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See page 40
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19 BIG KITS YOURS TO KEEP

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 ¼-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.”

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...
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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 degrees).
How to break the capacitor replacement habit

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.

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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...
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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-
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AUGUST, 1964
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For Engineering Bulletin TY-63 and full details, including basic data, circuit diagrams, specifications and application notes, write to 305 North Briant Street, Huntington, Indiana.

A VOTE FOR HIGH-GRADE TEST-INSTRUMENT PROJECTS

Dear Editor:

The article "A Lab-Quality Audio Generator," by Jon Idestam-Almqvist, 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

OPPOSES SCOUT SIGNALING REQUIREMENTS CHANGE

Dear Editor:

The proposed Revised Requirements for Boy Scouts of America, which became 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 Scout, 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 PROPP FOULED" in Morse code. I kept on as the ship approached, passed a few miles away and continued on its course.

As it was about to go out of sight, it changed course into a large cir-
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AUGUST, 1964
cile, 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 very little 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.

### RAVE REVIEW ON SONY 600

Radio-Electronics Magazine June, 1964 says:

“This recorder has some very good specifications and, although its price is above the ‘cheap’ range, one does not readily believe such excellent specs for a 4-track machine until they prove out. This machine fulfilled its promise. With it, you can tape your stereo discs and play them back without being able to detect any difference, which is saying something. The physical design of this unit is good, for either permanent installation or the most complete portability.

“The footage indicator is a footage indicator, not merely a place spotter, and it keeps its count with all normal tape movements. Independent control of left and right channels, so one can be operated in record, while the other is in playback, enable the unit to be used for an endless variety of ‘special’ effects. “Playback and record functions are completely separate, so that a recorded program can be monitored immediately. Microphone and auxiliary inputs can be mixed for combination and re-record effects. First stage amplification uses transistors, while the main amplification uses tubes—a good marriage in this particular design.

“The mikes are very good, compared with most of the ‘inexpensive’ types used with home recorders. Extremely good realism is possible for home recordings. I had my family ‘act natural’ in front of the two-mike combination and the playback was unbelievably real. The Sony 600 will naturally take a little playing around to find out how to do various ‘extra’ things you may want. But when you get to know it, you’ll find it a very versatile instrument. It’s a recorder with which familiarity brings confidence.”

Norman H. Crowhurst

For further information, or complete copy of the above test report, write Superscope, Inc. “600 Test Report G, Sun Valley, Calif.

### 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.

<table>
<thead>
<tr>
<th>ABBREVIATION</th>
<th>ELECTRONIC TERM</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>amperes(s)</td>
</tr>
<tr>
<td>ac</td>
<td>alternating current</td>
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<tr>
<td>acc</td>
<td>automatic control</td>
</tr>
<tr>
<td>adj</td>
<td>adjustment</td>
</tr>
<tr>
<td>af</td>
<td>audio frequency</td>
</tr>
<tr>
<td>afc</td>
<td>automatic frequency control</td>
</tr>
<tr>
<td>aft</td>
<td>audio-frequency transformer</td>
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<tr>
<td>age</td>
<td>automatic gain</td>
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<tr>
<td>am</td>
<td>amplitude modulation</td>
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<tr>
<td>amp</td>
<td>amperes(s)</td>
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<td>ampl</td>
<td>amplifier</td>
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<tr>
<td>ant</td>
<td>antenna</td>
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<tr>
<td>apc</td>
<td>automatic phase control</td>
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<tr>
<td>atcn</td>
<td>attenuator</td>
</tr>
<tr>
<td>autotrans</td>
<td>autotransformer</td>
</tr>
<tr>
<td>avc</td>
<td>automatic volume control</td>
</tr>
<tr>
<td>awg</td>
<td>American wire gauge</td>
</tr>
<tr>
<td>b or base</td>
<td>base (of transistors)</td>
</tr>
<tr>
<td>bal mod</td>
<td>balanced modulator</td>
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<tr>
<td>balun</td>
<td>balanced to unbalanced transformer</td>
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<tr>
<td>batt</td>
<td>battery</td>
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<tr>
<td>bci</td>
<td>broadcast interference</td>
</tr>
<tr>
<td>bfo</td>
<td>beat frequency oscillator</td>
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<tr>
<td>bfoh</td>
<td>Barkhausen oscillation</td>
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<tr>
<td>bfoh</td>
<td>Barkhausen oscillator</td>
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<tr>
<td>c</td>
<td>capacitor (capacitance)</td>
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<tr>
<td>calib</td>
<td>calibrate</td>
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<tr>
<td>cath</td>
<td>cathode</td>
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<td>cath fol</td>
<td>cathode follower</td>
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<td>cent</td>
<td>centering</td>
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<td>ch</td>
<td>choke</td>
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<tr>
<td>chan</td>
<td>channel</td>
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<tr>
<td>chg</td>
<td>charge</td>
</tr>
<tr>
<td>ckt</td>
<td>circuit</td>
</tr>
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</table>

(continued on page 22)

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<td>charge</td>
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<tr>
<td>ckt</td>
<td>circuit</td>
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</tbody>
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(continued on page 22)
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- **sound on sound**
- **tape and source monitor switch**
- **full 77' reel capacity**
- **microphone and line mixing**
- **magnetic phone and FM stereo inputs**
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- **hysteresis-synchronous drive motors**
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<table>
<thead>
<tr>
<th>ABBREVIATION</th>
<th>ELECTRONIC TERM</th>
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<tbody>
<tr>
<td>CTK BRKR</td>
<td>circuit breaker</td>
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<tr>
<td>coax</td>
<td>coaxial</td>
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<td>COM</td>
<td>common</td>
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<td>conductor</td>
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<td>CONN</td>
<td>connection</td>
</tr>
<tr>
<td>CONT</td>
<td>control</td>
</tr>
<tr>
<td>CONV</td>
<td>convergence, converter</td>
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<tr>
<td>CR</td>
<td>cathode-ray (tube, etc.)</td>
</tr>
<tr>
<td>CRO</td>
<td>cathode-ray oscilloscope</td>
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<tr>
<td>CRT</td>
<td>cathode-ray tube</td>
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<td>center tap</td>
</tr>
<tr>
<td>CW</td>
<td>continuous wave</td>
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<td>decibel</td>
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<td>direct current</td>
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<td>double cotton covered (wire)</td>
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<td>DC REST</td>
<td>direct current restorer</td>
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<td>definition</td>
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<td>direction finder</td>
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<td>discriminator</td>
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<td>double pole double throw</td>
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<td>double pole single throw</td>
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<td>double silk covered (wire)</td>
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<td>dynamic</td>
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<tr>
<td>dx</td>
<td>distance</td>
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<td>e</td>
<td>emitter (of transistors)</td>
</tr>
<tr>
<td>E</td>
<td>potential</td>
</tr>
<tr>
<td>E (sometimes V in transistor diagrams)</td>
<td>voltage</td>
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<td>ECO</td>
<td>electron coupled oscillator</td>
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<td>ELECT</td>
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<td>effective radiated power</td>
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<td>EXT</td>
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<td>F (as f = s)</td>
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<td>f. FREQ</td>
<td>frequency</td>
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<tr>
<td>FIL (F in tube diagrams)</td>
<td>filament</td>
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<tr>
<td>FM</td>
<td>frequency modulation</td>
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<td>FOLL (G in tube diagrams)</td>
<td>follower (-ing)</td>
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<td>inverter</td>
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<tr>
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<tr>
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<td>second</td>
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<td>SEL (RECT)</td>
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<td>second</td>
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<td>vibrator</td>
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<tr>
<td>VOM</td>
<td>volume</td>
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<tr>
<td>VOM</td>
<td>volt-ohmmeter</td>
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<tr>
<td>VR</td>
<td>voltage regulator (tube)</td>
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<td>VTM</td>
<td>vacuum tube voltometer</td>
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<td>VU</td>
<td>volume unit(s)</td>
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<td>crystal</td>
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<td>z</td>
<td>impedance</td>
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MOD: modulation (modulator)
MPX: multiplex
MULT: multiplier
MBV: 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)

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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.

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*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 "analyser" 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 abscesses for instance can be located by local temperature variations. Usually the site of an internal abscess 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 markup 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-
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...
Back of Meter Assembly

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

Front of Meter Assembly

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 components 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 3/8-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!

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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, Kamerlingh 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).

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.

When this superconducting magnet “went normal” (out of superconductivity), fantastic power of magnet plated 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.

At the same demonstration, RCA showed a microwave amplifier that uses superconductivity to work in the giga-cycle 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
HOME-MADE FOOT SWITCH AND PUSH-TO-TALK MIKE TURN LOW-PRICE PORTABLE TAPE RECORDER INTO GOOD DICTATING MACHINE

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.

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.

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.

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

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 microphone 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 micro-meter 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.

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
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.

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.

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 set screws and pull out the cord-protecting springs in both connectors. Saw a piece about 1/4 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.

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The adapter 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
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.

Watch Those Shifty Resistors!

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

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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.
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 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

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**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.

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Fig. 3—Electronic applications for thermistors. In 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 (normally 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.

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

**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.

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.
**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, automotive light transmission through the finger or ear lobe. It may make the conventional sphygmomanometer obsolete.

**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.

**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 6 1/2 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 ¼ inch thick. System connects to ac wall outlet and to any hi-fi amplifier.
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.

The collector voltage in Fig. 4-b 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. 5—Open emitter in (a) n-p-n circuit; (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 between base and emitter, 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.

**WHAT HAPPENS TO VOLTAGES WHEN ELEMENTS ARE OPEN**

<table>
<thead>
<tr>
<th>Transistor Type</th>
<th>Open Emitter</th>
<th>Open Base</th>
<th>Open Collector</th>
</tr>
</thead>
<tbody>
<tr>
<td>n-p-n</td>
<td>emitter 0</td>
<td>base 0</td>
<td>emitter 0</td>
</tr>
<tr>
<td></td>
<td>base 0</td>
<td>collector 0</td>
<td>base 0</td>
</tr>
<tr>
<td></td>
<td>collector 0</td>
<td></td>
<td>collector 0</td>
</tr>
<tr>
<td>p-n-p</td>
<td>emitter 0</td>
<td>base 0</td>
<td>emitter 0</td>
</tr>
<tr>
<td></td>
<td>base 0</td>
<td>collector 0</td>
<td>base 0</td>
</tr>
<tr>
<td></td>
<td>collector 0</td>
<td></td>
<td>collector 0</td>
</tr>
</tbody>
</table>

\[ = \text{higher-than-normal voltage} \quad \downarrow = \text{lower-than-normal voltage} \quad 0 = \text{zero voltage} \]

"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).
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.
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 power transformer. I made the power from the 6.3-volt heater winding. 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 sets). 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.

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 ac 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 synchronized 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!

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,) of around 10 pf. C, 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...
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 transmitting 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 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.

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 ¼ inch from the phone tip used to connect to the MFM antenna jack. Cable length is not critical.

Wiring the Pick-Off Box is a quick job.
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 voltmeter 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 hocus-pocus 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...
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.

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 "kettle-drum" 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 versions 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-
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 won'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 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 ¼ 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 sheet 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.

Case of the Lost Energy

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

Two one-microfarad capacitors, and a switch connecting them. The left capacitor has been charged up to 100 volts; the right one is uncharged. 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:

\[ \text{Energy} = \frac{1}{2} \times \text{Farads} \times \text{Volts}^2 \]

Let's try some numbers:

Originally,

\[ \text{Energy} = \frac{1}{2} \times 1 \, \mu\text{f} \times 100^2 = \frac{1}{2} \times 1 \, \mu\text{f} \times 0^2 \]

\[ = 2,500 \, \mu\text{Joules} \]

Finally,

\[ \text{Energy} = \frac{1}{2} \times 2 \, \mu\text{f} \times 50^2 \]

\[ = 2,500 \, \mu\text{Joules} \]

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?

(\text{Assume that the switch is perfect.})

\text{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, 1/8 second. These signals are applied to the grids of video tubes in turn through a distributor. With a 1/8-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 1/2 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.


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, west.

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.
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. 3,109,462 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.

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 smooths the pulses and delivers 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 until the tube is triggered with a voltage pulse. Fig. 1 shows the basic idea. 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 \( \frac{1}{2} (20 \times 2^2) = 40 \) watt-seconds.

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 photo-flood. 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.

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 thyatrons. 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 speed-light, he need fire only one from his camera. The light from it will fire his other lights if they have phototube connections.

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 thyatron 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 flash tube 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.

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 place 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

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**Fig. 6** A complete electronic flash circuit.
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 volt or vtm 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 for is 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. Dust 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. Photo tubes 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 flash-light 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.
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
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.

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 on 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 assembly 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 "flag," 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—booster, replacement antenna staff, 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.

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**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:

\[ P_s = \text{Area (sq. in.)} \times 0.008 \times T \]

where \( P_s \) is the maximum power radiated; \( T \), 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 1/2-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 *

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.

By normal precautions in wiring the input; the input impedance is high.

Construction is simple. The heater-regulating power transistor is mounted on a piece of aluminum 3 x 3 x 1/2 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 5 1/2 x 1 3/4 x 1/2 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

*Outboard Marine Research Center, Milwaukee, Wis.

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."
New 1964 Heathkit® All-Channel Color TV

Everyone Agrees It Outperforms Any Other, Is Easy To Build, & Saves Up To $400!

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 24 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."

Exclusive Built-In Service Center Eliminates Maintenance Costs! You adjust and maintain the GR-53A yourself with the degaussing coil, service switch, and built-in dot generator! No more costly TV service calls! No other set has these self-servicing features!

No Expensive Service Contract! Since you maintain the set, there's no need for a costly service contract. Heath warrants the picture tube for 1 year, all other parts for 90 days!

Keep Your Present TV As A "Second" Set! Many manufacturers require your present set as a trade-in to qualify for their advertised price. With Heath, no trade-in is required! ... your present set becomes a handy "second" set for use in den, children's room, bedroom, etc.!

Quality & Performance Comparable To Sets Costing $600 & More! Mr. J. I. Newton of Chapel Hill, N. C. is even more enthusiastic about the performance of his Heathkit Color TV: "My friends tell me the color is better than they have seen on sets costing $895, and I must say that I agree."

Compare These Additional Features: 26-tube, 8-diode circuit • Deluxe Standard-Kollman VHF tuner with push-to-tune fine tuning for individual channels, 2 thru 13 • New transistor UHF tuner for channels 14 thru 83 • High definition 70° 21" color tube with anti-glare bonded safety glass • 24,000 volt regulated picture power • Automatic color control & gated AGC for peak performance • 3-stage high gain video I.F. • Line thermistor for longer tube life • Thermal circuit breaker for component protection.

Cabinet Or Custom Installation! After assembly, just slip the complete unit into the handsome GRA-53-6 walnut-finished hardboard cabinet! Or, if you prefer, mount it in a wall or custom cabinet.

Enjoy Complete TV Reception Now! ... by ordering the new 1964 Heathkit 21" High Fidelity Color TV!

Kit GR-53A, chassis, tubes, mask, VHF and UHF tuners, mounting kit, speaker, 121 lbs. ........................................$399.00

GRA-53-6, walnut-finished cabinet 53 lbs. ........................................$49.00

FREE 1964 HEATHKIT CATALOG
See these and over 250 other exciting Heathkits available in easy-to-build kit form. Save 50% or more by doing the easy assembly yourself! Send for your free catalog today!

AUGUST, 1964
Fig. 1—Circuit of the direct-coupled amplifier.
1958...the RCA Radio-Phone Series
1959...the RCA Mark VII
1963...the RCA Mark VIII

and now 1964...

THE NEW RCA MARK NINE
the latest and greatest RCA CB radio of them all

Look at some of the new features...

NEW! Combination "S" Meter and Relative RF Output Meter
"S" Meter indicates the relative strength of incoming signal in "S" units. RF Output Meter (EO) indicates relative strength of the signal being transmitted.

NEW! Spotting Switch
Permits precise manual tuning of receiver without use of receiver crystals. Receiver can be tuned (or "spotted") quickly to any incoming channel. This means, when you buy crystals for extra channels, you can (if you wish) omit the RECEIVE crystals and buy only TRANSMIT crystals.

NEW! External Speaker Jack
Lets you connect an external speaker to the set, so incoming calls can be heard in remote locations.

RCA, a pioneer in the development of citizens' band radio, has been providing quality equipment since the inception of the Class D Citizens’ Radio Service in 1958. Now, these years of experience culminate in the great new RCA Mark Nine.

9 fixed crystal-controlled TRANSMIT/RECEIVE channels, separately controlled
All-channel continuously tunable receiver
Illuminated meter and working channel indicator
Push-to-talk ceramic mike with coiled cord

ONLY $134.75
AC UNIT

*Optional User Price

The Most Trusted Name in Electronics

AUGUST, 1964
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
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 cusp is 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

---

**SAVE VALUABLE SERVICING TIME with the Model 1400 IN-CIRCUIT CAPACITOR TESTER**

eliminates the time consuming method of unsoldering and resoldering when checking capacitors

The new Model 1400 IN-CIRCUIT CAPACITOR TESTER cuts capacitor testing time by at least 75% and enables you to service more TV sets in less time. It operates with amazing ease. You just connect the test leads across the capacitor in-circuit you wish to test. . . . set the range switch and the Model 1400 automatically indicates shorted or open capacitors. It will also check electrolytics, by-pass, coupling, blocking and filter capacitors, all without disconnecting them from the circuit! The valuable money-making time you save with the Model 1400 will pay for it over and over again.

**FEATURES**

- New, modern rectangular tuning-eye indicator...extremely sensitive and accurate
- Large, easy-to-read dial for precision readings
- Line isolated power supply...no shock or short-circuited hazards
- Special storage compartment stores coaxial cable and line cord
- Handsome two-tone metal housing
- Fully guaranteed by standard EI/A factory warranty

**SPECIALS**

- New low voltage electrolytics used in transistORIZED equipment
- Special low test voltage of 2.9 volts provided to prevent damage to the new low voltage electrolytics used in transistORIZED equipment

**SPECIFICATIONS**

**SHORTS TEST**
Detects shorted capacitors of all types in-circuit with shunt resistance as low as 0ohms.

**OPEN TEST**
Detects open capacitors for all values in-circuit down to 7 mfd., with shunt resistance as low as 150 ohms.

**VALUE TEST**
Indicates value of electrolytics in-circuit from 2 mfd. to 450 mfd.

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- This new non-commercial rate will enable you to buy or sell personal items or equipment at little cost.
- See the classified section for details and order form.
A FLAT-TOP ISN'T TOO BAD AS A TEEN-AGE 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 Blaaaaaaah!") 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.

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.

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 vtm, 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 age 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,
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 age action in this set by overriding the bias while watching the screen and setting the tuner. If this clear up buzz, check out the age circuit, especially the bypass capacitors in and around the tuner age.

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-μf 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.

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 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 21Z207 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, 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, III. 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 Input tuner to newer type?

Is it possible to change the Input tuner 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 Input tuner 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.
An Important Area of Audio Progress

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 those of 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: 0.7 mg

Compliance: 15 x 10^-6 cm/dyne in all directions

Tracking force: 0.7-1.5 grams for professional arms

Stylus length: 28 mm

Stylus tip: 0.7-mil diamond for microgroove discs

Dimensions: 40 x 20 x 15 mm

Frequency response: within 2 db of RIAA characteristic in all directions

Recommended load: 47,000 to 100,000 ohms

PCB: 500 x 320 x 120 mm

Weight: 0.40 g

The high compliance of 15 x 10^-6 cm/dyne accounts for the absence of resonance peaks within the audible range. The 78-rpm stylus 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 x 10^-4 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 equal the transparency of sound of the most advanced magnetic designs in heavy orchestral passages. 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.

Audio Equipment Report
The value of a name  Dealers have long found that SILVER SCREEN® 85 picture tubes move off the shelves fast. Why? One big reason is the tube's precision-engineered features. Another is that through the years these same features have created the guaranteed acceptance of a name—SILVER SCREEN 85. • In picture tubes no brand name approaches the assured recognition of SILVER SCREEN 85 tubes. To your customers, the name means built-in quality and long life dependability. To you, SILVER SCREEN 85 picture tubes mean sales, profits, fewer callbacks, better satisfied customers. • Sylvania values that acceptance and safeguards it by applying every new research and development technique for product improvement. That's why the newest SILVER SCREEN 85 picture tubes have longer life and greater product uniformity. • Stay with the quality name in TV picture tubes—SILVER SCREEN 85. See your Sylvania Distributor.

SILVER SCREEN 85 picture tubes are made only from new parts and materials except for the envelopes which, prior to reuse, are inspected and tested to the same standards as new envelopes.

SYLVANIA

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NEW CAPABILITIES IN: ELECTRONIC TUBES • SEMICONDUCTORS • MICROWAVE DEVICES • SPECIAL COMPONENTS • DISPLAY DEVICES

AUGUST, 1964

65
Sarkes Tarzian, Inc., largest manufacturer of TV and FM tuners, maintains two completely-equipped Service Centers, offering fast, dependable tuner repair service. Tarzian-made tuners received one day will be repaired and shipped out the next. More time may be required on other makes. Every channel checked and realigned per manufacturer’s specs. Tarzian offers full, 15-month guarantee against defective workmanship and parts failure due to normal usage. Cost, including all labor and parts (except tubes), is only $9.50 and $15 for UV combinations. No additional costs. No hidden charges. You pay shipping. Replacements and low-cost are available on tuners beyond practical repair.

Always send TV make, chassis and Model number with faulty tuner. Check with your local distributor for Sarkes Tarzian replacement tuners, parts, or repair service. Or, use the address nearest you for fast factory repair service.

# Bogen RT1000 Transistor AM-FM Stereo Receiver

The BOGEN RT1000 is an IMPRESSIVE IN-

The RT1000 has a line-cord FM antenna built into it, and it 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 appears more prone than even a simple dipole to multi-

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 complement 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 ear-

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-

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-

Again—a qualification. The hiss I

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

VOLUME CONTROL
and
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* NON-TOXIC
* NON-FLAMMABLE
* NO CARBON TET

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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 (5 3/4 inches high, 5 3/4 inches wide and 1 1/4 inches deep). The front panel is smaller than that of some v.t.v.m.'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 meg-ohm 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 face even when the vertical gain is set high enough to make the trace more than three times the CRT diameter. Such an expanded trace gives 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 (3.58 mc) will not
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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

AUGUST, 1964

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 given 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 ear, 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-ke "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 vtm on the ave 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 radiometer on a phone 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 Dorr

NEW SEMICONDUCTORS AND TUBES

Now: 10-pin miniatures

Four new standard-size miniature tubes with 10-pin ("decal") bases have been announced by Ampex. 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 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)

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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.

**Triae**

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.
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, -582

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...
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.

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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 braided instead of soldered.
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TUNNEL-DIODE CONVERTER FOR UHF

Model BTD-44 Ultravertor 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

plane beam widths have 1:2 ratio. Gain 16.5 ± 3 db over half-wavelength dipole. Aluminum elements, stainless steel take-offs.—JFD Electronics Corp., 15th Ave. at 62nd St., Brooklyn 19, N. Y.
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.

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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

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*All specifications from manufacturers' data.*


RECTIFIER LEAFLET, 4 pages outlining line of copper oxide instrument rectifiers with color codes, spec 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 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 3, N.Y.

Sweep and Signal Generators Catalog No. 44-4. 36 color pages contain general treatment of sweep generator operation, sweep measurement techniques. Spec, diagrams, oscilloscope patterns on 30 models. Describes accessories such as Luret 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 Form-tite tubing for insulating terminals and pigtail, jacketing wires to form cables, providing identify.

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Outperforms Finest Vacuum Tube Units

NEW SCOTT 312 SOLID STATE FM TUNER

Scott announces a top-performing solid-state FM stereo tuner at a modest price...a no-compromise tuner that exceeds the performance of conventional tube units...it's factory-guaranteed for 2 full years. Not just a redesigned unit, the Scott 312 incorporates an entirely new approach to tuner circuit design:

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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 FREE. ALL LITERATURE OFFERS ARE VOID AFTER SIX MONTHS.
An article by Bill Dufer, Jr., in the May 1961 issue of the 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 wanted posters. This has worked well. If a 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.

THE BOUNCING CHECK GATHERS NO CASH

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 not been paid, it will 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.

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 servicemen 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 (Seattle, Washington) 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.
terprise 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 comparable 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.

SEMICONDUCORS INVADE AUTOMOBILE FIELD

The automobile industry spent more than $15 million for semiconductor devices in 1963. According to D. J. 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 was in auto horns, fuel pumps and synchronized clocks.

SWEDISH 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

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, Griffiths 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 transistorized device that makes outdoor TV antennas unnecessary 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 being plugged between set and indoor antenna. It sells for approximately $12.

A British reporter who attended a demonstration of the new device told “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, individual equipment with miniature TV transmitter-receivers will communicate with one another via radio, switchboard transmitter-receivers will communicate with one another via radio, switchboard

IMMEDIATE DELIVERY … SCIENTIFIC LIGHT PACKING...
**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 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 signals from 0.5 to 30 cycles. Remove the 1-pf 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.

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-ke phase-shift oscillator described in "Build a Signal Injector Into Your VTVM" (Radio-Electronics, April 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 the primary connected 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 0.03 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 1% x 2½ 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 voltage ranges 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 to ground, the original 15-megohm 1/2-watt resistor should be substituted for the original 15-megohm 1/2-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-
for the critical recordist...
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THE 8000

It's shock-mounted! It's a dynamic! It's a cardioid! And it's only $29.95 (It's also guaranteed for 5 years!)

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For complete specifications, write Desk RE-8, LTV/University, 9500 West Reno, Oklahoma City, Oklahoma, LTV UNIVERSITY A DIVISION OF LING-TEMCO-VOUGHT, INC.

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
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+ 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. Measure the pot's resistance until the lamp just fires. Measure the resistance and use the next lower 10% 1/2-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, 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 10-10

To add intensity modulation to the Heath 10-10 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 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. Paffenbarg

Radio-Electronics
TRANISITOR 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. Newbower

COMPRSSSED 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, cooled surface. 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. Paffenbenger.

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
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 $10^1$ (10 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, $1/100$ (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 II, 1,000-000 is equal to $10^6$ cycles.

Table I is only a guide, not a crutch. The power of ten 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 $.0000000001$ 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.

To find the power of 10 without using the table, count all the digits to the left of the decimal point, and subtract one. For example, 10,000,000 is equal to $10^7$.

Table I—Some Powers of 10

<table>
<thead>
<tr>
<th>Power of Ten</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$10^6$</td>
<td>1,000,000</td>
</tr>
<tr>
<td>$10^5$</td>
<td>100,000</td>
</tr>
<tr>
<td>$10^4$</td>
<td>10,000</td>
</tr>
<tr>
<td>$10^3$</td>
<td>1,000</td>
</tr>
<tr>
<td>$10^2$</td>
<td>100</td>
</tr>
<tr>
<td>$10^1$</td>
<td>10</td>
</tr>
<tr>
<td>$10^{-1}$</td>
<td>0.1</td>
</tr>
<tr>
<td>$10^{-2}$</td>
<td>0.01</td>
</tr>
<tr>
<td>$10^{-3}$</td>
<td>0.001</td>
</tr>
<tr>
<td>$10^{-4}$</td>
<td>0.0001</td>
</tr>
<tr>
<td>$10^{-5}$</td>
<td>0.000001</td>
</tr>
</tbody>
</table>

Table II—Some Examples

<table>
<thead>
<tr>
<th>Value</th>
<th>Power of Ten</th>
</tr>
</thead>
<tbody>
<tr>
<td>34,865 cycles</td>
<td>$3.4865 \times 10^4$</td>
</tr>
<tr>
<td>3,600 pf</td>
<td>$3.6 \times 10^4$ farad</td>
</tr>
<tr>
<td>1,000 cycles</td>
<td>$10^3$ cycles</td>
</tr>
<tr>
<td>1 megohm</td>
<td>$1 \times 10^6$ ohms</td>
</tr>
<tr>
<td>17.5 mc</td>
<td>$1.75 \times 10^7$ cycles</td>
</tr>
<tr>
<td>0.00045 volt</td>
<td>$4.5 \times 10^{-4}$ volt</td>
</tr>
<tr>
<td>0.0018 microamp</td>
<td>$1.8 \times 10^{-6}$ amphere</td>
</tr>
</tbody>
</table>

A coil and capacitor to resonate at 10 mc. Complex?

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

Remember, if a power of 10 is on the right side of the dividing line, we can dispense with writing the 1. Therefore, $(10 \text{ mc})^2$ is equal to $10^{12}$ 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 again, and $10^{14} \times 10^{11} = 10^{25}$. After performing the rest of the regular division, we have .00557 over $10^5$.

By changing the sign of the number under the line may be moved to the top of the line by changing the sign of the superscript.

Table III—The Rules

Rule one: If two powers of 10 are multiplied together, just add the superscripts.

Examples: $10^{10} \times 10^4 = 10^{14}$

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: $3 \times 10^3 = 3 \times 10^{-3}$

By JERRY L. OGDIN
**SEISMOMETER**

**PATENT No. 3,118,126**

Fred A. Brock, Kenneth E. Burg, and Markwell 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 input 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 hermetically 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 Penausk, 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 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.

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An Efficient Wavemeter, by Thomas W. Benson.


Based on the author's Artisan organ, the book contains much information valuable to organ builders in general.


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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.


Covers handling of wires and components, soldering, protecting connections, laying, 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. 5 1/2 x 8 1/2 in., 192 pp. Paper, $2.95.

Information for the kit-builder, technician and operator. Covers typical equipment and latest regulations. Many schematics.


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.


A Pneumatic Lead Detector, by James L. Green.


The Marconi Fog-Gun.

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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.