a resonant circuit! It will oscillate. If it oscillates, it will radiate radio-frequency energy. And, the energy it radiates will be exactly equal to the difference between the initial and final energy in the circuit.

Any reasonable value of lead resistance will damp this circuit and it will not oscillate, so the resistance "wins" if it has half a chance.

### Doodles in May

The scope trace in the May 1964 issue can also be produced by quickly moving the HORIZONTAL POSITION knob when the same frequency is put into both horizontal and vertical inputs, out of phase so as to produce a circular Lissajous figure. By noting whether the cusps are up or down, you can figure out whether the spot is moving clockwise or counterclockwise. Thus you can tell which input, horizontal or vertical, is leading and which is lagging. I have generated this pattern for the purpose many times.—*Paul Penfield, Jr.*

### TV Sound On FM Tuner

In many parts of the country, people who have an FM section in their radios do not use it because there are no local FM stations. But it may be desirable to readjust the FM section to pick up the sound from television channel 6, if it is in use locally. There are TV programs which are interesting to listen to, such as special events and newscasts or weather reports. Blind persons particularly may wish to receive TV sound only.

The oscillator of an FM receiver may be readjusted to receive the TV sound (87.75 mc) at the low end of the dial and still pick up FM stations (you may lose a few at the high end of the band). Of course, the dial numbers will no longer be correct but for such limited use this is not objectionable.—*Hugh Linebeck*

by Jack Darr
Service Editor

# Service clinic

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

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

A FLAT-TOP ISN'T TOO BAD AS A TEENage hair style, but it can play the dickens with an audio amplifier! One often unsuspected trouble, especially in fairly high-powered audio amplifiers, is clipping of the tops of the signal. This gives an unusual-sounding distortion, hard to describe but readily apparent when you listen to it. (This is the kind usually described by the customer as "It sounds Blaaaaaah!") Seems to take place mostly on high-level sound. And it's quite possible for an amplifier to clip on lows and not on highs, or vice versa.

Quick check: look for it with a scope. Fig. 1 shows a sine-wave (single-tone) signal going through an amplifier with no clipping, and Fig. 2 shows the same signal with clipping. (The distortion here is actually caused by the odd-ball harmonics generated by the square-wave shape that the sine-wave signal gets made into.) This waveform was taken from the output plate, but you can check at any grid or plate all the way from the input.

Note that Fig. 2 shows both tops and bottoms of the waves clipped. This usually means that the trouble is taking place before the phase inverter or in the phase-inverter itself. Trouble in either one of the output tubes mostly shows up as clipping of either top or bottom alone. (Unless the clipping is due to simple overloads, but you can check that by reducing the input signal level.)

Common causes: drift in bias resistors, plate load resistors, screen-grid resistors, etc.; gassy tubes or tubes with grid emission in high-gain preamps. The most common cause, coupling capacitors with just a wee bit of leakage.

This often shows up in guitar amplifiers. Get someone to hit a chord on the guitar. This gives you several frequencies at the same time, and most of 'em are pretty pure sine waves. (I know that a lot of guitar players sound anything but pure, but that's the way they'll look on a scope!) At any rate, set the amplifier gain as high as possible so that you can see the tops and bottoms of the waves. You may see, as I did on the last one, quite a few pretty good waves, and a few in the background with very distinct "flat-top" haircuts! This is a sure sign of distortion.

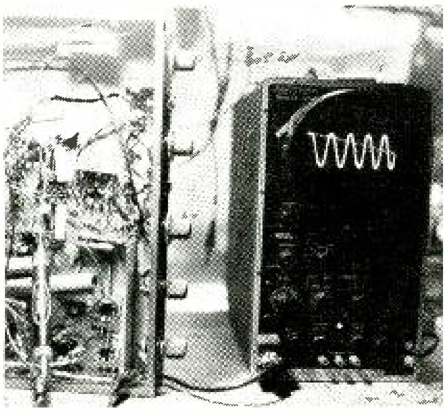


*Fig. 1—Clean sine waves near amplifier's maximum output mean that it's working pretty well.*

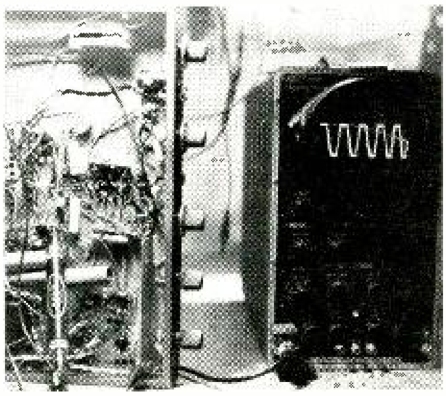


*Fig. 2—Flat-topping like this is audible as harsh, gritty sound. If it isn't due just to overdriving the amplifier, look for shifted resistor values or leaky coupling capacitors.*

A scope is about the only instrument that will definitely show up this kind of distortion. You won't get very much difference in the grid voltage readings, even with a vtvm, and the leakage will be so small that you could even pass the capacitors on a test, but if it shows up flat-topping, I'd change the coupling capacitors on general principles.

Of course, with a guitar amplifier, sometimes the player tries to get more and more volume by cranking up the gain further. Since the amplifier can put out only its rated power, this kind of overdriving can cause distortion that isn't the amplifier's fault.

Incidentally, if you don't happen to have a tame guitar player around, you might try playing a guitar *record* through the amplifier. Probably better get one of the "classical" types or something like Chet Atkins, rather than some of the "surfing" type music. (That is, if you're looking for distortion, don't *start out* with it!)

### Buzz in sound—good picture

*I can't get picture and sound together on an RCA KCS-49A. Detune the fine tuner to one side of the best picture, and the sound is good. If I set up for the best picture, the sound develops a loud buzz. Could this trouble be in the tuner?—J. B., Brooklyn, N. Y.*

Possible, but unlikely. The most likely cause of this trouble is misalignment, of either the sound i.f. or video i.f., or both. This kind of trouble is quite common in the fringe areas, but not too often encountered in strong-signal areas, unless it is due to agc troubles.

I'd recommend setting the tuner up on a strong signal for the best picture, then trying a "twiddling" adjustment on the sound, especially the discriminator transformer. See if you can clear up the buzz. While "random experimental adjustments" often lead to trouble in i.f. stages, in this case it's worth a try. If this doesn't cure it, you're going to have to run a complete realignment of the whole set anyhow!

Check all parts and tubes in the sound i.f.'s, especially the electrolytic capacitors, and the matching of the resistors across the discriminator output, etc. Check the 6AL5 tube for equal emission on both sides.

The video i.f.'s are a stagger-tuned 20-mc strip in this set. If you have a "droop" in the curve near the sound end, it can cause this kind of trouble. Run a single-signal alignment of the whole strip, then sweep it, to see if the curve is the proper shape.

You can check agc action in this set by overriding the bias while watching the screen and setting the tuner. If this clears up the buzz, check out the agc circuit, especially the bypass capacitors in and around the tuner agc.

### Vertical blanking for KCS-72

*I can't find a place to get a vertical retrace blanking pulse on an RCA KCS-72 chassis. I need a negative pulse. Can I get this from the grid of the 6K6?—H. P., Minneapolis, Minn.*

In this circuit, which uses an autotransformer, you can get negative-going pulses from the grid circuit of the vertical output tube.

Feed them through a differentiating circuit consisting of something like a .002-$\mu$f capacitor and an 8,200-ohm resistor in series. You'll need a spike of voltage, not a saw-tooth pulse. Try different part values for different circuits. If the retrace lines get worse when you connect the pulse, you've got the wrong polarity. Either reverse the polarity of the pulse or feed it to the other element of the CRT. Incidentally, blanking can be applied to the signal element, since the pulse should have no effect during picture-signal time, only during retrace time, when the beam should be blanked anyhow.

### Momentary vertical roll

*One of my customers complains bitterly because his TV sets rolls up a frame or two when there is a change in pictures, as when the station switches from program to commercial or from local to network programs. I've checked the set, and can't find anything wrong with it. The vertical hold is good.—A. P., Los Angeles, Calif.*

This "flipping" on changes of program material isn't uncommon at all. Many sets do it, and it can be pretty difficult to stop entirely. When a TV station changes from local to network program material, there is necessarily a change in sync: from locally generated sync to network sync. Even from local live to film camera, there is a change. Each camera may have its own sync generator. So, if there is a difference of a fraction of a frame in phase betwen the two pictures, there will be at the very best a slight jump. If the sync catches the vertical oscillator halfway between frames, then the picture will roll up, usually.

Some of this may be due to the way the customer is operating the set. If he has a habit of setting the vertical hold so that the picture is just barely locked in, in either direction, any disturbance can cause a momentary loss of sync. Also, check the picture proportions: if the picture is overscanned vertically, stretched, it will lose a great deal of its holding ability. Set it up for about ½ inch overscan at top and bottom, and the hold will be at maximum.

Tell the customer to set his vertical hold control near the center of its range. This will give him maximum stability, and the worst that should happen on picture changes will be a slight jump, as the new sync takes over.

You might also check the tiny vertical integrators used in this set. They are special "res-cap" combinations, and one of them could be leaking. This chassis should have very good "snap" in the vertical circuits; if it doesn't find out why.

### Vertical troubles

*When a Radio Craftsmen RC200 TV is turned on, the picture almost fills the screen, except for 3 inches from the bottom. After the tubes warm up thoroughly, the picture is only about 5 inches high, perfectly centered on the tube. It's in sync, showing only lack of height. Filters all good, tubes test good. Any suggestions?—D. B., Midland, Mich.*

Lots of 'em! Most of this trouble is due to weak tubes. Always test them by replacement; a tube-tester reading is sometimes misleading, especially in vertical output stages.

Check operating voltages on both oscillator and output stages. I believe you're going to find a defective resistor somewhere in the oscillator stage, because you say the picture is linear, though small. The worst offender in these cases is the oscillator plate load or dropping resistor, which is sometimes the same. If the oscillator plate is fed from B-plus boost, there may be an extra dropping resistor in there, around 150,000 or 270,000 ohms. Check it for drift in value under load.

### Metal-glass CRT conversion

*Can I use a glass 21ZP4-B picture tube in an RCA 21T207 TV set to replace a metal 21AP4? Will the glass tube fit in the sponge-rubber mount on the front, or will I have to modify it?—C. H., San Antonio, Tex.*

First question, yes. The 21ZP4-B is an exact replacement for the metal tube electrically. The -ZP4 is just a fraction of an inch longer overall.

As to the rubber mount, a lot of RCA's used a sort of plastic "socket" affair on the front (mask) which could be converted to hold the face of a glass tube by just cutting out some parts with a good sharp pocket-knife. These were the cabinet-mounted tubes, and the straps that held the original tube can be used to hold the new one. Best way: place the cabinet face down on an old quilt, etc. Carefully set new tube down on the plastic mask. Note where cutouts need to be made, then trim the mask until the new tube drops down against it to make the front look neat. Install the straps, tighten well and the job is done.

### Scott TV

*I am enclosing a copy of the operating instructions for a TV set I just got in. It's a "Scott", and I can't find a schematic for the thing anywhere. Can you help me?—J. T., Brooklyn, N. Y.*

Not too much, I'm afraid. However, even though I couldn't find any information at all on this brand name, I did notice one clue. On the back of the sheet you sent were the tiny letters "WG & C Series N71." This means that the set was originally built by the Wells-Gardner Co. for whoever sold it under the name of "Scott".

You can probably get the data from Wells-Gardner. Their address is Wells-Gardner Co., 2701 N. Kildare Ave., Chicago 39, Ill. Send to the service department.

If this doesn't work, try the "similarity method" we use so often. Get a schematic of another set made by Wells-Gardner using the same tubes, and you'll probably find it checks out pretty closely with the one you have.

### Change Inputuner to newer type?

*Is it possible to change the Inputuner on a DuMont RA-103 TV set to one of the newer types?—R. N., Brooklyn, N. Y.*

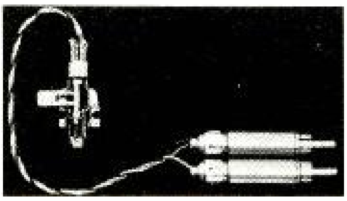
Your worst trouble here will be size: the original Inputuner was pretty small. However, Standard Coil now has a line of very small tuners, and one of them should be small enough to fit this chassis. Get the new Standard Coil catalogue and check the dimensions. (Be sure you pick a 20-mc type!)

Electrically, there is only one possible change. The DuMont has the first video i.f. coil on the chassis instead of inside the tuner. Try connecting the tuner output directly to the video i.f. grid, disconnecting the original first i.f. coil. If that doesn't work, short out the coil in the tuner and reconnect the original. Give the whole video i.f. a thorough sweep alignment, and you should wind up with a very nice job. END

# AUDIO EQUIPMENT REPORT

## *Sonotone Mark IV Ceramic Cartridge*

AN IMPORTANT AREA OF AUDIO PROGRESS which has not received the recognition it deserves is the recent improvement of ceramic phono cartridges. Virtually since the beginning of the hi-fi era in the late 1940's, magnetic cartridges dominated the field. Crystal and ceramic models were used mostly where low cost was more important than high fidelity. This concept has been challenged lately by a few quality ceramics offering, at a modest price, performance comparable to that of many magnetic cartridges. A case in point is Sonotone's Velocitone Mark IV stereo cartridge, model 9TAHC.



**SPECIFICATIONS**
(All specifications are the manufacturer's)

**Frequency response:** within 2 db of RIAA characteristic from 20 to 17,000 cycles. Deliberate rolloff to 20,000 cycles
**Separation:** 30 db
**Stylus mass:** 3 mg
**Compliance:** $15 \times 10^{-6}$ cm/dyne in all directions
**Tracking force:** 1.5 to 3 grams for professional arms; 3 to 4 grams for changers
**Output voltage:** 7 mv/channel with equalizers; 0.2 v/channel without equalizers
**Recommended load:** 47,000 to 100,000 ohms with equalizers; 1 to 5 megohms without equalizers
**Weight:** 3.2 grams

Unlike most current high-fidelity cartridges, 9TAHC is a turnover design with dual-tip stylus. One side has a 0.7-mil diamond for microgroove discs, the other a 3-mil sapphire for 78's. Serious collectors who still like to spin their vintage records once in a while will find this a great convenience. The 78-rpm styli for magnetic cartridges are hard to come by, and often a cartridge change is necessary between LP's and 78's.

Taking the Velocitone from its box, you notice that no stylus guard is provided. It isn't necessary. The so-called Sono-Flex anchorage of the stylus shank in butyl rubber is so compliant that it is virtually impossible to damage the stylus. No matter how it is bent, it snaps right back into proper alignment. If the tone arm is accidentally dropped or scraped across a disc, the elasticity of the stylus mount protects the record and prevents chipping the diamond. This design makes the cartridge resist rough handling and eliminates the need for additional protective devices in the tone arm.

The high compliance of $15 \times 10^{-6}$ cm/dyne in all directions accounts for the light tracking of the Velocitone Mark IV. When mounted for testing in a high-quality tone arm (Grado), the cartridge tracked most music at 1 gram stylus pressure. It had no trouble in even the heaviest orchestral passages at inner record diameters at 1.5 grams pressure—a feat that only top-rank magnetics will equal. In automatic record changers the recommended tracking force is 3-4 grams.

Specified frequency response is 20-17,000 cycles ±2 db with a deliberate rolloff to 20,000 cycles. When plugged directly into a high-impedance amplifier input (1–5 megohms), the cartridge automatically equalizes the RIAA recording curve. For amplifiers that have no separate input for ceramic or crystal cartridges, two plug-in equalizers are provided, one for each channel. With these equalizers on the input cables, the cartridge can be hooked up to any magnetic phono input without mismatch.

(Bear in mind, though, that old 78's were not recorded with the RIAA curve. When the cartridge is used to reproduce such discs, the bass must be reduced and the treble increased with the amplifier tone controls.)

Listening tests revealed that the character of individual instruments and of the human voice comes through quite free of artificial coloration. Despite the length of the stylus cantilever, its total moving mass is only 3 milligrams, which probably accounts for the absence of resonance peaks within the audible range. Percussive transients sound clean and snappy, without a trace of blur, and 30-db separation keeps stereo directionality clearly defined.

In A-B comparisons it seemed that the Velocitone did not quite equal the transparency of sound of the most advanced magnetic designs in heavy orchestrations. This difference was detectable only on an extremely fine speaker system. Surface noise was quiet and unobtrusive—further indication of peak-free response. Thanks to the high compliance, needle talk was very low.

Being nonmagnetic, the Velocitone cartridge is immune to hum. In hum-plagued sound systems, replacing a magnetic cartridge with a Velocitone might be advisable as a quick way to cure the trouble. And low-fi phonographs will be spectacularly improved if the Velocitone is substituted for stiff-jointed cartridges. The output of 0.20 volt per channel is sufficient without preamplification. With equalizers for magnetic inputs, the output is reduced to 7 mv so as not to overload the preamps. The cartridge can thus be used with virtually any phono amplifier.

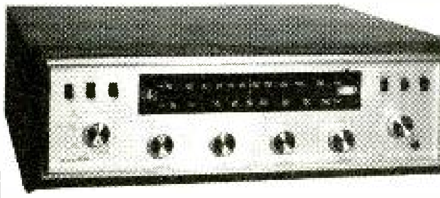
If any criticism can be leveled against this Sonotone design, it is that the terminal pins are too close together,

making it difficult to keep the pin jacks from touching each other.

The price of the Velocitone Mark IV with diamond tip for microgroove and a sapphire for 78's is $20.25 (model 9TAF-SDHCV). An alternate model with two diamond microgroove tips to provide double LP stylus life sells for $24.25 (model 9TAF-D77HCV). On both models the styli are instantly replaceable.—*Hans Fantel.*

## *Bogen RT1000 Transistor AM-FM Stereo Receiver*

THE BOGEN RT1000 IS AN IMPRESSIVE INstrument. Sounds fine, too. The only things to tip you off that it's all-transistor are the almost instant start (no warmup) and the hiss (back to that in a moment).



**SPECIFICATIONS**
(All specifications are the manufacturer's)
**Power output:** 50 watts per channel, 100 watts combined (IHF music waveform rating)
**Frequency response:** 15–45,000 cycles ± 1 db
**Distortion:** 0.6% at rated output
**Hum:** —60 db
**FM sensitivity:** 2.5 μv IHF
**AM loop sensitivity:** 75 μv per meter for 20 db quieting
**FM stereo separation:** 35 db at 1,000 cycles
**Monitoring output:** Stereo headphones
**Antenna:** FM, built-in line with external connection for balanced 300-ohm feed or 75-ohm coax cable. AM, ferrite loop. External connection for outdoor antenna
**Audio sensitivity:** Mag. phono 3.5 mv, Tape head 2 mv, aux 0.25 v
**Controls:** 6-position program selector, loudness, balance, tuning, separate bass and treble, volume, low filter, high filter, tape monitor, mode, phase, afc, power, reverse, output
**Output impedances:** 8/16 ohms
**Outputs:** Speakers, tape, third-channel, headphones
**Inputs:** Mag phono, tape head, aux, tape monitor
**Multiplex:** Time-division type with "stereo-minder" indicator and tape recording filter
**Semiconductor complement:** 43, 22 diodes
**Accessories:** Walnut cabinet — model WE10 ($29.95 extra)
**Dimensions:** 16-3/16 in. wide x 4-5/8 in. high x 15-13/16 in. deep, including knobs
**Price:** $549.95

The RT1000 has a line-cord FM antenna built into it, and I was curious to see how it worked. Pretty well, for strong-signal locations (just what you'd expect, really). The only other qualification is that such an antenna seems more prone than even a simple dipole to multipath reception and consequent distortion in stereo. I was surprised at first, until I realized that such an antenna includes a tremendous length of wire: the set's cord itself, then who-knows-how-many feet of power wiring in the walls, and so on. And the direction of the wiring is anything but constant. But the receiver's performance with its own antenna was good enough on almost all stations in metropolitan New York to be completely satisfying.

The audio quality is crisp and up to the best modern standards. It's difficult to find anything new to say about it; it's not really distinguished in any particular way. That's probably the highest compliment one can pay an audio instrument.

Again—a qualification. The hiss I mentioned at the beginning of the report is common to many all-transistor amplifiers and receivers. In this one, it is present even at zero volume, like a faint surf noise. It is more prominent with the volume (loudness) control turned up, but of course it is often masked by program material. Not always, though. At moderate volume settings, during soft musical passages in a quiet room, it is definitely noticeable. More so with earphones.

An unusual feature of the Bogen RT1000 is the way some circuit functions are switched. Pulling the loudness control knob out turns the control into a straight, uncompensated volume control. Pulling out the treble control knob switches in a treble filter (with a sharp pop!). Pulling the bass control puts in a low-cut filter. And (I think this is an especially nice touch) pulling the balance control reverses the channels! This approach increases control flexibility without making the panel look like something out of a spaceship.

If any one thing could be singled out to distinguish the RT1000, it would be that control flexibility. The receiver has about every control and switch feature that could possibly be useful, including afc defeat, channel phase, tape monitor, speaker on-off, in addition to the pull-knob ones. Exception: no stereo noise filter. Front-panel headphone jack, though, which is good for a gold star in my book.

The RT1000 can receive AM, too. Why, I don't know. After spending half an hour or so listening to FM and FM stereo, I switched to AM and was greeted by a mixture of fluorescent-light hash and motor noise, salted with a few dozen treble-less stations. About half of them could be received painlessly with perfect clarity on FM. The RT1000 has no whistle filter.

On the back of the chassis are loud (visual) warnings not to short the speaker terminals. Good idea, for a shorted output is the easiest way to do-in a transistor amplifier in milliseconds. The manufacturer meets the user halfway by spacing the terminal screws an inch apart, making it practically impossible to get a stray wire strand snuck out from under one screw to touch the other. In case someone manages nevertheless, there are fuses.

The back of the chassis also bears a "third-channel" output jack, for connecting a center-channel speaker or mono extension (remote) speakers.

The manual with the receiver is concise but comprehensive, rounding out the favorable overall impression I had of the RT1000.—*Peter E. Sutheim*

# test equipment reports

*Eico 430 general-purpose oscilloscope*

THIS 3-INCH SCOPE IS TRULY PORTABLE. It weighs but 11 pounds and takes about as much room as 24 issues of RADIO-ELECTRONICS (8½ inches high, 5¾ inches wide and 11¼ inches deep). The front panel is smaller than that of some vtvm's.

To make this size possible, front-panel controls have been reduced to a minimum for the simplest possible operation and less confusion. It's very difficult to grab the wrong knob when you're in a hurry. Automatic sync eliminates the sync-gain control.

There is a MuMetal shield around the neck of the 3-inch flat-faced CRT. This reduces the effects of external magnetic fields—the scope's power transformer and others nearby as well as things like motors and fluorescent light ballasts.

The 1,500-volt power supply gives a sharp, bright trace with no "blooming". Intensity and focus controls are on the front panel. Astigmatism adjustments can be made without removing the cabinet.

The intensity modulation input has an impedance of 2 megohms shunted by 25 pf.

The preamplifiers and sweep oscillator are powered from a voltage-regulated point on the power supply bleeder. The sweep amplifier tubes use 400 volts B-plus, unregulated.

The vertical amplifier is flat from 2 cycles to 500 kc and down 6 db at 1 mc. The sweep sensitivity is 25 mv per centimeter. Input impedance is 1 megohm shunted by 30 pf, through a switchable 100:1 coarse attenuator into a cathode follower. Putting the "fine" gain control at the cathode-follower output increases the high-frequency response.

Vertical centering will let any part of the trace be centered on the CRT even when the vertical gain is set high enough to make the trace more than three times the CRT diameter. Such an expanded trace give details equivalent to the trace on a 9-inch CRT.

Expanded traces on the horizontal sweep are only twice the diameter of the CRT face. The horizontal amplifier is flat from 2 cycles to 350 kc with a sensitivity of 250 mv per centimeter.

The sweep selector has four overlapping ranges of sawtooth sweep from 10 cycles to 100 kc as well as 60-cycle sine-wave sweep. The four sawtooth sweep ranges have full retrace blanking with a choice of internal or external synchronization. The external sweep input is also selected by the sweep range switch.

The frequency response of the vertical amplifier is sufficient for most hi-fi, radio and black-and-white TV work. It can be used with a sweep generator for i.f. alignment. Video-signal and sync-pulse waveform observations will not be distorted by what may seem to be too low a high-frequency limit (500 kc). The color-burst frequency (3.85 mc) will not

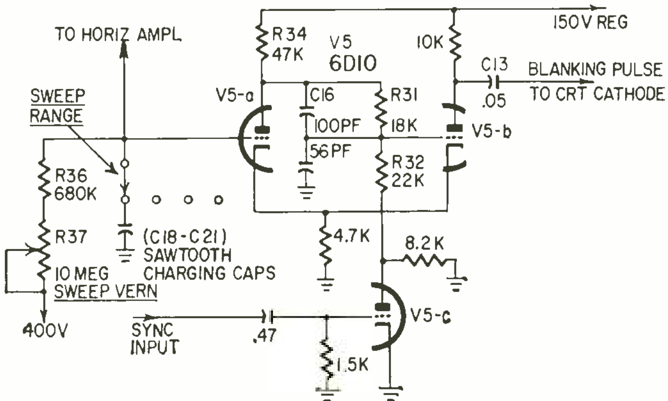



*Fig. 1—Compactron type 6D10 triple-triode is used in Eico 430 as sawtooth sweep generator, blanking pulse generator and automatic sync.*

be visible—it is too far out of the amplifier bandpass.

Jacks and a switch make it easy to connect directly to the vertical deflection plates for making percentage-modulation tests on AM transmitters.

For technicians who have never used a scope with automatic sync, this unit will be a surprise and a treat. The juggling of the horizontal sweep vernier and sync-gain controls to get a stationary trace has been eliminated. All waveforms snap right in as long as the horizontal sweep isn't set too far off frequency.

This pleasure is made possible by a circuit using the 6D10 triple triode (Fig. 1). The three triodes provide the sawtooth sweep, retrace blanking and automatic sweep synchronization. Switches have been eliminated to simplify the circuitry.

The sawtooth charging capacitors are in the grid of V5-a. Whichever is selected charges through the 10-meg sweep vernier control (R37) and R36 across the 400-volt source.

When the grid of V5-a becomes positive with respect to the cathode, the capacitor discharges through the tube which, at this instant, might just as well be a diode—with the grid acting as an anode (plate). This discharge (the retrace) and the slow-charge waveform are fed to the horizontal amplifier.

The current flow during this discharge causes a voltage drop across R30—cutting off both V5-a and -b. With V5-a cut off, the voltage at the plate of V5-a rises and makes the grid of V5-b more positive (through R31 and C16). The current flow through R30 and V5-b keeps V5-a cut off and allows the sawtooth charging capacitor to charge.

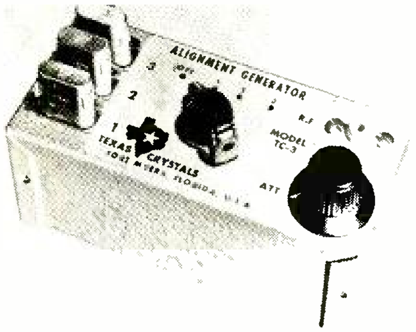
When the voltage on the grid becomes more positive than its cathode, the capacitor discharges—starting the sweep cycle over again.

When both V5-a and -b are cut off, the voltage at the plate of V5-b rises sharply. The pulse drives the cathode of the CRT more positive (through C13) in relation to the CRT grid and the electron beam is cut off—the tube is "blanked" during the retrace.

The sync-control triode (V5-c) also controls the bias on V5-b. When V5-c is driven into conduction by a positive synchronization pulse on its grid, the voltage drops across R34 and R31 increase. This makes the grid of V5-b less positive. With the grid of V5-b less positive, the flow through the tube drops and V5-a can conduct sooner. When the capacitor discharges through V5-a, the sweep oscillator cycle starts. V5-c controls the point at which the retrace starts.

The Eico model 430 is priced at $65.95 as a kit, and at $99.95 wired.—*Elmer C. Carlson*

## *Texas Crystals Alignment Generator Model TC-3*




TEST SIGNALS ARE VERY HANDY BUT they must be accurate. The crystal oscillator is the easiest way of getting accuracy. Texas Crystals' TC-3 test oscillator can provide any three selected frequencies between 200 kc and 3 mc, with crystal accuracy. Many harmonics are also usable, as with any crystal oscillator like this.

Literally small enough to be held in the palm of your hand—and transistorized, of course—the TC-3 uses a standard 9-volt battery. Three small standard crystals are plugged into the row of sockets on the left end and a combination on-off switch and crystal selector is in the center. A 250,000-ohm pot is used as an attenuator, and rf output varies from 100 mv at the high end of the range, around 3 mc, to 500 mv at the low end. Rf output is taken from a standard phono type coaxial jack; a 50-pf blocking capacitor in series with this cable is recommended, just in case you happen to hit a high-voltage point in the circuit under test!

This unit may be ordered with any three crystals in its range. Each is calibrated at the factory, and the actual frequency is entered on the instruction sheet. I chose a 1-mc crystal, which was given as 1,000.004 kc (well within the .002% tolerance claimed by the maker). Beating the 10th harmonic of this against WWV on 10 mc, I could hear an audio beat note which was very close to 40 cycles, without making a precision measurement. This accuracy is ample for all service shop usage, and the stability is excellent. I left it hooked up for about 15 minutes on zero-beat with WWV, and the drift wasn't perceptible to the "naked ear."

An instrument like this could be very handy in the shop, especially for remote use: auto radio, two-way radio and such. We aligned a car radio, in the car, as a test, on 260 kc, checked the low i.f. of a two-way FM receiver at 455 kc, in the car, with the greatest of ease. CB radio work could be made easy by choosing the special 2708-kc "Frequency Spotter" crystal offered; crystals for any CB channel (on the appropriate harmonic, of course) could also be used, as could the i.f. crystals. The signal is not modulated, but you can get indication of output from the set in several ways: in FM receivers by using the built-in grid-current metering system, in CB sets with a vtvm on the avc line, etc.

Battery life should be good, if you remember to turn the oscillator off each time you're through with it! By the way, this would be a dandy instrument for setting up antenna trimmers on CB rigs, after installing them in the car. You can put a small radiator on a phono plug, hook it to the TC-3 and then set the thing on the fender, so that it radiates a weak signal into the antenna. This will allow peaking the trimmer very precisely, since the signal strength can be adjusted by moving the oscillator farther away or nearer.

Price of the Texas Crystals TC-3 is $29.95 complete with three crystals.—*Jack Darr*

# New Semiconductors and Tubes

### Now: 10-pin miniatures

Four new standard-size miniature tubes with 10-pin ("decal") bases have been announced by Amperex. The tubes originated in Holland with the Philips Co.'s Electron Tube Div.

The four tubes are the 6X9, 6U9, 6W9 and 6V9.

Why the 10-pin bottoms? The extra connection is used to get greater flexibility of internal element design and

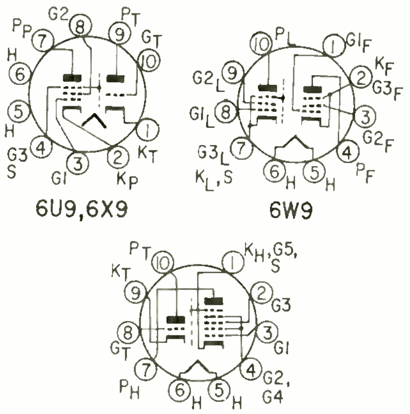
connection. For example, in the 6X9/ECF200, a triode–pentode, the pentode's suppressor is connected, together with an internal inter-section shield, to a separate base pin, and not to the cathode as in earlier designs. Thus it and the shield can be grounded, to give less interaction between sections. The same structure applies to the 6U9 ECF201.

The EFL200 (6W9) is a double pentode. The "F" (voltage-amplifier) section can be used as a sound-i.f. amplifier

*(continued on page 72)*

fier, agc amplifier or sync separator. The "L" (power) section is designed as a video output stage, and can provide 100 volts of composite video signal with a plate load of 2,000 ohms.

The remaining tube, the ECH200/6V9, is a triode-heptode for use as sync amplifier and sync separator. Both sections are completely independent (except for the heater) and shielded from



6U9,6X9 6W9 6V9

each other—a result of using the 10-pin base.

The 10-pin base has the same pin-circle diameter as the familiar 9-pin (noval) miniature. Room for the extra pin comes from reducing the spacing between pins. According to a Philips bulletin, increase in interelectrode capacitance as a result of the closer spacing is negligible.

Ultimate objective of the new design is to make possible more compact TV sets by combining functions that till now had to be handled by separate tubes.

### "Fast Fax" tube data file

A unique card file of condensed characteristics of the latest receiving tube types has been introduced by Raytheon Co.'s Industrial Components Division. The file is designed for ready reference by technicians, service dealers and tube distributors.

Tube data and basing diagram are on the same side of the card, so that all pertinent information can be seen without turning the card over. Tabbed index separator cards make it easy to locate tube cards. The set comes complete with


100 most-popular tube types and all new ones registered with the EIA in 1962, 1963 and the early part of 1964. It will be kept current with supplementary cards mailed automatically to subscribers. The first supplement, due in September, will include all new types used in 1965 radio and TV sets.

Each card slides onto binder rods in the file holder without tools or dismantling. Cards can be removed, but will not come out accidentally.

Also included is an inventory control form on the back of each card, and an interchangeability guide. Suggested list price for the file, with one-year supplement service, is $3.95. It is being offered through franchised Raytheon distributors.

### Triac

A special silicon power semiconductor—a gate-controlled ac switch with three leads—has been announced by General Electric. It works more or less like two silicon controlled rectifiers connected in parallel back to back.

This characteristic permits it to conduct and control full-wave ac rather than pulsating dc as a single SCR does.

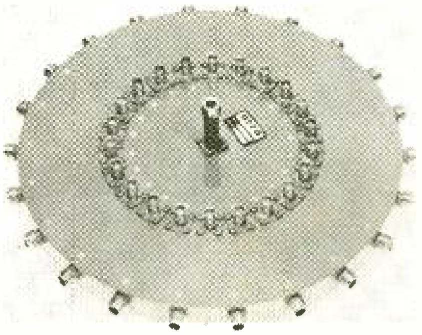
The Triac requires less than 3 volts at less than 50 ma to trigger it into conduction. The gating (or triggering) signal may be dc, ac or short pulses of either polarity.

G-E expects the Triac's widest application in explosion-proof static contactors for on–off switching of motors and lighting; motor starters and controllers; temperature regulators; welding controls, etc.

The device is packaged in conventional stud-mount or press-fit housings. A photo of it appeared on page 43 of the April 1964 RADIO-ELECTRONICS.

### 22-throw diode coax switch

An all-solid-state diode coaxial switch with 22 positions has been announced by ARRA (Antenna and Radome Research Associates). The units are usable up to 2 gc, have a maximum insertion loss of 3.5 db and a minimum



isolation of 30 db, and can handle up to 1 watt. Switching time is 100 nsec.

The switches are used for multichannel antenna receiver switching applications, antenna lobing, and beam shaping in phased and steerable antenna arrays. Similar units, with insertion losses of only about 1 db, are available for the 100- to 1,000-mc range.

The price depends on the customer's requirements, but be sure you really need one before you order. The price will range from $900 to $1,500. END

# TECHNOTES

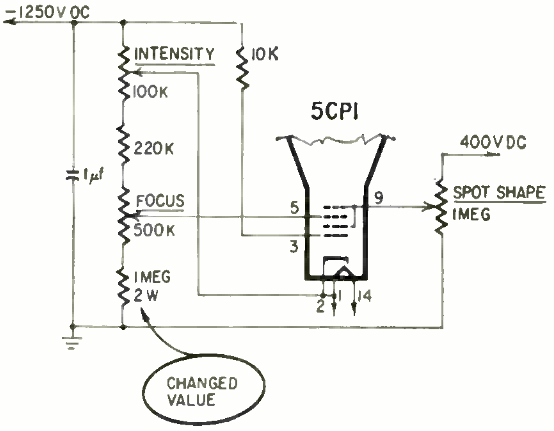
### INTERMITTENT IN BROWN MODEL 152 ELECTRONIC INDUSTRIAL RECORDER

When you troubleshoot one of these recorders for intermittent, erratic operation (after you determine that the electronic amplifier and the measuring circuit components are not at fault), check the wiring harness located at the top left side of the instrument case. Loosen the chassis latch and swing the chassis out of the case. The harness, a laced cable, has a flexing point between the moving chassis and the clamp on the case. The wires in the harness eventually break because of this flexing, causing a hard-to-find intermittent. The harness must be replaced.—*F. G. Lewis*

### POOR FOCUS IN HEATH 0-8 SCOPE

The user of this oscilloscope found he couldn't focus the trace until the focus pot was all the way against one end stop. Brightness control was satisfactory.

The trouble was traced to the 1-megohm resistor at the bottom of the string (see schematic). Its value had risen to over 2 megohms, throwing the range of voltage adjustment beyond the value needed by the CRT. A new resistor restored proper focus control.—*Donald R. Hicke*




### REMEDY FOR INSUFFICIENT WIDTH

In sets with insufficient width (and no width control), after everything is known to be working correctly, try increasing the value of the horizontal output-tube screen resistor by 50% to 60%.

This reduces high voltage. To restore it to its former level, you will usually have to decrease the capacitor in the damper circuit by about 25% to 30%. Use a ceramic rated at 6 kv.

The changes can increase width by 2 inches or sometimes more.—*E. L. Deschambault*

### INSUFFICIENT HEIGHT IN MOTOROLA TS-581, -584

A loss of vertical size in these chassis may be the result of an increase in the resistance of the 3.3-megohm resistor in series with the vertical size control. Sometimes the resistor may open up completely, killing the vertical sweep altogether.

This resistor is part of the vertical size and noise-gate control assembly and so can't be replaced separately. But

*Continued from page 25*

so strong that it will transilluminate the thickest part of the body. Thus the physician by accurate focusing can actually see *in three dimensions* your heart as it beats, *probably in full color*. He can also see the heart's interior and watch the working of the heart valves. He will watch the actual working of many of your glands, either with his own eyes, *by photography, or by motion pictures*.

"When that time comes, *and it is coming*, we will at long last know what makes us really tick."

**This was written long before the laser was invented. Now we have a most powerful new tool, which the present writer believes will in the not too distant future be used to transilluminate the body. Using ordinary X-ray techniques but substituting a laser or related means, it should be possible to use a super-power beam or ray of coherent laser light that is sufficiently powerful to pierce any part of the human body. Then by focusing it accurately on any organ it can be transilluminated—probably in color—in its entirety. The new technique simply depends on the correct amount of applied power and intensity to achieve penetration of an opaque—or, let us say, a semi-translucent—subject, the body. The intensity of *pulsed* laser light is stupendous, many thousands of times greater than even sunlight.**

**Will the patient not be burned? No, not with the correct filters and, more important, the correct time exposure of the body. Future exposures—similar to present-day X-rays—will be done in very small fractions of a second.** —*H.G.*



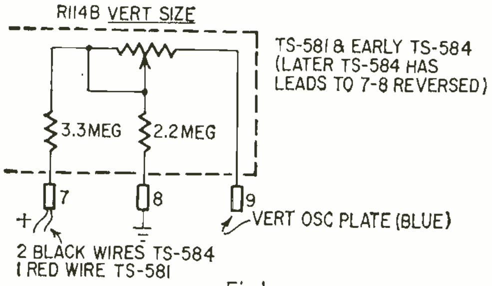



Fig.1

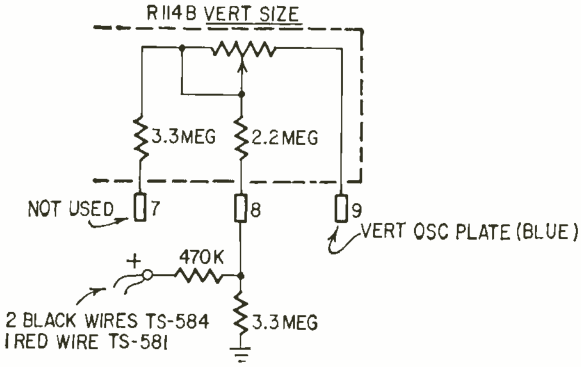



Fig.2

you can avoid having to replace the entire package by rewiring the circuit slightly. This will also prevent recurrence of the trouble. Fig. 1 shows the original circuit, and Fig. 2 the rewired version. You will have to ground the *horizontal* module at any convenient point.—*Motorola Tech-Review*

### PULL-TYPE SPEAKER SWITCHES ON GERMAN RECORDERS

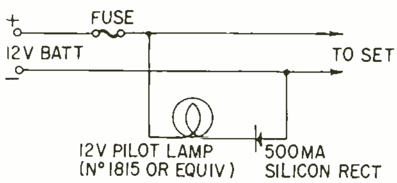
The Grundig TK40 and TK42, and the Uher SR 111 use pull type speaker cutouts. Lifting the volume knob disconnects the internal speaker when the recorder is used to drive other systems.

If you have to remove the volume knob, leave plenty of clearance between the knob and the surface below when you replace it. Putting the knob too far down on the shaft may make it impossible to turn on the internal speaker.

When you return one of these machines to the customer, make sure the switch is in the ON position. Nontechnical people who have never used the switch may not be able to operate the machine and will bring it back to you.—*S. P. Dow*

### BATTERY POLARITY WARNING REDUCES SERVICE CALLS

In my area (Vancouver Island, British Columbia) there are many remote logging camps where people rely heavily on portable radiotelephones. Since these are mainly nontechni-




cal people, reversed battery connections often mean a long airplane trip to a service technician. In transistor or hybrid equipment, wrong polarity can ruin a set.

To combat this, I include the circuit shown here in all installations. If connections are reversed, the bulb lights, warning the operator before he turns the set on.—*A. A. Lamont*

### FAULTY TUNER CAUSES INTERMITTENT PICTURE

In Motorola TS-539's, the three wafer strips in the tuner *plug in* to the tuner, and the plugs and electrical connections on each wafer are *bradded* instead of soldered.

# Coming Next Month in Radio-Electronics

### ADD A MECHANICAL FILTER

Would you like to tune out stations on 1460 and 1470 kc and tune in a European on 1466? That's what our reviewer did when testing this little device. Using a Collins magnetostriction filter, and a single transistor, this unit plugs into an i.f. tube socket, is a great help in separating crowded stations on the broadcast band or short waves. Next month—how you can do it.

### FLEXIBLE HOME INTERCOM

A system that permits any station to call and speak to any other, without going through a "master" station; to address all other stations simultaneously, or to switch to a "music mode" and listen to background music. In addition any station can switch so it cannot be called, and no station can be monitored arbitrarily by another. Only one amplifier (transistor-type) is used for the whole system.

### MAKE MONEY WITH ELECTRONICS AFLOAT

The vast number of pleasure boats and the increasing amount of electronic gear they carry means there is a lot of work around for the service technician who goes after it. Marine equipment is simple and straightforward (at least compared to TV!) but the work calls for its own approaches and techniques.

### RELIABLE TRANSISTOR IGNITION SYSTEM

A three-transistor circuit that makes it possible to construct a transistor ignition system without buying a special coil. Also makes Zener diodes unnecessary. Our checker reports "Acceleration and engine smoothness seemed improved, especially on long upgrades. Gas economy up. . . ."

*You'll find these and many other articles, features and regular departments in next month's* RADIO-ELECTRONICS.

**SEPT. ISSUE (on sale Aug. 18)**



After a short time, the brads loosen or oxidize, and the result is intermittent or very poor reception. Each wafer section must be removed very carefully and all pins and brad connections soldered with a small gun or soldering pencil. To remove the wafer strips, the tuner must first be removed and the following steps completed:

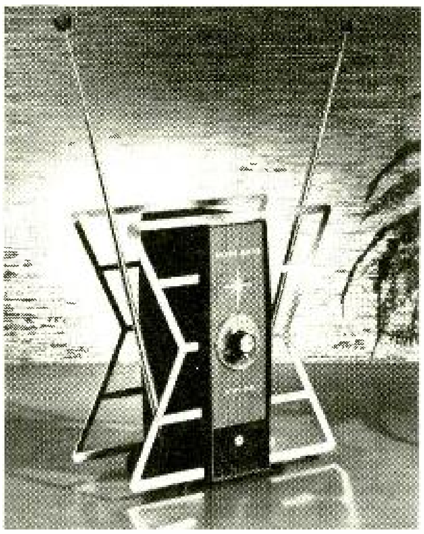
(1) Remove the seven mounting screws holding the tuner to chassis.
(2) Drop the front end of tuner downward so that it protrudes toward the bottom of chassis.
(3) On automatic-tuning models (motor on rear of tuner), remove the motor mounting screws and remove motor from tuner.
(4) Remove the screw holding the automatic channel-selector disc to the rear of the tuner shaft. Remove the disc.
(5) Remove the tuner cover plate to get at the wafer sections.
(6) Remove Phillips screw holding the tuning shaft to detent mechanism.
(7) Remove shaft by pulling straight out from the front of the tuner.

Each wafer can be removed by pulling it firmly but carefully out from the bottom of the tuner. After soldering each brad connection, replace the wafer carefully and see that each wafer pin is properly in place. Use a minimum of solder around pins.—*John B. Ledbetter*

**BURNED VERTICAL OUTPUT RESISTOR IN PACKARD-BELL 99 CHASSIS**

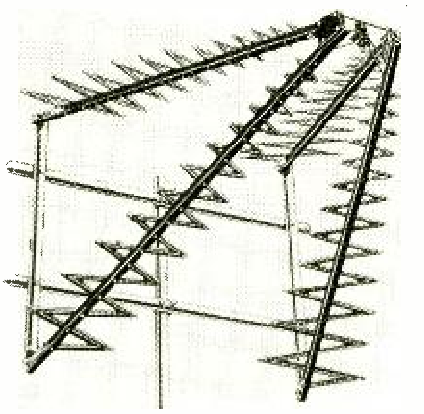
Whenever one of these sets loses boost voltage, the vertical output tube's plate dropping resistor burns up. The reason is that the vertical oscillator's plate supply is from the boost, while the vertical output stage draws its current from B-plus. When boost disappears, the oscillator stops, removing drive from the output stage grid. The output stage's plate current soars, burning the resistor.—*Joseph K. Nicholson* END

# new Products



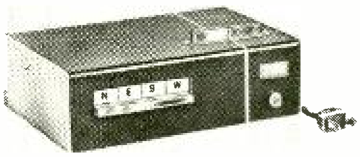
**INDOOR ANTENNA**

*VU-82, model 4000,* for uhf/vhf/FM. 2 antennas in one, each with own transmission line. Uhf diplexer circuit gives unidirectional pattern, can be automatically reversed 180° by switching, lets both uhf dipoles operate simultaneously, with twice gain of single antenna. Electronic tuner matches antenna's 300-ohm impedance to set and adjusts length of vhf elements to wavelength of channel. 96-in. elements joined to 10-in. walnut-grained column.—**Channel Master Corp.**, Ellenville, N. Y.



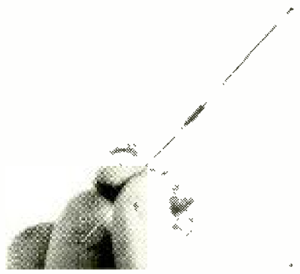
**LOG-PERIODIC TV ANTENNA FOR UHF**

*LPV-ZU20: Zig-a-Log* beam widths no less than 20° for easy orientation, uniform gain and impedance across wide bandwidth. Maximum usable gain for weak signal areas and minimal side lobes for ghost rejection. Input impedance matches 300-ohm transmission line. Vswr less than 1.8:1 across uhf channels. E- and H-plane beam widths have 1:2 ratio. Gain 16.5 ±½ db over half-wavelength dipole. Aluminum elements, stainless steel take-offs.—**JFD Electronics Corp.**, 15th Ave. at 62nd St., Brooklyn 19, N. Y.



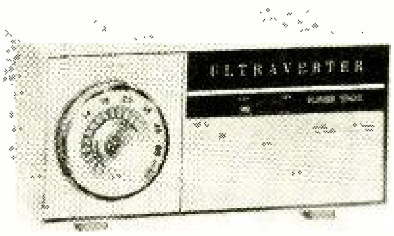
**ANTENNA ROTOR SYSTEM**

*TR-2C,* features new control box with heavy-duty CD rotator. Finger-touch control. By depressing lever to left or right, antenna is rotated and position monitored by series of compass lights. Black leatherette and brushed aluminum. 6 x 4 x 2 in.—**Cornell-Dubilier Electronics Div.**, 50 Paris St., Newark 1, N. J.



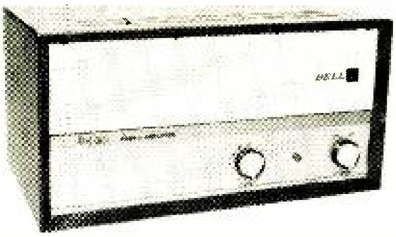
**CORDWOOD-SIZE CERAMIC CAPACITOR**

*MC-70.* Ratings from 10 to 20,000 picofarads. For automatic insertion in printed circuits. 0.260-in. maximum length by 0.100-in. maximum diameter, with axial leads at least 1½ in. long.—**Aerovox Corp., Distributor Div.**, New Bedford, Mass.




**TUNNEL-DIODE CONVERTER FOR UHF**

*Model BTD-44 Ultraverter* cordless unit, uses single flashlight battery as power supply. Converts all uhf channels to vhf channel 5 or 6.—**Blonder-Tongue Labs, Inc.**, 9 Alling St., Newark, N. J. 07102



**BOOSTER AMPLIFIERS**

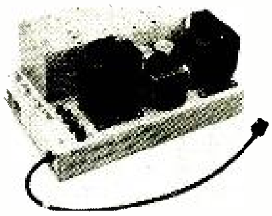
*35BA* and *75BA*, 35 and 75 watts, respectively, for additional power as slaves to main PA system. Used with Bell *BE-M4* microphone mixer to form complete PA system. Signal-to-noise ratio over 75 db, frequency response 30 to 15,000 cycles. Plug-in relay for remote control of ac power or standby operation. Styled like *BE* series; bridging input standard but converts to 600 ohms balanced line with plug-in transformer input.—**TRW Columbus Div., Thompson Ramo Wooldridge, Inc.**, 6325 Huntley Rd., Columbus 24, Ohio.

**HAZARD SENSOR**

Has circuit breaker and fast-acting fault detector for 50/60 cycle ac. Protects equipment operators and others from electrical shock, instantaneously shuts down equipment when faults develop, detects danger from hot lines and opens source before shock hazard develops. Can be set on ac or pulsating dc.—**Shock-Proof Electronics, Inc.**, 1601 Girard Trust Bldg., Philadelphia, Pa. 19102

**ELECTRONIC NOTEBOOK**

Transistorized, records up to 30 minutes on 1 tape. Picks up ordinary conversation 25 ft away. Rewinds in less than 3 minutes. Built-in speaker. 1½ lb, 2 x 3½ x 5 in. Powered by standard 1.5-volt penlight batteries. Remote-control microphone, earphone, 4 batteries, tape, extra reel, leather carrying case, shoulder strap. Telephone pickup for recording phone conversations available.—**Hahn Co.**, Dept. R-E, 3408 Motor Ave., Los Angeles, Calif. 90034

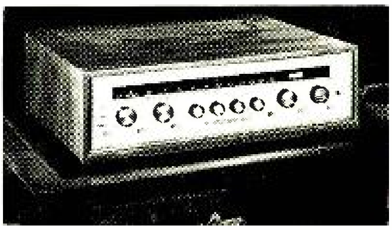


**TV/FM DISTRIBUTION AMPLIFIER**

*Model LHD-404R.* Feeds low and high vhf TV and full FM signals into as many as four distribution lines with output level of 50 db above 1 mv at channel 13. Fed from directional coupler or from end of distribution line; serves as either bridging or distribution line extender. Feeds 1½ miles of distribution lines.—**Entron, Inc.**, 2141 Industrial Parkway, Silver Spring, Md.

**ORGAN KIT**

*Cinema*, smallest Artisan theater organ—30 in. deep, 46 in. high. Meets AGO specs with 3 full 61-note manuals, concave 32-note clavier. Intermanual couplers, twin expression pedals, independent vibratos, independent oscillators for each key, built-in music light and preset combination pistons. Stop list of authentic theater voices. Chimes, orchestra bells, vibra harp and band box optional. Variety of finishes.—**Artisan Organs**, 2476 N. Lake Ave., Altadena, Calif.

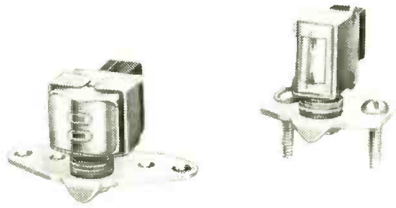


**TUNER/AMPLIFIER**

*S-8000IV.* 80 watts. Powered center speaker channel for center or third-channel speaker system or extending mono speakers in other rooms. Front-panel stereo headphone jack and speaker disabling switch. 1.8 μv (IHF) FM sensitivity. 2.4-db capture effect. FM interchannel hush. FM distortion ⅓% at 100% modulation. 8-inch tuning dial with frequency markings every 200 kc.—**Sherwood Electronic Laboratories, Inc.**, 4300 N. California Ave., Chicago, Ill. 60618

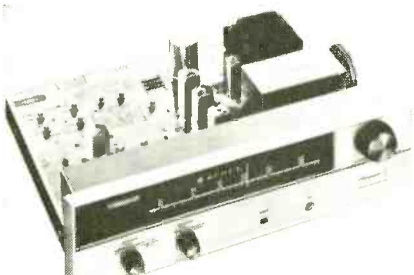

**MINIATURIZED POWER SUPPLY**

Lectrocell replaces dry battery in vtvm ohmmeter circuit. Same size and shape as 1½-volt battery it replaces.—**Lectrotech, Inc.**, 1737 W. Devon Ave., Chicago, Ill. 60626



**REPLACEMENT TAPE HEADS**

(for Sony tape decks and recorders). Laminated professional type, match Sony models 101, 262-D and 262-SL. Packed in kit with mounting hardware, replacement pressure-pad material and instructions.—**Nortronics**, 1801 Nicollet Ave., Minneapolis, Minn. 55403



**TRANSISTOR FM STEREO TUNER**

*Model 312.* Silent automatic stereo switching not affected by momentary changes in signal strength; usable sensitivity (IHF) 2.2 μv (minimum); signal-to-noise ratio 65 db, distortion under 0.8%; drift less than 0.02%. Frequency response (stereo) ±1 db, 30–15,000 cycles. Capture ratio 4 db; selectivity 35 db; cross-modulation rejection 80 db. AM suppression 55 db; accuracy of calibration 0.5%; separation 35 db; 4 all-silicon i.f.'s. 15½ x 5¼ x 13¼ in.—**H. H. Scott, Inc.**, Dept. P, 111 Powdermill Rd., Maynard, Mass. END

*All specifications from manufacturers' data.*

# New Literature

booklets · catalogs · charts

**CRYSTALS AND EQUIPMENT CATALOG.** 24 pages, 2 colors, photos, charts and curves. Lists commercial crystals, crystal ovens, amateur and CB crystals, accessories, oscillators, frequency-alignment equipment, transistor subassemblies, transmitters oscillators, converters and 3 pages of technical data for 1964.—**International Crystal Mfg. Co. Inc.**, 18 No. Lee, Oklahoma City, Okla.

**RELAY CATALOG.** 20 pages, 2 colors, describes line of standard industrial relays. Photos and charts, sectioned into high-performance, power, special, general and telephone types. Lists coil voltages, resistances, time values, contact ratings, terminations, dimensions for each relay.—**Potter & Brumfield, Div. of American Machine & Foundry Co.**, Princeton, Ind.

**TRANSISTORS AND DIODES WALL CHART.** *CH-10-50M*, 19 x 25 in., 2 colors. Lists 40 basic semiconductor replacements for EIA types, private-manufacturer and foreign types.—L. Rivman, **Semitronics Corp.**, **265** Canal St., New York, N.Y. 10013

**GLOSSARY** of 99 tape recording terms, 4 pages of well-spelled-out definitions of some of most common terms.—**3M Co.**, 2501 Hudson Road, St. Paul 19, Minn.

**PERMANENT MAGNETS.** *Bulletin 21* describes bars, multiple bars, rods, U-shapes, cylinders, arched and channel horseshoes and rings. Photos, charts, and dimensional drawings. 12 pages, 2 colors.—**Indiana General Corp., Magnet Div.**, Valparaiso, Ind.

**SEMICONDUCTORS.** 8-page brochure containing 8 typical circuits for n-p-n germanium alloy transistors, including characteristic curves in industrial and entertainment applications.—**Sylvania Electric Products Inc.**, SM-3929, 1100 Main St., Buffalo, N.Y. 14209

**STEREO COMPONENTS CATALOG** *CL-643*, 16 pages, describes full line of tuners, amplifiers, receivers, tape decks, tape recorders with specs and photos.—**Bell Sound, TRW Columbus Div.**, 6325 Huntley Road, Columbus, Ohio

**SERVICE COMPONENTS CATALOG** for 1964. 20 pages, photos, graphs and diagrams of line of wirewound and carbon potentiometers, fixed value or adjustable wirewound resistors, switches. —**Distributor Div., Clarostat Mfg. Co. Inc.**, Dover, N.H.

**INSTITUTE PAMPHLET.** "Opportunities in Electronics For You." 28-page booklet with photos suggest areas open to electronics technicians—**Cleveland Institute of Electronics, 1776** E. 17 St., Cleveland, Ohio

**CATALOG** of Teflon terminals including standoffs, feedthroughs, "cloverleaf" receptacles, bushings, test-point jacks, taper pin receptacles, probes and plugs, transistor units. Cross-indexed 40 pages with dimensional drawings, photos, specs. **—Sealectro Corp.**, 225 Hoyt St., Mamaroneck, N.Y.

**ELAPSED-TIME INDICATORS**, miniaturized *series 95C* and others described in 8-page booklet with photos, diagrams and specs.—**Elgin National Watch Co., Communications Div.**, Industrial Group, 366 Bluff City Blvd., Elgin, Ill. 60120

**OPTOELECTRONIC CONTROL DEVICES** folder describes 19 models of 4-terminal units operating via controlled light falling on photoresistive element. Photos, diagrams, chart.—Richard Finger, **Raytheon Co., Industrial Components Div.**, 55 Chapel St., Newton, Mass. 02158

**STEREO EQUIPMENT**—small folder describes *Allegra* series of stereo amplifiers, tuners and receivers. Photos and specs.—**Grommes, Div. of Precision Electronics Inc.**, 9101 King St., Franklin Park, Ill.

**DC POWER SUPPLY DESIGNS.** *Form 1039*, electrical data sheets to build 36 miniature power supplies including transformers, rectifiers and filters. Dc voltages from 10 to 80, power rating from 280 mw to 24 watts.—**J. S. Conklin, Magnetic Circuit Elements Inc.**, 3720 Park Place, Montrose, Calif.

**COAXIAL CABLE** *Catalog CC-5*, 16 pages, describes construction and characteristics of 58 coaxial cables made with polyethylene and Teflon insulation. Photos and charts.—**Alpha Wire Corp., U.S. Wire & Cable Div.**, 180 Varick St., New York, N.Y. 10014

**CAPSULE THERMISTOR** *Course No. 6*, "Thermistor Probe Assembly Design" discusses housing configurations for a thermistor probe assembly in a given application. Single loose-leaf page.—Sales Engineering Dept., **Fenwal Electronics Inc.**, 63 Fountain St., Framingham, Mass.

**RECTIFIER LEAFLET.** 4 pages outlining line of copper oxide instrument rectifiers with color code, specs, dimensions and internal circuits.—**Conant Labs**, Box 3997, Bethany Sta., Lincoln 5, Neb.

**BRUSHLESS GENERATORS** *Bulletin GET-3137*, 16 pages punched for ring binder describe 3 components of set—brushless generator, brushless exciter and SCR voltage regulator—no brushes, slip rings or commutators. Characteristics, photos, charts and circuit diagrams of SCR voltage regulator. For use where continuous or stand-by power required; can be direct-connected to gas or steam turbines or diesel engines.—**General Electric Co.**, Attn: Gregory Ellis, Schenectady 5, N.Y.

**SWEEP and SIGNAL GENERATORS** *Catalog No. 64-A*, 36 3-color pages contain general treatment of sweep generator operation, sweep measurement techniques. Specs, diagrams, oscilloscope patterns on 30 models. Describes accessories such as turret and toggle switch attenuators, coaxial switches, detectors, oscillators, cable sets. Section on crystal, harmonic, single-frequency, variable and sideband markers.—**Telonic Industries, Inc.**, 60 N. First Ave., Beech Grove, Ind.

**HEAT-SHRINKABLE TUBING.** Leaflet, in full color with photos and sample, describes Formite tubing for insulating terminals and pigtails, jacketing wires to form cables, providing identify-

ing markers, shockproofing tool handles and leakproofing hydraulic fittings and plumbing.—**Surprenant Mfg. Co.,** Div. of ITT, Clinton, Mass.

**PRECISION TOOLS CATALOG,** 16 pages, punched for ring binders. Photos. Data covers burnishers, cleaning spray, cutters, files, tools kits, microscopes, mirrors, pliers, screwdrivers, tweezers, vises and other precision electronic tools for servicing equipment and relays.—**Jonard Industries Corp.,** 3733 Riverdale Ave., Bronx, N.Y. 10463

**FUSES AND FUSE HOLDERS.** *Forms SFB, US, HL-163* (latter two are supplements), punched for ring binders; 24 pages, 3 colors, with drawings, dimensions, weights, blowing-time charts, resistance, voltage ratings, vibration characteristics of Buss fuses, Fusetrons, and fuseholders.—**McGraw-Edison Co.,** Bussman Mfg. Div., St. Louis, Mo. 63107

**MILITARY SPECS WALL CHART,** 2-color, 20 x 26 in. All current military specs in detail for all fixed capacitors.—**Federal Pacific Electric Co.,** Cornell-Dubilier Electronics Div., 50 Paris St., Newark 1, N.J.

**RESISTORS DATA SHEET,** *CE-2.12.* Single looseleaf sheet with specs, characteristics and derating curve on 4 types of C-style tin oxide film resistors; design tolerances.—**Corning Electronic Components,** Corning Glass Works, Raleigh, N.C.

**CAPACITOR CATALOG AND PRICE LIST,** Miniature Alumalytic Capacitors (General Electric Type 76F), from 3 to 150 volts. Characteristics and dimensions, ratings, catalog numbers, curves, specs and separate price sheet. 9 pages, line of 109 capacitors.—**Semiconductor Specialists, Inc.,** 5700 W. North Ave., Chicago, Ill. 60639

**BULLETIN** *GEA-7850,* 6-page, 3-color folder with photos, specs and diagram describes the TE-17-A Educational Television Operating Center, a system of audio and video components for origination of broadcast or in-school TV programs.—**General Electric Co.,** Visual Communication Products, 212 W. Division St., Syracuse, N.Y.

**TRANSISTORIZED LEARNING LABS,** 12-page brochure (*GEA-7550*) gives details and illustrations on teacher's control console, tape decks and recorders, amplifiers, student booths, headphones and microphones.—**General Electric Co.,** *Visual Communication Products,* 212 W. Division St., Syracuse, N.Y.

**WALL CHART** of "quick-disconnect" devices, 8 x 11 in., 2-color, has 14 actual samples mounted on it in categories such as snap plugs, push-on terminals, adapters, insulated snap plug and tab receptacles, etc. *Form DD-3.*—**Waldom Electronics, Inc.,** 4625 W. 53rd St., Chicago 32, Ill.

**VARACTORS CHART** for harmonic generator applications, 6 pages, 3 colors, indicates appropriate varactor for doubler, tripler and quadrupler circuits for given input frequency range and power level.—**Sylvania,** Semiconductor Div., 100 Sylvan Rd., Woburn, Mass.

**ULTRAMINIATURE CAPACITORS,** *Bulletin NPJ-131,* single looseleaf page, gives photo, specs and stock listing of TTC-type electrolytic capacitors, so small that markings are limited to voltage and capacitance.—**Aerovox Corp.,** Distributor Div., New Bedford, Mass.

**PHASE CALCULATION NOMOGRAPH** covers frequency range from 200 to 10,000 mc, makes quick conversion from wavelength to distance along a slotted line in centimeters. Useful in Smith Chart calculations in conjunction with slotted-line measurements.—**General Radio Co.,** West Concord, Mass.

**CATALOG SHEET.** Single loose-leaf addition to Ferroxcube catalog listing 17 Ferroxkits with short descriptions, photos, and prices.—**Ferroxcube Corp. of America,** Saugerties, N.Y. END

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.

# technicians' News

### THE BOUNCING CHECK GATHERS NO CASH

An article by Bill Dufer, Jr., in the May *NATESA Scope* brought together several noteworthy hints on handling the bad-check problem. The suggestions were more preventive than curative, but that's as it should be. Better not to accept a bad check in the first place than to try and make it good later.

One radio-TV technician, the article says, has installed in his shop a bulletin board on which he tacks up local "wanted" posters—photos and descriptions of "paperhangers" thought to be working in the vicinity. The board also bears up-to-date newspaper clippings of sentences meted out to check passers who have tried to bamboozle local merchants.

This same technician also has posters on his wall: "Please check your current checking account balance before tendering us a check." Such posters, the author points out, do not offend customers whose intentions are honorable. If they irritate those customers whose intentions *aren't* honorable—well, who wants them, anyway?

Another shop insists that every customer who wants to pay by check show a checkbook and a deposit slip not more than a week old, unless the owner knows him personally. Every patron who tenders a check for "services rendered" receives a "conditional receipt"—a service invoice with the words "If this invoice has been paid by check, it will not be considered as having been paid until check clears *our* bank."

If the customer gets cash change, the amount is noted on the invoice, and the customer must sign it. The shop will not pay out more than $10 in cash to anyone not personally known to them.

### FTC FILES AGAINST DELAWARE VALLEY ASSOCIATION

Two former executives and present directors of the Television Service Association of Delaware Valley have been ordered by the Federal Trade Commission to appear at a hearing in Washington on July 20.

The FTC notified them that they would have to answer complaints against the local organization, and respond to a cease and desist order regarding the following charges:

That the TSADV was inciting servicers to boycott parts distributors who continue selling to the public or to non-servicing dealers; and that TSADV was intimidating distributors' organizations and advocating a policy of blacklisting distributors who didn't stop open selling.

Named specifically in the complaint were Herman Shore, former president and current member of the group's board of directors, and Raymond Fink, former recording secretary and now a director.

### MILITARY MOONLIGHTER ORDERED TO HALT

Some members of the King County (Washington) Television Service Association noticed a TV service ad that gave a local military base (Fort Lawson) telephone exchange and featured evening service. TSA called the commanding officer of the post to ask about the Army's regulations covering use of military facilities for a commercial enterprise in competition with civilian businesses outside the base.

The post commander agreed that the free telephone, free rent and other tax-free benefits were a definitely unfair means of competition to outside establishments that couldn't have such advantages.

After investigation, the CO called TSA to assure them that the specific operation had been closed down, and that the post's daily bulletin would warn all personnel on the base that such operations are prohibited.

### SEMICONDUCTORS INVADE AUTOMOBILE FIELD

The automobile industry spent more than $15 million for semiconductor devices in 1963. According to D. I. Van Blois, graduate student at Michigan State University, the expenditure for 1965 will be about $20 million, and in 1970 possibly $65 million.

The most important use of semiconductors in automobiles, Van Blois said, was in car radios, which in 1963 represented $8.2 million. Next significant use is in car alternators. At about 6 diodes per car, $7.7 million was spent in 1963.

The transistorized voltage regulator is another important semiconductor adjunct, though cost is keeping down its wide-scale use. Transistor ignition is also, of course, one of the most rapidly growing consumers of semiconductors. Now available as an optional item on Pontiac and Chevrolet cars and Ford trucks, its use is expected to spread rapidly.

Other uses of semiconductors are in temperature control systems ("Comfort Controls") automatic headlight dimmers, auto horns, fuel pumps and synchronized clocks.

### SWEDE TV VIEWERS UNHAPPY WITH TV DO SOMETHING ABOUT IT

A novel form of TV entertainment has been proposed by about 400 discontented television viewers of Smedjebacken, Sweden. According to a recent Reuters report, Ulf Jansson, a caretaker, stated, "We are tired of television and of staring stupidly at the screen. Now we aim to get together and have some fun instead. We will hold a dance here on Saturday and after the dance we will make a bonfire of 400 television sets."

### INFRARED RADIATION NEW SERVICE TECHNIQUE?

Infrared radiation from electronic components can be used to identify short-life parts and predict the reliability of circuits. This statement was made by A. Feduccia of Rome Air Development Center, Griffis Air Force Base, New York, to the International convention of the IEEE.

An infrared camera is used to make thermal photographs (thermographs), showing the temperature distribution over desired areas. Cold areas are darker. As components become warmer, they appear as lighter and lighter grays. Thus a thermograph of the underside of a chassis, printed-circuit board or single component can show immediately whether any areas of the components are hotter than normal, as indicated by comparison with a thermograph of known-good equipment.

### TRANSISTOR ANTENNAS INVADE BRITAIN

An electronics engineer in Devon, England, claims to have invented a cigarette-pack-size transistor-and-battery device that makes outdoor TV antennas unnecessary and at the same time improves reception.

The unit, reminiscent of our recent endeavors in "antennaless antennas", is apparently some sort of booster, since it is described as plugging between set and indoor antenna. It sells for approximately $12.

A British reporter who attended a demonstration of the new device told of "a brilliantly sharp picture and no interference."

---

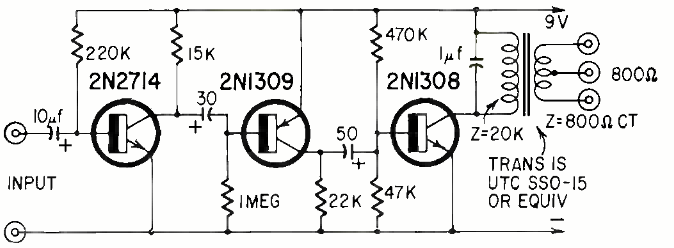
David Sarnoff, chairman of RCA, predicts 3-D wall TV by the end of the century. He also said: "Ultimately, individuals equipped with miniature TV transmitter-receivers will communicate with one another via radio, switchboard and satellite, using personal channels, similar to today's telephone number."

END

# noteworthy Circuits

### BRAIN-WAVE AMPLIFIER

This simple-appearing amplifier uses a 2N2714 in its input circuit to handle much lower voltages than do ordinary transistors. The 2N2714 is an epitaxially grown passivated unit designed nals from 0.5 to 30 cycles. Remove the 1-$\mu f$ capacitor across the transformer and the bandwidth rises to 20 kc. Input can be as low as 5 microvolts at 10 cycles and must not exceed 1 millivolt.




for high-gain, low-noise applications. With selected transistors, the amplifier's gain can be as high as 500,000.

The amplifier was designed for brain-wave potentials and handles sig-

Operated within its range, the amplifier makes a fine scope preamp. A step attenuator can be used to increase the range.—*Tom Jaski*

### MORE ON THE SIGNAL INJECTOR

A number of readers constructed the 1-kc phase-shift oscillator described in "Build a Signal Injector Into Your VTVM" (RADIO-ELECTRONICS, April

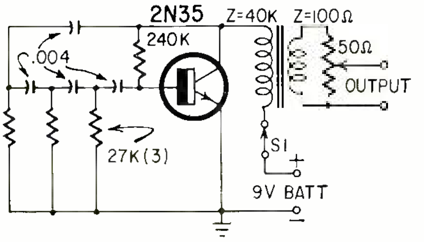



Fig.1

1963) and have requested information on adapting it for other applications. Some want to use it as a troubleshooting accessory with battery power and a low-impedance output for feeding low-impedance mike inputs. Fig. 1 shows the circuit modified to comply with these requests.

The 25,000-ohm output potentiometer has been replaced by a transformer with a 100-ohm output impedance. (I used an Argonne AR-150 input transformer with the primary connected

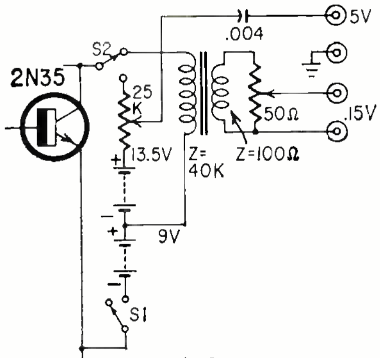



Fig.2

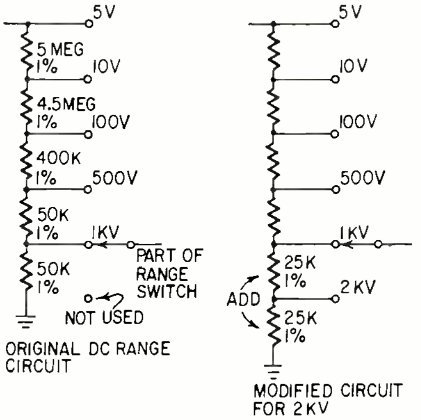
as the secondary.) The original circuit received its power from the vtvm. The version in Fig. 1 uses a 9-volt battery such as the RCA VS-300A. The maximum output level is 0.15 volt. After 8 hours of continuous operation, the output drops not more than .03 volt.

Some constructors wanted both high- and low-impedance outputs so they would have the high output (up to 5 volts) for feeding directly into power amplifiers. Fig. 2 shows how the output circuit can be modified. S2 selects the desired output.

Several readers report constructing the oscillator in a 1⅝ x 2⅛ x 3¼-inch aluminum utility box and carrying it in their tool box for testing and troubleshooting.—*Harold Reed*

### ADD A 2-KV RANGE TO EICO VTVM

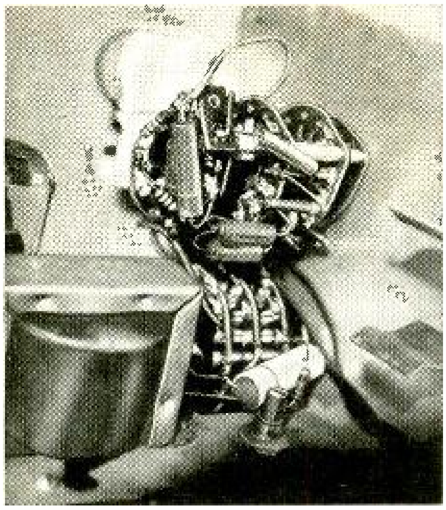
The versatility of Eico model 214 and 221 vacuum-tube voltmeters can be increased by doubling the upper voltage range of 1,000 volts dc. The 2,000-volt range permits troubleshooting higher-voltage devices such as oscilloscopes and medium-power transmitters. Since these generally employ voltages rang-




ing between 1,000 and 2,000, you can't check them ordinarily without a high-voltage probe—with its inherent excess range multiplication.

Many Eico vtvm's employ a range-selector switch with an unused position beyond 1,000 volts. A simple circuit change utilizing this extra switch position permits adding a 2,000-volt range without difficulty. The original voltage-divider resistor to ground in the meter on the 1,000-volt range position is 50,000 ohms, 1%. To add a 2,000-volt range, substitute two 25,000-ohm 1% resistors for the 50,000-ohm unit. The diagrams show the original and modified circuits. The photo shows the modified range switch. If the lugs on the other sections of the range switch for this position are *not* wired connect them to the lugs corresponding to the 1,000-volt position. To prevent breakdown of the probe resistor, two series-wired 7.5-megohm ½-watt 5% (or better) carbon-composition resistors should be substituted for the original 15-megohm ½-watt 5% resistor. As an additional safety precaution, a more effectively insulated probe may well be used.

To use the vtvm on this new range, all readings made on the 1,000-



(0-10) volt scale are multiplied by 2.
—*Harold J. Weber*

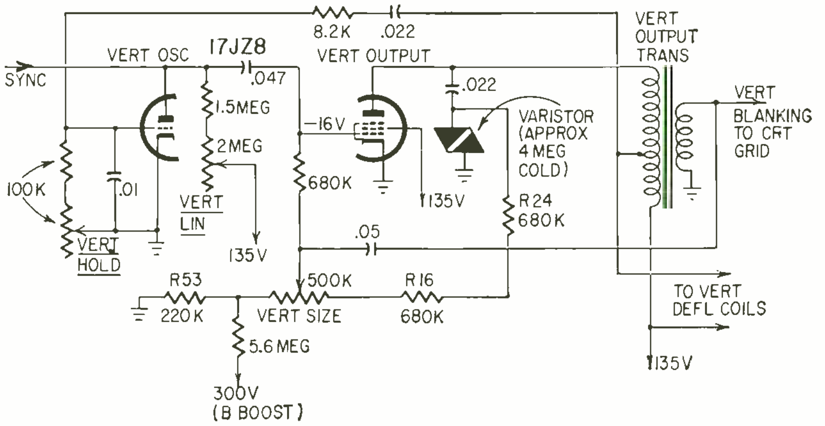
[Eico engineers report that this is a worth-while modification but stress the fact that the switch insulation may break down. Keep the switch wafer clean and free of flux, dust and other foreign matter that may cause arcing or high-resistance shorts. They warn that this modification is limited to the dc voltage range. Attempting to measure over 1,000 volts ac is likely to damage the ac rectifier.—*Editor*]



### VERTICAL DEFLECTION CIRCUIT

The 1964 Philco chassis have a number of interesting features. Among them are the unusual vertical size compensation circuit and a vertical size control that replaces the height control in earlier circuits. The vertical deflection circuit in the 14G20 chassis is shown in the diagram. Minor circuit variations are used in other recent chassis.

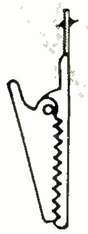
The varistor is a sort of automatic size control. It prevents any changes in the brightness setting or CRT operating level from affecting the overall height of the picture. During the retrace interval, high positive peaks are developed in the output transformer and across the .022-$\mu$f capacitor and varistor in series. The varistor's resistance drops and the pulse is absorbed in charging the capacitor. During the normal sweep, the varistor's resistance returns to normal. The capacitor discharges through R24, R16, the VERT SIZE control and R53, and develops a negative voltage across this network. This biases the output stage.




Since the negative voltage is proportional to the amplitude of the vertical deflection voltage, it varies the bias in the direction that holds height constant.

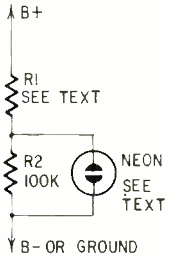
The VERT SIZE control is unusual in that it affects the top and bottom of the picture. (Most height controls affect only the top of the picture.) The B-boost voltage (300 volts) is fed to the bias network for the output stage. When the BRIGHTNESS control is advanced, the beam current increases, the high voltage drops and the picture tends to expand. However, as the high voltage drops, the boost voltage decreases in proportion. The voltage across the size control becomes more negative. The bias increases and the deflection voltage is reduced to hold picture size constant.—*H. Maxwell*

# try This one



### NEON PILOT IS READY LIGHT

By connecting a small neon lamp (like one of the NE-2 or NE-51 series) as shown in the diagram below, you can make a pilot light that indicates when

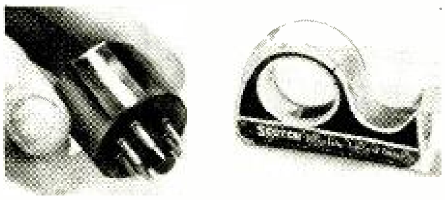



B-plus is up to full operating value.

To set up the circuit, connect the lamp across R2, 100,000 ohms, and use a 1-megohm pot as R1, set to maximum resistance. Reduce the pot's resistance until the lamp just fires. Measure the resistance and use the next lower 10% ½-watt fixed resistor.—*Irwin Math, WA2NDM*

### TWO-FACED TAPE HOLDS TURNS

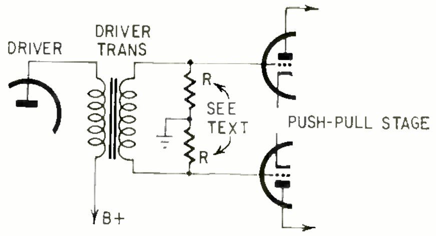
If you wind your own coils on smooth plastic or Bakelite forms, take a couple of strips of double-faced plastic



tape and place them on opposite sides of the coil form, lengthwise. The sticky, low-loss tape will hold each strand of wire securely in place so that the coil can be wound easily and spaced accurately. —*John A. Comstock*

### RESISTORS "SPLIT" TRANSFORMERS WINDING

Occasionally you may need to drive a push-pull stage, yet not have a split or center-tapped transformer, or room for a




phase inverter. Use a single-plate-to-single-grid transformer with a pair of closely matched resistors R connected as shown here. Values from 47,000 to 470,000 ohms are usually satisfactory.—*Irwin Math*

[This method is not generally good for class-$AB_2$ or -B amplifiers, which must have low grid impedances.—*Editor*]

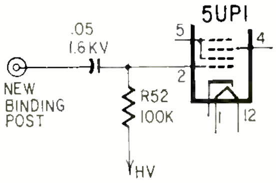
### CLOTHESPIN WIRE STANDOFFS

Need some standoff insulators for a radio or TV lead-in?

You can make ordinary plastic clothespins into low-loss standoffs for round or ribbon wire. Simply saw off the legs of each pin and cement them back in place at an angle to form feet. Don't try to heat and bend the legs, for they will probably break. Most any good plastic cement may be used. Mount the insulators with small nails driven through the holes in the feet.—*John A. Comstock*

### INTENSITY MODULATING HEATH IO-10

To add intensity modulation to the Heath IO-10 dc oscilloscope, all that is needed is one high voltage capacitor,




connected to pin 2 of the CRT socket, and one new binding post. There is plenty of space for the post on the rear panel of the scope.—*Tom Jaski*

### STORING SPARE PLUGS

In areas where you meet several kinds of power receptacles, compatibility is a problem. Sometimes adapters are available; sometimes not—the only choice is to change the plug. The problem here

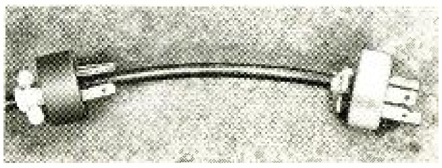


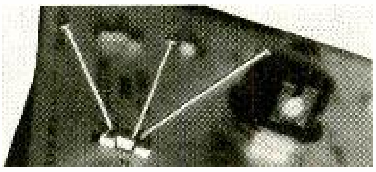
*Photo by Morgan S. Gassman, Jr.*

is that the unused plug is likely to get lost.

I saw a Western Union maintenance shop solve the problem as shown in the photo. The unused connector is slid back on the cord and fastened with the cable clamp. The required fitting is installed as usual. The unused plug can't possibly be lost, and is available right away when it's needed.—*Roy E. Pafenberg*

### TRANSISTOR TEST LEADS

Many times it is impossible to remove a transistor completely for insertion in a transistor tester, and many testers have no provision for connecting test leads. The easiest way to make the proper connection is to insert ordinary straight pins into the transistor socket of the tester. (Bend them away from



each other to avoid shorts.) Then use ordinary test leads or clip leads, with alligator clips at both ends, to complete the connection between tester and transistor.

If you have to do in-circuit testing frequently, it is a good idea to make a plug to fit the tester. One can be made easily by opening a dead transistor's case and soldering to the leads on the inside. Cut all leads on the outside to ½ inch and straighten them out. The other ends of the three leads soldered to your new plug should be fitted with alligator clips. Label the clips C, E and B.—*Ronald S. Newhower*

### COMPRESSED AIR AIDS PRINTED CIRCUIT REPAIR

Any radio or television technician who has worked in a shop where compressed air was available is well aware of the contribution this facility makes to volume, high quality service. A well lighted cleaning booth with forced ventilation and a medium-pressure air hose will make light work of even the dirtiest chassis.

Those who have toiled over removing multiple-lead components from a printed-board circuit will be happy to learn that a blast of compressed air is just as effective in removing excess molten solder. Use a small iron for just as long a time as necessary to melt the solder. The instant the iron is removed, direct a blast of compressed air at the connection. The solder will lift off, leaving a clean tinned board. Direct the air blast to avoid splattering components, such as variable capacitors, that are easily damaged. There is much less mess than would be expected since the solder is cooled and solidified by the air the instant it is lifted from the connection.

This method is equally effective in removing the excess solder from those difficult sweated-solder jobs.—*Roy E. Pafenberg.* END

### IODINE EATS RUST

A few drops of iodine on the rust that binds a bolt or screw will quickly loosen the most rust-seized component. The iodine dissolves the rust in a hurry. —*Harry J. Miller*

# $10$ to the many

**By JERRY L. OGDIN**

| | |
|---|---|
| $10^6$ | 1,000,000 |
| $10^5$ | 100,000 |
| $10^4$ | 10,000 |
| $10^3$ | 1,000 |
| $10^2$ | 100 |
| $10^1$ | 10 |
| $10^0$ | 1 |
| $10^{-1}$ | 0.1 |
| $10^{-2}$ | .01 |
| $10^{-3}$ | .001 |
| $10^{-4}$ | .0001 |
| $10^{-5}$ | .00001 |
| $10^{-6}$ | .000001 |

**Table I**—*Some Powers of 10*

EVER HAD ONE OF THOSE EQUATIONS that turned out like Fig. 1? Well, read on, brother, you've company!

Most technicians shy away from mathematics because of the assumed complexity, but plenty of mathematicians wouldn't open a transistor radio for fear of getting shocked.

I propose to show you how you can reduce those formulas with many numbers to mere shadows of their former selves. Take another look at that formula in Fig. 1. It's only the calculation of a coil and capacitor to resonate at 10 mc. Complex?

**Table II**—*Some Examples*

| | |
|---|---|
| 34,865 cycles | $3.4865 \times 10^4$ cycles |
| 3,600 pf | $3.6 \times 10^{-9}$ farad |
| 1,000 cycles | $10^3$ cycles |
| 1 megohm | $10^6$ ohms |
| 17.5 mc | $1.75 \times 10^7$ cycles |
| .00045 volt | $4.5 \times 10^{-4}$ volt |
| .0018 microamp | $1.8 \times 10^{-9}$ ampere |

Now look at Fig. 2. Believe it or not, it's the same formula.

### The power of ten

Ten is a funny kind of number, because we happen to have based our number system on it. 10 times 10 is 100, 10 times 10 times 10 is 1,000. In other words, every time we multiply by 10, we add a zero to the right side of the number. Odd, isn't it? Instead of writing 10 times 10 times 10 ad nauseam, let's indicate how many times 10 is multiplied by itself with a *superscript*. A superscript is a number placed to the upper right of any other number. Thus, 10 *multiplied by itself* 5 times (which equals 100,000) is $10^5$. Note that this is different from 10 *multiplied by* 5 (which equals 50). This system gives us multiples of 10 from 1 ($10^0$ equals 1) to as high as you'd like to carry it.

To get numbers between 0 and 1, we can *divide* 10 by itself as many times as necessary. We show numbers between 0 and 1 with a *negative* superscript, one with a minus sign. Therefore, .01 or 1/100 (1 *divided* by 10 times 10) is the same as $10^{-2}$.

The purpose of using the powers of 10 is to indicate large or small numbers conveniently. For example, 1 mc is 1,000,000 cycles. From Table I, 1,000,000 is equal to $10^6$ cycles.

Table I is only a guide, not a crutch. To find the power of 10 without using the table, count all the digits in the number, and subtract one. For our example, 1,000,000 has seven digits. Subtracting one leaves six. Therefore, 1,000,000 is equal to $10^6$.

For decimals, count all the digits to the right of the decimal point, but do *not* subtract. For another example, assume a 1-pf capacitor. 1 pf is equal to .000000000001 farad. Counting all the digits, we find there are 12. Because the number is a decimal, the superscript will be negative. Therefore, 1 pf is equal to $10^{-12}$ farad.

REMEMBER, use *negative* superscripts for decimals, and *positive* superscripts for numbers 1 or larger.

What happens when you're working with some value that isn't evenly divisible by 10? Well, just multiply. If we were solving our frequency example for 5 mc, we could say that 5 mc equals 5 times 1 mc. Now solve for the power of 10 for 1 mc. The answer is written

$$5 \text{ mc} = 5 \times 10^6 \text{ cycles}$$

Using the system outlined above the answer will always be some number between 1 and 10, times some power of 10. Some examples are shown in Table II.

Let's summarize so far:

a. The superscript is positive for numbers 1 or over.

b. The superscript is negative for numbers less than 1.

c. The superscript may be found for numbers from 0 to 1 by counting the number of digits to the right of the decimal point.

d. The superscript for numbers 1 or more may be found by counting the number of digits to the left of the decimal point, and subtracting one.

### Rules for use

Now that we have our new tool, how do we use it? The rules are shown in Table III. This gets easier all the time!

Referring to Fig. 1, we know the frequency is 10 mc, but this must be squared for use in the formula ($1 \times 10^7 \times 1 \times 10^7 = 1 \times 10^{14}$). Because any number multiplied by 1 is the same number, we can dispense with writing the 1. Therefore, (10 mc$^2$ is equal to $10^{14}$ cycles. The 50-pf capacitor is $5 \times 10^{-11}$ farad. When these figures are put into the proper slots in the formula, we can multiply by 10's again, and $10^{14} \times 10^{-11} = 10^3$. After performing the rest of the regular division, we have .00557 over $10^3$.

By the rules in Table III, the number under the line may be moved to the top of the line by changing the sign of the superscript. Applying powers of 10 again, the answer is $5.57 \times 10^{-6}$ henry, which is 5.57 microhenries.

By proper use of the powers of 10, the accuracy of your math will be increased, because you won't have to wrestle with cumbersome long numbers.

Good luck when you get a number like $10^{1362}$. END

**Table III**—*The Rules*

**Rule one:** If two powers of 10 are multiplied together, just add the superscripts.

**Examples:** $10^{10} \times 10^4 = 10^{14}$

$10^6 \times 10^{-3} = 10^3$

$10^{-2} \times 10^{-4} = 10^{-6}$

**Rule two:** If a power of 10 is on the "wrong side of the dividing line," we can move it, but we must change the sign of the superscript.

**Examples:** $\frac{3}{10^3} = 3 \times 10^{-3}$

$4 \times 10^{-2} = \frac{4}{10^2}$

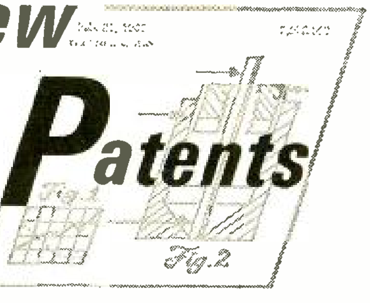
$$L = \frac{1}{4\pi^2 CF^2} = \frac{1}{4 \times 100000000000000 \times .00000000005 \times \pi^2} = .00000557$$

*Fig. 1—In this disarmingly simple formula, L is inductance in henries, C capacitance in farads, and F frequency in cycles per second. All you have to do is lose count of the zeros, and then where are you?*

$$L = \frac{1}{4\pi^2 CF^2} = \frac{1}{4 \times 5 \times 10^{14} \times 10^{-11} \times \pi^2} = \frac{.00557}{10^3}$$

*Fig. 2—Same formula, same numbers, expressed a different way. More convenient, because manipulation of powers of 10 uses just simple addition and subtraction. Takes less space, too. Likelihood of errors is drastically reduced.*

# new Patents

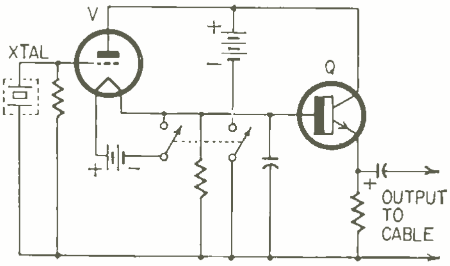


### SEISMOMETER

**PATENT No. 3,118,126**

*Fred A. Brock, Kenneth E. Burg, and Markwick K. Smith, Dallas, Tex. (Assigned to Texas Instruments, Inc.)*

Conditions below the earth's surface can be explored with pressure or shock waves. Reflections detected by a seismometer indicate the composition and density of the earth's layers. This seismometer, designed for underwater placement, contains a piezoelectric crystal, a tube, a transistor




and batteries. It matches the high-impedance crystal and a low-impedance transmission line output. The tube, connected as a cathode follower, has an input impedance of several megohms. Its relatively low output impedance feeds the transistor, an emitter follower, which has an output impedance of only a few hundred ohms.

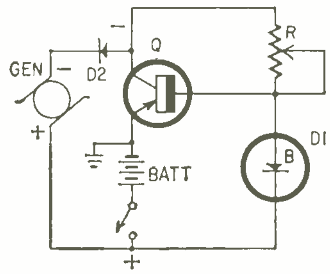
V and Q are inside a compartment hemetically sealed against seepage. The crystal is constructed as a hollow cylinder, sensitive to pressure waves. A cable connects the instrument to a recording station on land.

### AUTO BATTERY CHARGER

**PATENT No. 3,117,269**

*Louis Pensak, Princeton, N.J. (Assigned to Radio Corp. of America)*

The battery is charged from rectified output of a generator. D1 (a Zener diode) and R form a voltage divider for the base of Q. Assume the switch is closed. If the battery voltage is low (discharged), D1 operates below Zener value and



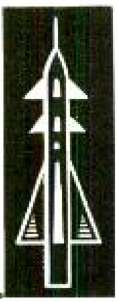

does not conduct. The base return is to the *negative* terminal. Therefore Q conducts heavily, and passes charging current into the battery.

As the battery voltage rises, a higher voltage appears across D1. When the Zener value is reached, D1 conducts and provides a path between base and the *positive* terminal. If R is properly set, Q is blocked and overcharging is prevented.

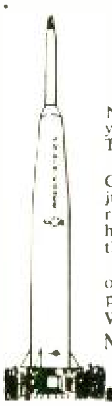
D2 is a conventional diode that merely protects the transistor from bearing the entire back voltage if the generator should fail when the battery is fully charged. It can be omitted if the transistor's breakdown rating is high enough. END

# SCHOOL DIRECTORY

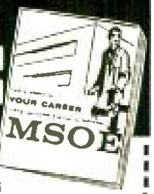












# new Books

ORGAN BUILDERS MANUAL, by Robert L. Eby. *Artisan Organs, 2476 N. Lake Ave., Altadena, Calif. 8½x 11 in., 250 pp. Paper, $5*

Based on the author's Artisan organ, the book contains much information valuable to organ builders in general.

BASIC ELECTRONICS, (2nd edition), by Royce G. Kloeffler, Maurice W. Horrell and Lee E. Hargrave, Jr. *John Wiley & Sons, 605 Third Ave., New York 16, N. Y. 5¾ x 9 in., 643 pp. Cloth, $11.*

An intermediate level text that covers transistors, tubes and circuits. Math is held to a minimum.

HANDBOOK OF TRANSISTOR CIRCUITS, by Allan Lytel. *Howard W. Sams & Co., Inc., 4300 W. 62 St., Indianapolis 6, Ind. 5½ x 8½ in., 224 pp. Paper, $4.95.*

A compilation of industrial and experimental circuits using SCR's, Zener diodes, tunnel diodes and other semiconductors. Each is accompanied by parts list and descriptive writeup.

RELIABLE ELECTRICAL CONNECTIONS (Vol. I). *Space Publications, Inc., Times Bldg., 221 Holmes Ave., Huntsville, Ala. 5½ x 7¾ in., 68 pp. Paper, $2.*

Covers handling of wires and components, soldering, protecting connections, lacing, problems of printed circuitry. With appendix and index.

CITIZENS BAND RADIO HANDBOOK, by David E. Hicks. *Howard W. Sams & Co., Inc., 4300 W. 62 St., Indianapolis 6, Ind. 5½ x 8½ in., 192 pp. Paper, $2.95.*

Information for the kit-builder, technician and operator. Covers typical equipment and latest regulations. Many schematics.

MASERS AND LASERS, How They Work, What They Do, by M. Brotherton. *McGraw-Hill Book Co., 330 W. 42 St., New York, N.Y. 10036. 5½ x 8¼ in., 207 pp. Cloth, $8.50*

The first six chapters are devoted to an introduction and explanation of the principles underlying maser action. Two chapters on the microwave maser follow, then eight on the laser. Elementary. 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 and the Electrical Experimenter on file for interested readers.

***In August, 1914, Electrical Experimenter***

An Efficient Wavemeter, by Thomas W. Benson.

Selenium Cells and How to Use Them, by "A Selenium Specialist".

Experimental Electricity Course, Lesson 13.

Wireless Receivers (A Compendium).

A Variable Condenser for Receiving and Transmitting, by Irving Byrnes.

A Peroxide of Lead Detector, by James L. Green.

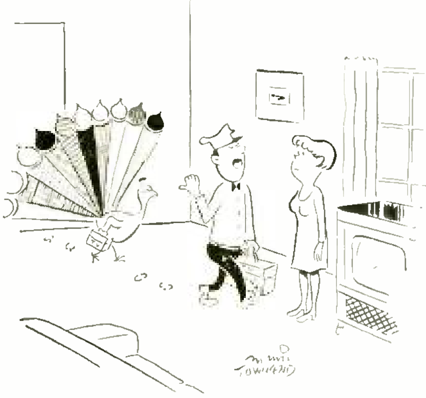
A High Frequency Transmitting Buzzer, by Thos. W. Benson.

The Marconi Fog-Gun.

An Automatic Radio Tuning Device, by Earl G. Stalnaker.

A New Low Altitude Antenna.

The Boron Detector, by Ezechiel Weintraub.



*"He helps me repair the color sets."*

# Radio-Electronics Market center

# CLASSIFIED ADVERTISING ORDER FORM

Please refer to heading at top of classified section for complete data concerning terms, frequency discounts, closing dates, word count, etc.

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| 6 | 7 | 8 | 9 | 10 |
| 11 | 12 | 13 | 14 | 15 |
| 16 | 17 | 18 | 19 | 20 |
| 21 | 22 | 23 | 24 | 25 |
| 26 | 27 | 28 | 29 | 30 |
| 31 | 32 | 33 | 34 | 35 |

______ No. of Words { @ .30 Non-Commercial Rate / @ .55 Commercial Rate } =$_____

Total Enclosed $________

Insert______time(s)

Starting with__________issue

Payment must accompany order unless placed through accredited advertising agency. 84

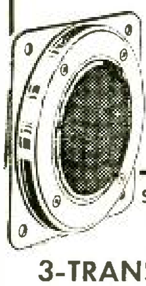
NAME ____________

ADDRESS ____________

CITY________STATE________ZIP____

SIGNATURE____________

MAIL TO: RADIO-ELECTRONICS, CLASSIFIED AD DEPT., 154 WEST 14TH ST., NEW YORK, N.Y. 10011



# HI-FI SPECIAL! ELECTROSTATIC TWEETER

MADE BY FAMOUS LORENZ—I.T.T.—FOR GRUNDIG—NEVER BEFORE OFFERED FOR SALE

BUY 2 FOR STEREO—4" SQ.

IT'S A NATURAL FOR THE HI-FI ENTHUSIASTS (Illustration resembles tweeters in stock)

$1.49 ☐ EACH Includes Hookup ☐ 2 for 2.50

SUBMINIATURE 1.95 3-TRANSISTOR ☐ AMPLIFIER

- Only 3"x2"x¾"
- Printed Circuit
- Wired
- W/Transistors

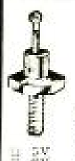
## DOUBLE BONUS

$25 ☐ FREE WORTH OF
- Transistors
- Rectifiers
- Condensers
- Diodes
- Knobs
- Coils, etc.

PLUS FREE

CHOOSE ANY $1 ITEM FREE

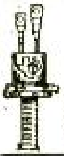
GET BOTH GIFTS FREE WITH EVERY $10 ORDER



TESTED 10 WATT ZENERS $1.49 EA.

☐ 3V ☐ 6V ☐ 12V ☐ 20V ☐ 24V ☐ 42V ☐ 45V ☐ 60V ☐ 70V ☐ 80V ☐ 90V ☐ 100V ☐ 110V ☐ 124V

WRITE FOR OTHER VOLTAGES



TESTED TRANSITRON SCRs Silicon Controlled Rect.

| PRV | 7 AMP | 15 AMP | 25 AMP |
|---|---|---|---|
| 50 | ☐ 1.00 | ☐ 1.25 | ☐ 1.50 |
| 100 | ☐ 1.20 | ☐ 1.95 | ☐ 2.25 |
| 150 | ☐ 1.75 | ☐ 2.25 | ☐ 2.75 |
| 200 | ☐ 1.95 | ☐ 2.75 | ☐ 2.95 |
| 250 | ☐ 2.25 | ☐ 3.05 | ☐ 3.25 |
| 300 | ☐ 2.60 | ☐ 3.19 | ☐ 3.50 |
| 350 | ☐ 2.95 | ☐ 3.50 | ☐ 4.25 |
| 400 | ☐ 3.25 | ☐ 3.95 | ☐ 4.50 |

CD'ERS ATTENTION 30 MC TRANSISTORS

TO-5 case, with built-in shield, like 2N247, untested 10 FOR $1

## FACTORY TESTED SEMI-KON-DUCTORS

- ☐ 1—85W 2N1212 NPN SILICON, TO10 ....... $1
- ☐ 6 2N404 TYPE TRANSISTORS, rf. if. TO5 case... $1
- ☐ 6 2N112 TYPE IF, OSC TRANSTRS, TO22 Untested. $1
- ☐ 1 2N706 500MW, 300MC NPN PLANAR, TO18 $1
- ☐ 3 TEXAS 20W TRANS'RS, 2N1038, heatsink, TO5 $1
- ☐ 1 TRANSITRON 85-W SILICON npn mesa. 2N424. $1
- ☐ 4 G.E. 2N43 OUTPUT TRANSISTORS, TO5 case.. $1
- ☐ 3 2N1264 UHF TRANSISTORS, 300 MC TO 5 case. $1
- ☐ 10 PNP SWITCHING TRANSISTORS, TO 5 case.. $1
- ☐ 1 2N964 EPITAXIAL MESA, 500 MC, PNP, TO-18. $1
- ☐ TEXAS 20-WATT, TO5, heat sink stud, 2N1042 $1
- ☐ 6 750 MA 400V EPOXY DIODES ........ $1
- ☐ 6 ZENER DIODES, upright styles, assorted .... $1
- ☐ 3 2N243 750 MW NPN SILICON trans'tors, TO22 $1
- ☐ 1 85W SILICON PWR TRANSTR, npn, like 2N1212 $1
- ☐ 2 TRANSITRON 1N429 ZENER REFERENCES .... $1
- ☐ SILICON PLANARS: ☐ 2N497, ☐ 2N498, each .. $1
- ☐ 4 SUBMINIATURE 2N131 TRANSTRS, rf-if, pnp . $1
- ☐ 4 CK721 TRANSTRS in new aluminum case, pnp . $1
- ☐ 10 NPN SWITCHING transistors, 2N440 equals . $1
- ☐ 2 CBS 35W PWR TRANSTRS, 2N1434, pnp, stud . $1
- ☐ 10 FAMOUS CK722 TRANSISTORS, pnp ....... $1
- ☐ 15 PNP TRANSISTORS, asst types and cases .... $1

10c FOR OUR "SUMMER" BARGAIN CATALOG ON: ☐ Semiconductors ☐ Poly Paks ☐ Parts

- ☐ 15 CBS GERMANIUM DIODES, 1N34 equals ... $1
- ☐ 15 NPN TRANSISTORS, asst types and cases .... $1
- ☐ 2—2N341 NPN SILICON TRANSISTORS, 1 watt $1
- ☐ 3 CBS 20-WATT TRANSTRS, pnp, stud, 2N1320 . $1
- ☐ 1 3N35 TETRODE 150mc transistor, silicon .... $1
- ☐ 5 SUN BATTERIES TO 1½" sizes, lite sensitive . $1
- ☐ 3 2N255 PWR TRANSISTORS, or equal, TO3 case $1
- ☐ 25 SEMI-KON-DUCTORS: transistors, diodes, rect. $1
- ☐ 3 ONE WATT ZENERS, 6V, gold, axial ........ $1
- ☐ 5 GENERAL ELECTRIC 2N107 PNP transistors ... $1
- ☐ HOFFMAN SATELITE SILICON SUN CELL, ⅜x1" $1
- ☐ 4 GENERAL ELECTRIC 2N170 RF NPN transistors $1
- ☐ 15 UPRIGHT SILICON DIODES, worth $40 ...... $1
- ☐ 2 'MESA' 4-WATT TRANSTRS, npn, silicon, TO5 . $1
- ☐ 6 TRANSISTOR RADIO SET, osc-ifs-driver, p-p .. $1
- ☐ 2—25-AMP SILICON STUD RECTIFIERS ....... $1
- ☐ 1—2N705 MESA 300 mc, 300 mw, pnp, TO18 .. $1
- ☐ 20 WATT NPN SILICON MESA 2N1648 tr'sistors $1
- ☐ 2—500 MC PNP MESA TRANSISTORS, TO18 case $1
- ☐ 6 TOP HAT RECTIFIERS, 750 mil, 400 volts .... $1
- ☐ 1—SILICON NPN "PLANAR" 2N718, TO18 case. $1

## WORLD'S MOST POPULAR $1 PARTS PAKS

- ☐ 3 SUBMINIATURE MIKE TRANSFORMERS ...... $1
- ☐ 30 MOLDED COND., black beauty, mylar, vit-Q $1
- ☐ 10 PHONO PLUG-n-JACK SETS, tuners-amps .... $1
- ☐ 3 SUBOUNCER TR'STOR tr'stormer, input, output. $1
- ☐ 10 ELECTROLYTICS, FP & tubulars, to 500 mf .. $1
- ☐ 30 "TEXAS" PRECISION RESISTORS to 20W, 1% $1
- ☐ 60 CERAMIC CONDENSERS, discs, npo's to .05mf $1
- ☐ 4 TRANSISTOR TRANSFORMERS, asst. worth $25 $1
- ☐ 40 WORLD'S SMALLEST RESIST., 5% too, 1/10W $1
- ☐ 40 SUBMINIATURE COND., to .05mf, cerafil too . $1
- ☐ 3 'TINY' V. CONTROLS, 2/sw, 2k, .5 meg, 1 meg $1
- ☐ 4 TRANSISTOR TRANSFORMERS, asst, worth $25 . $1
- ☐ 1—INFRA-RED PHOTO DETECTOR TRANSDUCER $1
- ☐ 1—INFRA-RED PARABOLIC REFLECTOR & FILTER $1
- ☐ 30 PRECISION RESISTORS, ½, 1, 2W, 1% .... $1
- ☐ 50 ONE WATTERS, resistors, asstd values, 5% too $1
- ☐ 60 TUBULAR CONDENSERS, to .5mf to 1KV .... $1
- ☐ 40 DISC CONDENSERS, 27mmf to .05mf to 1KV . $1
- ☐ 60 TUBE SOCKETS, receptacles, audio, plugs, etc.. $1
- ☐ 10 PANEL SWITCHES, rotary-micro-slide-power .. $1
- ☐ 30 POWER RESISTORS, to 50W, to 24 Kohms ... $1
- ☐ 50 MICA CAPACITORS, to .01mf, silvers too ... $1
- ☐ 10 VOLUME CONTROLS to 1 meg, switch too ... $1
- ☐ 50 RADIO & TV KNOBS, asstd. colors, styles .... $1
- ☐ 10 TRANSISTOR ELECTROLYTICS, 10 to 100mf. $1
- ☐ $25 RADIO-n-TV SURPRISE, wide variety ...... $1
- ☐ 50 COILS & CHOKES, rf-if, osc-peaking-etc ..... $1
- ☐ 35 ALLEN BRADLEY & IRC TWO WATTERS .... $1
- ☐ 100 ASST. HALF WATT RESISTORS, 5% too .... $1
- ☐ 60 HI-Q RESISTORS, ½, 1, 2W to 1 meg, 5% too $1
- ☐ 10 TANTALUM ELECTROLYTICS, worth $15 .... $1

## 150 WATT TRANSISTOR— $1

TEXAS INSTR.—PNP—T03—SWITCHING

SALE! SALE! SALE!

25 — $1 per pak

- ☐ 25 TRANSISTORS: audio switching, rf untested ..
- ☐ 25 TOP HAT RECTIFIERS 750 mil untested ......
- ☐ 25 EPOXY RECTIFIERS axial lead, 750 mil untested ..................
- ☐ 25 GERMANIUM DIODES 1N34, 1N48 untested ..

## SILICON POWER DIODE STUDS

| Amps | Volts | Sale | Amps | Volts | Sale | Amps | Volts | Sale |
|---|---|---|---|---|---|---|---|---|
| ☐ 6 | 50 | 15c | ☐ 25 | 100 | 1.29 | ☐ 50 | 100 | 2.95 |
| ☐ 6 | 100 | 29c | ☐ 25 | 200 | 1.60 | ☐ 50 | 200 | 3.75 |
| ☐ 6 | 200 | 37c | ☐ 25 | 300 | 1.75 | ☐ 100 | 25 | 1.50 |
| ☐ 6 | 400 | 59c | ☐ 25 | 400 | 1.95 | ☐ 100 | 50 | 1.80 |
| ☐ 6 | 600 | 69c | ☐ 25 | 600 | 2.50 | ☐ 100 | 100 | 2.25 |
| ☐ 6 | 800 | 89c | ☐ 35 | 50 | 1.05 | ☐ 100 | 150 | 2.75 |
| ☐ 6 | 1000 | 95c | ☐ 35 | 100 | 1.29 | ☐ 240 | 25 | 4.50 |
| ☐ 12 | 50 | 49c | ☐ 35 | 150 | 1.50 | ☐ 240 | 50 | 4.95 |
| ☐ 12 | 100 | 69c | ☐ 35 | 200 | 1.75 | ☐ 240 | 100 | 5.90 |
| ☐ 12 | 200 | 88c | ☐ 35 | 250 | 1.95 | ☐ 240 | 150 | 6.75 |
| ☐ 12 | 300 | 1.19 | ☐ 35 | 300 | 2.55 | ☐ 240 | 200 | 8.25 |
| ☐ 12 | 400 | 1.37 | ☐ 50 | 25 | 1.50 | ☐ 240 | 300 | 12.50 |
| ☐ 25 | 50 | .99 | ☐ 50 | 50 | 1.95 | ☐ 240 | 400 | 19.95 |

**POLY PAKS**

TERMS: send check, money order, include postage—avg. wt. per pak 1 lb. Rated, net 30 days. COD's 25%

P.O. BOX 942R
SO. LYNNFIELD, MASS.
"PAK-KING" OF THE WORLD

# ADVERTISING INDEX

*Radio-Electronics does not assume responsibility for any errors which may appear in the index below.*

# Classified Ads

COMMERCIAL RATE (for firms or individuals offering commercial products or services): 55¢ per word . . . minimum 10 words.

NON-COMMERCIAL RATE (for individuals who want to buy or sell personal items): 30¢ per word . . . no minimum.

Payment must accompany all ads except those placed by accredited advertising agencies. 10% discount on 12 consecutive insertions, if paid in advance. Misleading or objectionable ads not accepted. Copy for October issue must reach us before August 14th.

WORD COUNT: Include name and address. Name of city (Des Moines) or of state (New York) counts as one word each. Zone or Zip Code numbers not counted. (We reserve the right to omit Zip Code if space does not permit.) Count each abbreviation, initial, single figure or group of figures or letters as a word. Symbols or groups such as 8x10, COD, AC, etc., count as one word. Hyphenated words count as two words. Minor over-wordage will be edited to match advance payment.

## Audio—Hi-fi

SAVE 30-60% Stereo music on tape. Free bargain, catalog / blank tape / recorders / Norelco speakers. **SAXITONE,** 1776 Columbia Road, Washington D. C.

WRITE for highest discounts on components, recorders, tapes, from franchised distributors. Send for FREE monthly specials. **CARSTON,** 125-R East 88, N.Y.C. 10028.

RENT STEREO TAPES—over 2,500 different—all major labels — free brochure. **STEREO-PARTI,** 1616 Terrace Way, Santa Rosa, Calif.

PHONOGRAPH NEEDLE discount sale. Write for Free brochure. **MOORE'S,** 19 Goldsboro, Easton, Md.

HI FI, Ham Equipment, Discount Catalog. **MENDOTA CAMERA SHOP,** Mendota, Minn.

TAPE recorders, Hi-Fi components, Sleep-learning equipment, Tapes. Unusual values. Free catalog. **DRESSNER,** 1523 Jericho Turnpike, New Hyde Park 5, N.Y.

WINDSOR TAPE CLUB members HEAR BEFORE THEY BUY. Free "samplers" of new releases. Save on tape purchases—all major labels. Free Brochure—**WINDSOR TAPE CLUB,** Dept. A, Windsor, Calif.

HI-FI COMPONENTS, Tape Recorders, at guaranteed "WE will not be undersold" prices. 15-day moneyback guarantee. Two-year warranty. NO Catalog. Quotations Free. **HI FIDELITY CENTER,** 1797 (R) 1st Ave., New York, N. Y. 10028.

## EDUCATION/ INSTRUCTION

SLEEP LEARNING. Hypnotism! Tapes, records, books, equipment. Details, strange catalog FREE. **RESEARCH ASSOCIATION,** Box 24-RD, Olympia, Wash.

HIGHLY—effective home study review for FCC commercial phone exams. Free literature! **COOK'S SCHOOL OF ELECTRONICS,** Craigmont, Idaho 83523.

FCC LICENSE in 6 weeks. First Class Radio Telephone. Results Guaranteed. **ELKINS RADIO SCHOOL,** 2603E Inwood, Dallas, Tex.

PHOTOGRAPHY FOR PLEASURE or profit. Learn at home. Practical basic training. Long established school. Free book. **AMERICAN SCHOOL OF PHOTOGRAPHY,** 835 Diversey Parkway, Dept. 187C, Chicago, III. 60614.

## BUSINESS AIDS

JUST STARTING IN TV SERVICE? Write for FREE 32 PAGE CATALOG of Service Order books, invoices, job tickets, phone message books, statements and file systems. **OELRICH PUBLICATIONS,** 6556 W. Higgins, Chicago, III. 60656.

1,000 Business Cards. "Raised Letters" $3.75 postpaid. Samples. **ROUTH,** RE8, 2633 Randleman, Greensboro, N.C. 27406.

## Electronics

RADIO & TV TUBES 33¢. Free List. **CORNELL,** 4217-E University, San Diego, Calif. 92105.

BEFORE You Buy Receiving Tubes, Test Equipment, Hi-Fi Components, Kits, Parts, etc. . . . send for your Giant Free Zalytron Current Catalog, featuring all STANDARD BRAND TUBES all Brand New Premium Individually Boxed. One Year Guarantee—all at BIGGEST DISCOUNTS in America! We serve professional servicemen, hobbyists, experimenters, engineers, technicians. WHY PAY MORE? **ZALYTRON TUBE CORP.,** 469R Jericho Turnpike, Mineola, N. Y.

TRANSISTORIZED Treasure Detectors Find buried gold, silver, coins. $19.95 up. Kits available. Free catalog. **RELCO**-A25, Box 10563, Houston 18, Texas.

PRINTED CIRCUIT BOARDS. Hams, Experimenters. Catalog 10¢. **P/M ELECTRONICS,** Box 6288, Seattle, Wash. 98188.

TRANSISTOR TELEVISION TRANSLATORS. Rebroadcast 25 miles, meets F.C.C. specifications. Battery powered. **KEITH ANDERSON COMPANY,** Piedmont, So. Dak.

7" TV TEST TUBE—$6.99. Tubes 6146—$2.95; 6211 (12AU7 equiv.) 39¢, 3 for $1. Germanium diodes, tested, equiv. 1N34, 1N60 etc., 30 for $1. Tophat silicon rectifiers, 750MA—1000 PIV 75¢. Transistors, tubes, resistors, condensers, etc., bargain priced. Free catalog. **ARCTURUS ELECTRONICS,** Dept. RE, 502-22nd St., Union City, N. J. 07087.

DIAGRAMS FOR REPAIRING RADIOS $1.00. Television $2.50. Give make, model. **DIAGRAM SERVICE,** Box 1151 RE, Manchester, Conn.

IGNITION! Transistor, Coil, Ballast $7 50. Free Parts List. **TRANSFIRE,** Carlisle 20, Mass.

TRANS-NITION Electronic Ignition parts kit. Negative ground $20. Coil. Manual SPECIAL $8.50 Manual $2. **ANDERSON ENGINEERING,** Wrentham, Mass.

CONVERT any television to sensitive, big-screen oscilloscope. Only minor changes required. No electronic experience necessary. Illustrated plans $2. **RELCO,** Box 10563, Houston 18, Tex.

TRANSISTORS, SCR's, diodes, nickel-cadmium batteries, meters, crystals, components. Quality guaranteed. Send 10¢ for catalog. **ELECTRONIC COMPONENTS CO.** P.O. Box 2902B, Baton Rouge, La. 70821.

TV CAMERAS, transmitters, converters, etc. Lowest Factory prices. Catalog 10¢. **VANGUARD,** 190-48-99th Ave., Hollis, N.Y. 11423.

SEMICONDUCTORS, miniature electronic components, surplus bargains.-free catalog. **ELECTRONIC CONTROL DESIGN COMPANY**—P.O. Box 1432A, Plainfield, N.J. 07061.

GOVERNMENT SURPLUS JEEPS—$62.50, Voltmeters — $1.05, Transmitters — $6.18 Oscilloscopes, Walkie-Talkies, Multimeters. Typical Surplus Prices. Exciting Details Free. Write: **ENTERPRISES,** Box 402-F19, Jamaica 30, N.Y.

METER PROTECTOR, will protect the meter of your multi-tester permanently from accidental overloads due to the selector switch set on wrong position for voltage encountered, protector does not wear out, will not affect the accuracy of multi-tester, with this protector it will become impossible to bend the pointer, or burn out the meter, you need this protection as you need the volt ohm meter itself, install yourself in few minutes, satisfaction guaranteed or money refunded. $3.95 PP. **JAMES ELECTRONICS,** 8 W. Main Street, Du Quoin, III. 62832.

JAPANESE MERCHANDISE from Radio to Camera. Any inquiries answered. Catalog, and information $1.00. **TOMIO UENO,** No. 538 Shibamatacho Katushikaku, Tokyo, Japan.

F.M. TUNERS. Single tube units 88-108 mcs. Brand new less tube. Die cast unit-pulley/string drive as used by Admiral-RCA in recent models. Output 10.7 mcs I.F. can be used for series or parallel heaters. 130 volts. B plus. Excellent for general replacement or construction. With instructions. Price only $5.00 post paid. NO COD. **SELVEY ELECTRONICS,** 2409 Main Street, Evanston, III.

BRAND NEW 8YP4 Test Tube—$17.95. "A must for every serviceman". (RADIO-ELECTRONICS, January, 1964 issue. Page 32.) Send check or money order for immediate delivery to: **SAMSON KINESCOPE,** Inc. 250 No. Goodman Street, Rochester, N.Y. 14607.

PROFESSIONAL ELECTRONICS PROJECTS — Organs, Timers, Computers, etc.—$1 up. Catalog free. **PARKS,** Box 1665, Seattle, Wash. 98125.

FREE ELECTRONICS CATALOG. Tremendous bargains. **ELECTROLABS,** Department C-226G, Hewlett, N.Y. 11557.

## General

TV SERVICE ORDER BOOKS for use with your rubber stamp. Duplicate or triplicate. Low cost. Write for FREE 32 PAGE CATALOG and Special Rubber Stamp Offer. **OELRICH PUBLICATIONS,** 6556 W. Higgins, Chicago, III. 60656.

## Canadians

CANADIANS Have you seen ELECTRON, Canada's own Service and Hobby magazine? Subscription $3.50. **ELECTRON,** Box 796, Montreal, Canada.

## WANTED

QUICK CASH . . . for Electronic EQUIPMENT, COMPONENTS, unused TUBES. Send list now! **BARRY,** 512 Broadway, New York, N. Y. 10012, 212 WALKER 5-7000.

PHOTOGRAPHS and TRANSPARENCIES wanted — to $500.00 each. Valuable information — Free. Write **PICTURE,** Box 74607, Hollywood, 90004.

G-R, H-P, L&N, etc. Special tubes, manuals, military electronics. **ENGINEERING ASSOCIATES,** 434 Patterson Road, Dayton 19, Ohio.

## SERVICES

TRANSISTORIZED products dealers catalog, $1. INTERMARKET, CPO 1717, Tokyo, Japan.

SPEAKER RECONING. Satisfaction Guaranteed. **C & M RECONE CO.,** 18 E. Trenton Ave., Morrisville, Pa.

ALL MAKES OF ELECTRICAL INSTRUMENTS AND TESTING equipment repaired. **HAZELTON INSTRUMENT CO.,** 128 Liberty St., New York, N.Y.

INVENTORS. We will develop, help sell your idea or invention, patented or unpatented. Our national manufacturer clients are urgently seeking new items for outright cash sale or royalties. Financial assistance available. 10 years proven performance. For free information, write Dept. 53, **WALL STREET INVENTION BROKERAGE,** 79 Wall Street, New York, N. Y. 10005.

TV TUNERS Rebuilt and Aligned per manufacturers specification. Only $9.50. Any Make UHF or VHF. We ship COD Ninety day written guarantee. Ship complete with tubes or write for free mailing kit and dealer brochure. **JW ELECTRONICS.** Box D, Bloomington, Ind.

METERS—MULTIMETERS REPAIRED and calibrated. **BIGELOW ELECTRONICS,** Box 71-B, Bluffton, Ohio.

## MISCELLANEOUS

HIGH WEEKLY EARNINGS! Address-mail letters featuring real merchandise. Get $10 with every order-keep $8 profit. Supplies furnished. Free particulars. MODERN MERCHANDISIN, Box 357, Oceanside, N.Y.

# RAD-TEL'S
*AMAZING OFFER...*
*YOUR CHOICE*
## IB3-IG3-IK3-IJ3
# FREE!

HURRY OFFER EXPIRES
OCTOBER 31, 1964

# RAD-TEL'S QUALITY
# BRAND NEW TUBES
## ONE YEAR GUARANTEE

Rad-Tel will replace any tube that does not give efficient performance for 1 year from date of purchase.

## ONE TUBE FREE
## IB3-IG3-IK3-IJ3

with the purchase of every 10 Rad-Tel Quality
BRAND NEW TUBES

up to **75% OFF*** 

*Manufacturers Suggested List Price

**500 TYPES IN STOCK**


**EACH TUBE INDIVIDUALLY & ATTRACTIVELY BOXED & BRANDED RAD-TEL**

| Qty. | Type | Price |
|---|---|---|
| ___ | 0Z4 | .79 |
| ___ | 1AX2 | .62 |
| ___ | 1B3 | .79 |
| ___ | 1DN5 | .55 |
| ___ | 1G3 | .79 |
| ___ | 1J3 | .79 |
| ___ | 1K3 | .79 |
| ___ | 1R5 | .77 |
| ___ | 1S5 | .75 |
| ___ | 1T4 | .72 |
| ___ | 1U5 | .65 |
| ___ | 1X2B | .82 |
| ___ | 2AF4 | .96 |
| ___ | 3AL5 | .46 |
| ___ | 3AU6 | .54 |
| ___ | 3AV6 | .42 |
| ___ | 3BC5 | .63 |
| ___ | 3BN6 | .75 |
| ___ | 3BU8 | .78 |
| ___ | 3BY6 | .58 |
| ___ | 3BZ6 | .56 |
| ___ | 3CB6 | .56 |
| ___ | 3CS6 | .58 |
| ___ | 3DG4 | .85 |
| ___ | 3DK6 | .60 |
| ___ | 3DT6 | .54 |
| ___ | 3GK5 | .99 |
| ___ | 3Q4 | .63 |
| ___ | 3S4 | .75 |
| ___ | 3V4 | .63 |
| ___ | 4BQ7 | 1.01 |
| ___ | 4CS6 | .61 |
| ___ | 4DT6 | .55 |
| ___ | 4GM6 | .60 |
| ___ | 5AM8 | .79 |
| ___ | 5AN8 | .90 |

| Qty. | Type | Price |
|---|---|---|
| ___ | 5AQ5 | .54 |
| ___ | 5AT8 | .83 |
| ___ | 5BK7 | .86 |
| ___ | 5BQ7 | 1.01 |
| ___ | 5BR8 | .83 |
| ___ | 5CG8 | .81 |
| ___ | 5CL8 | .76 |
| ___ | 5CQ8 | .84 |
| ___ | 5EA8 | .80 |
| ___ | 5EU8 | .80 |
| ___ | 5J6 | .72 |
| ___ | 5T8 | .86 |
| ___ | 5U4 | .60 |
| ___ | 5U8 | .84 |
| ___ | 5V6 | .56 |
| ___ | 5X8 | .82 |
| ___ | 5Y3 | .46 |
| ___ | 6AB4 | .46 |
| ___ | 6AC7 | .96 |
| ___ | 6AF4 | 1.01 |
| ___ | 6AG5 | .70 |
| ___ | 6AH4 | .81 |
| ___ | 6AH6 | 1.10 |
| ___ | 6AK5 | .95 |
| ___ | 6AL5 | .47 |
| ___ | 6AM8 | .78 |
| ___ | 6AQ5 | .53 |
| ___ | 6AS5 | .60 |
| ___ | 6AT6 | .49 |
| ___ | 6AT8 | .86 |
| ___ | 6AU4 | .85 |
| ___ | 6AU6 | .52 |
| ___ | 6AU8 | .87 |
| ___ | 6AV6 | .41 |
| ___ | 6AW8 | .90 |
| ___ | 6AX4 | .66 |

| Qty. | Type | Price |
|---|---|---|
| ___ | 6AX5 | .74 |
| ___ | 6BA6 | .50 |
| ___ | 6BC5 | .61 |
| ___ | 6BC8 | 1.04 |
| ___ | 6BE6 | .55 |
| ___ | 6BF5 | .90 |
| ___ | 6BF6 | .44 |
| ___ | 6BG6 | 1.70 |
| ___ | 6BH8 | .98 |
| ___ | 6BJ6 | .65 |
| ___ | 6BJ7 | .79 |
| ___ | 6BK7 | .85 |
| ___ | 6BL7 | 1.09 |
| ___ | 6BN6 | .74 |
| ___ | 6BQ6 | 1.12 |
| ___ | 6BQ7 | 1.00 |
| ___ | 6BU8 | .70 |
| ___ | 6BX7 | 1.11 |
| ___ | 6BZ6 | .55 |
| ___ | 6BZ7 | 1.03 |
| ___ | 6C4 | .45 |
| ___ | 6CB6 | .55 |
| ___ | 6CD6 | 1.51 |
| ___ | 6CG7 | .61 |
| ___ | 6CG8 | .80 |
| ___ | 6CL8 | .79 |
| ___ | 6CM7 | .69 |
| ___ | 6CN7 | .70 |
| ___ | 6CQ8 | .92 |
| ___ | 6CR6 | .60 |
| ___ | 6CS6 | .57 |
| ___ | 6CS7 | .69 |
| ___ | 6CU5 | .58 |
| ___ | 6CU6 | 1.08 |
| ___ | 6CY5 | .70 |
| ___ | 6CY7 | .71 |

| Qty. | Type | Price |
|---|---|---|
| ___ | 6DA4 | .68 |
| ___ | 6DE6 | .61 |
| ___ | 6DG6 | .62 |
| ___ | 6DJ8 | 1.21 |
| ___ | 6DK6 | .59 |
| ___ | 6DN6 | 1.55 |
| ___ | 6DQ6 | 1.10 |
| ___ | 6DT5 | .81 |
| ___ | 6DT6 | .53 |
| ___ | 6DT8 | .94 |
| ___ | 6EA8 | .79 |
| ___ | 6EB5 | .73 |
| ___ | 6EB8 | .94 |
| ___ | 6EM5 | .77 |
| ___ | 6EM7 | .82 |
| ___ | 6EU8 | .79 |
| ___ | 6EV5 | .75 |
| ___ | 6EW6 | .57 |
| ___ | 6EY6 | .75 |
| ___ | 6FG7 | .69 |
| ___ | 6FV8 | .79 |
| ___ | 6GH8 | .80 |
| ___ | 6GK5 | .61 |
| ___ | 6GK6 | .79 |
| ___ | 6GN8 | .94 |
| ___ | 6H6 | .58 |
| ___ | 6J5GT | .51 |
| ___ | 6J6 | .71 |
| ___ | 6K6 | .63 |
| ___ | 6S4 | .52 |
| ___ | 6SA7GT | .99 |
| ___ | 6SH7 | 1.02 |
| ___ | 6SJ7 | .88 |
| ___ | 6SK7GT | .95 |
| ___ | 6SL7GT | .84 |
| ___ | 6SN7 | .65 |

**RAD-TEL TUBE CO. NOT AFFILIATED WITH ANY OTHER MAIL ORDER TUBE COMPANY**

| Qty. | Type | Price |
|---|---|---|
| ___ | 6SQ7GT | .94 |
| ___ | 6T4 | .99 |
| ___ | 6T8 | .85 |
| ___ | 6U8 | .83 |
| ___ | 6V6GT | .54 |
| ___ | 6W4 | .61 |
| ___ | 6W6 | .71 |
| ___ | 6X4 | .41 |
| ___ | 6X8 | .80 |
| ___ | 7A8 | .68 |
| ___ | 7AU7 | .65 |
| ___ | 7EY6 | .75 |
| ___ | 7Y4 | .69 |
| ___ | 8AU8 | .90 |
| ___ | 8AW8 | .93 |
| ___ | 8BQ5 | .60 |
| ___ | 8CG7 | .63 |
| ___ | 8CM7 | .70 |
| ___ | 8CN7 | .97 |
| ___ | 8CS7 | .74 |
| ___ | 8EB8 | .94 |
| ___ | 8FQ7 | .56 |
| ___ | 9CL8 | .79 |
| ___ | 11CY7 | .75 |
| ___ | 12A4 | .60 |
| ___ | 12AB5 | .60 |
| ___ | 12AC6 | .55 |
| ___ | 12AD6 | .57 |
| ___ | 12AE6 | .50 |
| ___ | 12AE7 | .94 |
| ___ | 12AF3 | .73 |
| ___ | 12AF6 | .67 |
| ___ | 12AJ6 | .62 |
| ___ | 12AL5 | .47 |

| Qty. | Type | Price |
|---|---|---|
| ___ | 12AL8 | .95 |
| ___ | 12AQ5 | .60 |
| ___ | 12AT6 | .50 |
| ___ | 12AT7 | .76 |
| ___ | 12AU6 | .51 |
| ___ | 12AU7 | .61 |
| ___ | 12AV6 | .41 |
| ___ | 12AV7 | .82 |
| ___ | 12AX4 | .67 |
| ___ | 12AX7 | .63 |
| ___ | 12AY7 | 1.44 |
| ___ | 12AZ7 | .86 |
| ___ | 12B4 | .68 |
| ___ | 12BD6 | .50 |
| ___ | 12BE6 | .53 |
| ___ | 12BF6 | .60 |
| ___ | 12BH7 | .77 |
| ___ | 12BK5 | 1.00 |
| ___ | 12BL6 | .56 |
| ___ | 12BQ6 | 1.16 |
| ___ | 12BR7 | .74 |
| ___ | 12BV7 | .76 |
| ___ | 12BY7 | .77 |
| ___ | 12BZ7 | .86 |
| ___ | 12CN5 | .56 |
| ___ | 12CR6 | .67 |
| ___ | 12CU5 | .58 |
| ___ | 12CU6 | 1.06 |
| ___ | 12CX6 | .54 |
| ___ | 12D4 | .69 |
| ___ | 12DE8 | .83 |
| ___ | 12DL8 | .88 |
| ___ | 12DQ6 | 1.04 |
| ___ | 12DS7 | .84 |

| Qty. | Type | Price |
|---|---|---|
| ___ | 12DT5 | .76 |
| ___ | 12DT7 | .79 |
| ___ | 12DT8 | .78 |
| ___ | 12DW8 | .89 |
| ___ | 12DZ6 | .62 |
| ___ | 12ED5 | .62 |
| ___ | 12EG6 | .62 |
| ___ | 12EK6 | .62 |
| ___ | 12EL6 | .50 |
| ___ | 12EZ6 | .57 |
| ___ | 12F8 | .66 |
| ___ | 12FA6 | .79 |
| ___ | 12FM6 | .50 |
| ___ | 12FR8 | .97 |
| ___ | 12FX8 | .90 |
| ___ | 12GC6 | 1.06 |
| ___ | 12J8 | .84 |
| ___ | 12K5 | .75 |
| ___ | 12L6 | .73 |
| ___ | 12SF7 | .69 |
| ___ | 12SK7GT | .95 |
| ___ | 12SL7 | .80 |
| ___ | 12SN7 | .67 |
| ___ | 12SQ7GT | .91 |
| ___ | 12U7 | .62 |
| ___ | 12V6 | .63 |
| ___ | 12W6 | .71 |
| ___ | 12X4 | .47 |
| ___ | 17AX4 | .67 |
| ___ | 17DQ6 | 1.06 |
| ___ | 18FW6 | .49 |
| ___ | 18FX6 | .53 |
| ___ | 18FY6 | .50 |

| Qty. | Type | Price |
|---|---|---|
| ___ | 19AU4 | .87 |
| ___ | 19BG6 | 1.39 |
| ___ | 19EA8 | .79 |
| ___ | 19T8 | .85 |
| ___ | 21EX6 | 1.49 |
| ___ | 25AX4 | .70 |
| ___ | 25C5 | .53 |
| ___ | 25CA5 | .59 |
| ___ | 25CD6 | 1.52 |
| ___ | 25CU6 | 1.11 |
| ___ | 25DN6 | 1.42 |
| ___ | 25EH5 | .55 |
| ___ | 25L6 | .57 |
| ___ | 25W4 | .68 |
| ___ | 32ET5 | .55 |
| ___ | 35C5 | .51 |
| ___ | 35L6 | .60 |
| ___ | 35W4 | .42 |
| ___ | 35Z5 | .60 |
| ___ | 36AM3 | .36 |
| ___ | 50B5 | .69 |
| ___ | 50C5 | .53 |
| ___ | 50EH5 | .55 |
| ___ | 50L6 | .61 |
| ___ | 70L7 | .97 |
| ___ | 117Z3 | .85 |
| ___ | 807 | .75 |

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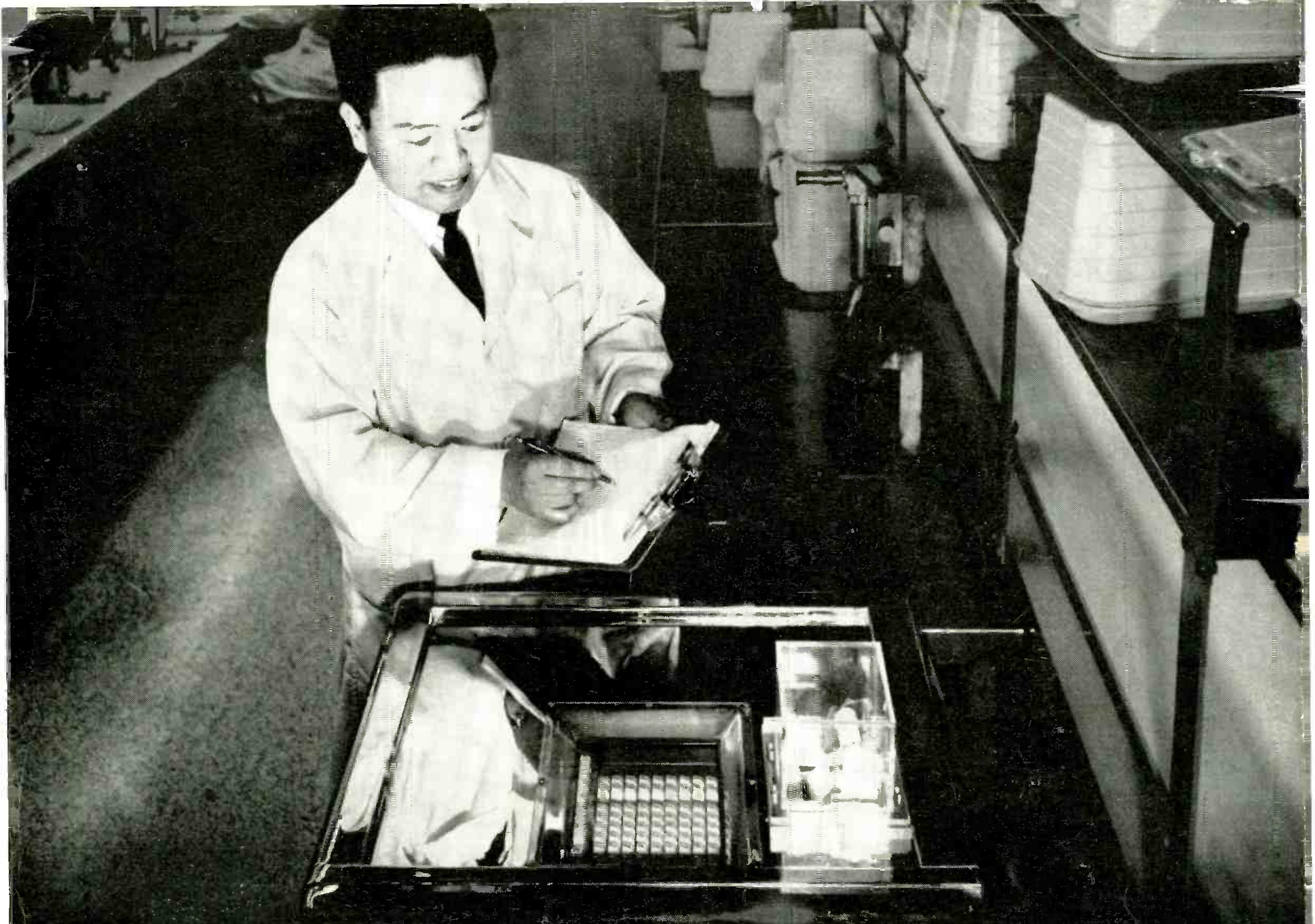


# ELECTRONIC DUST COUNTER IMPROVES RCA PICTURE TUBES

## Strict environmental control extends electron gun life and performance

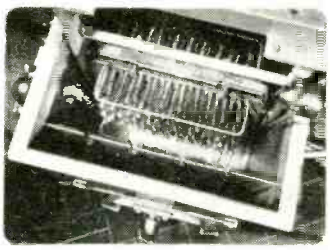
Even the smallest particle of dust can affect the life and precision performance of an electron gun in a television picture tube. In order to assure ultra-clean conditions for assembling guns that go into Silverama® Picture Tubes, RCA designed and built a space-age white room in its Marion, Indiana, plant.

Air in the white room is controlled by an electrostatic precipitator-type air conditioner. Higher than normal air pressure is maintained in the white room so no outside air can enter. At the entrance, "sticky floor mats" remove dust from workers' shoes. Workers wear lint-free Dacron smocks, lint-free nylon gloves, and rubber finger cots.

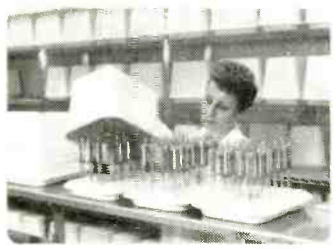
Yet, in addition to these precautions, RCA continually monitors the white room's dust count by means of the digital-dust counter shown in the photo above. The unit is so sensitive it counts all dust particles from 0.32 micron (a micron is about one 39-millionth of an inch) to 8 microns. Only when the "dust count" is below an acceptable level can electron guns be processed.

These exceptionally strict environmental controls are another reason why you can be sure of customer satisfaction when you install an RCA Silverama Picture Tube.

Silverama is made with an all-new electron gun, finest parts and materials, and a glass envelope that has been thoroughly cleaned and inspected prior to re-use.



**Electron gun mounts** are washed by ultra-sonic vibration in extra-pure water to remove microscopic particles.



**Electron guns, after drying,** are kept in covered racks as further assurance against dust contamination.

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