SERVICE COLOR TV
TRAPS AND PITFALLS

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Radio-Electronics

TELEVISION · SERVICING · HIGH FIDELITY

A GERNSBACK PUBLICATION

HUGO GERNSBACK, Editor in-chief

1.35

REPAIR
Record Changers

BUILD
The Busy Box:
A THINKING TOT'S TOY

TRACK
Radio and
TV Interference

BUILT FROM A KIT:
All-transistor
Electronic Organ

Every 40 seconds a burglary takes place in the United States.

TECHNICAL INFORMATION

The RADAR SENTRY ALARM is a complete U.H.F. Doppler Radar System which saturates the entire protected area with invisible r.f. microwaves. It provides complete wall to wall—floor to ceiling protection for an area of up to 5,000 square feet. Without human movement in the protected area, the microwave signal remains stable. Any human movement (operation is unaffected by rodents and small animals)in the area causes the doppler signal to change frequency approximately 2 to 4 cps. An ultra-stable low frequency detector senses this small frequency change, amplifies it and triggers the police type siren—which is heard up to a half mile away.

In addition, the RADAR SENTRY ALARM's protection can be extended to other areas with the use of the following optional accessories:

- *remote detectors for extending coverage to over 10,000 sq. ft.*
- *rate of rise fire detector U.L. approved for 2,500 sq. ft. of coverage each (no limit on the number of remote detectors that can be used)*
- *hold-up alarm*
- *central station or police station transmitter and receiver (used with a leased telephone line)*
- *relay unit for activating house lights*
- *battery operated horn or bell which sounds in the event of: powerline failure; equipment malfunction or tampering*

At that rate, it's a multi-million dollar a year business...for burglars.

And an even better business opportunity for you.

Why? Because burglary can be stopped...with an effective alarm system.

In fact, police and insurance officials have proved that an alarm system reduces, and in many cases, eliminates losses—even helps police apprehend the criminal.

Here's where you come in.

Only a small percentage of the more than 100 million buildings—stores, offices, factories, schools, churches and homes are protected by an effective alarm system.

That means virtually every home, every business is a prospect.

You can sell them!

And you don't have to be a super-salesman to sell the best protection available—a Radar Sentry Alarm unit. All you have to do is demonstrate it...it sells itself.

A glance at the technical information shows why.

It's the most unique and effective alarm system ever invented.

And here's the proof.

In the past six years, thousands of RADAR SENTRY ALARM units have been sold in the Detroit, Michigan area alone—sold by men like yourself on a part-time and full-time basis.

Here are just a few customers who are protected by RADAR SENTRY ALARMS:

U.S. Government
U.S. Air Force
Detroit Board of Education
Hundreds of Churches, Banks, Businesses and Homes.

Everyone is a prospect.

So take advantage of your profession. Put your technical knowledge and experience to work for you in a totally new area—an area that will make money for you!

Don't wait!

Let us prove that crime does pay.

Become a distributor.

Write now for free details.

RADAR SENTRY ALARM

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Mail to: RADAR DEVICES MANUFACTURING CORP.
22003 Harper Ave., St. Clair Shores, Michigan 48080

Please tell me how I can have a business of my own distributing Radar Sentry Alarm Systems. I understand there is no obligation.

Name________________
RE-12
Address________________
City________ **State & Code**________

Get with the new PRECISE Green line for truly new design and decor in test instruments. These unique units have color dynamic front panels featuring easy-on-the-eyes Green to aid readability and accuracy. New functional design and layout make operation fast and foolproof. Inside, they're on line with sophisticated circuitry checked out for reliability. So when it comes to test instruments, take the best course. Swing with PRECISE scopes, VTVMs, power supplies, signal generators, tube testers, decade boxes and probes.

MODEL 636
AF SINE SQUARE GENERATOR — 20 cps to 200 kc in four ranges. Less than 0.25% sine wave distortion at 10 vrms into 600 ohms load.
Kit: $45.95 Net Wired: $61.95 Net

MODEL 780
CONTINUOUSLY VARIABLE REGULATED VOLTAGE SUPPLY — Regulated dc output from 0 to +400 v at 150 ma, and 0 to −150 v bias. Also provides unregulated ac. Meters for voltage and current.
Wired: $99.95 Net

MODEL 905
VACUUM TUBE VOLTMETER — Comes with assembled dc/ac-ohms probe. Direct reading of p-p voltages. Separate ac low voltage scale. Low 0.5 vdc range for transistor circuit measurements.
Kit: $32.95 Net Wired: $49.95 Net

PRECISE ELECTRONICS / Division of Designatronics, Inc. / Mineola, L. I., N.Y.

Circle 3 on reader's service card

Radio-Electronics

Over 55 Years of Electronic Publishing

SEMI-ANNUAL INDEX

EDITORIAL

AUDIO

ELECTRONICS

TEST INSTRUMENTS

GENERAL

TELEVISION

RADIO

THE DEPARTMENTS

Member, Institute of High Fidelity
Radio-Electronics is indexed in Applied Science & Technology Index (Formerly Industrial Arts Index).

Cover photograph by Harry Schlack

HUGO GERNSBACK, *editor-in chief and publisher*. M. HARVEY GERNSBACK, *editor*. Fred Shunaman, *managing editor*. Robert F. Scott, W2PWG, *technical editor*. Peter E. Sutheim, *associate editor*. Jack Darr, *service editor*. I. Queen, *editorial associate*. John J. Lamson, *eastern sales manager*. Wm. Lyon McLaughlin, *technical illustration director*

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NEWS BRIEFS

AUTOMATED NEWSPAPER ESTABLISHED IN ENGLAND

The Evening Post of Reading, England is going to press with computer control, photographic typesetting and offset color printing. The owner of the new Post, Lord Thomson of Fleet, states that computer operations may be extended to more of his 128 newspapers. He said, "I can envisage one big computer that would be capable of setting type for the whole of England."

The copy is first typed manually onto punched tape. This tape is fed into a computer, which divides the typed material up into lines and justifies the lines—makes a uniform right margin—like a newspaper column. It also hyphenates words properly when they have to be divided at the end of a line.

The tape produced by the computer is fed into a photographic typesetting device that turns out readable newspaper columns. These are assembled on pages and reproduced on photosensitive plates from which the newspaper is printed by the offset method.

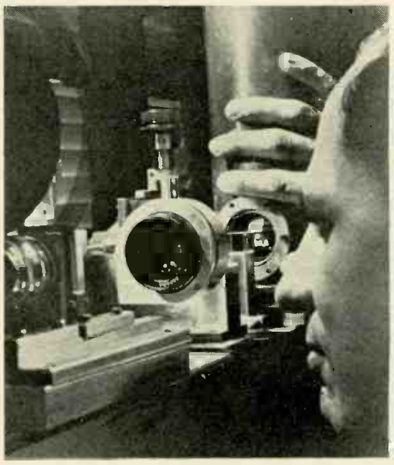
ANALYZING HEARTBEATS ULTRASONICALLY

A device which uses the Doppler shifts of frequency in the ultrasonic echoes returned by moving surfaces is being used in cardiovascular research at the National Naval Medical Center in Bethesda, Md. The invention of J. R. Richards, it can detect the respiratory activity of a goldfish, monitor different parts of the heart, or keep check on a baby's heart during delivery. Cost is estimated at about one-seventh the price of a complete electrocardiograph.

NEW LASER LIGHT DETECTOR HAS HIGH SENSITIVITY, SPEED

A new supersensitive light detector for practical laser communications has been announced by the Radio Corporation of America. Developed by Drs. Henry S. Sommers, Jr. and Edward K. Gatchell, the new light sensor is said to be the first detector developed with a sensitivity, speed and frequency range that could make laser communications practical across the optical spectrum. It can sense up to 100 million intensity changes a second in a beam of light. Thus it could distinguish as many as 25 separate TV programs carried simultaneously.

The new light sensor is a freckle-size speck of photoconductive material mounted in a small cavity, continuously bathed in microwaves at a frequency of 10 gigacycles. When amplitude-modulated light enters the cavity and strikes the photoconductor, it frees electrons, which begin to oscillate rapidly up and down within the material in response to the alternating electric field of the microwaves. The amplitude of these oscillations controls the amount of microwave power permitted to leave the cavity. Thus intensity variations in the incoming light are converted to intensity variations in the outgoing microwaves. The modulated microwave signal can then be detected and processed by conventional techniques.



Herbert Ogawa of RCA's Princeton Laboratories checks the high-frequency laser detector.

MICROWAVE FREQUENCY MULTIPLIER SHOWS 4-DB POWER GAIN

The first single transistor to offer *watts* of microwave power was announced recently by RCA Electronic Components & Devices. The new device is an "overlay" transistor, RCA 2N4012. It extends transistor performance into the gigacycle frequency region with 2.5 watts output and 4 db conversion gain when operated as a tripler with output at 1 gc. One 2N4012 can replace both the transistor power-amplifier and varactor-diode stages formerly required, making it possible to simplify circuit design greatly and to reduce cost in new telemetry and microwave equipment.

Frequency multiplication with power amplification is possible with the overlay structure because the variable collector-to-base capacitance becomes the nonlinear element of a harmonic generator. The collector-to-base capacitance acts like a variable-capacitance diode, or varactor, in parallel with the amplifier section of the transistor.

In the overlay structure, which has been used before for uhf–microwave work, are a number of individual emitter sites, all connected in parallel and used with a single base and collector region. This arrangement provides a substantial increase over other transistor structures in emitter periphery, increasing current or power; and a corresponding decrease in emitter and collector areas, reducing input and output capacitances. The overlay structure thus offers greater power output, gain, efficiency and frequency capability.

SWEDISH STAMP COMMEMORATES ONE HUNDRED YEARS OF ITU

The Swedish government has issued a stamp with a short-wave antenna motif, commemorating the centenary of the International Telecommunications Union. The stamp is modeled after an actual log-periodic antenna belonging to a remote-controlled short-wave transmitting station of the Swedish Post Office. The antenna is installed at Grimeton. It is rotatable, and both its direction and frequency are automatically controlled from Stockholm, 300 miles away.

The 43-meter antenna and its single-sideband short-wave transmitter

Circle 4 on reader's service card

were designed and built by the German firm of Rohde & Schwarz. Sweden, one of the 20 nations that 100 years ago signed the International Telegraphic Convention that led to today's ITU, has issued the stamp in two denominations, 60 and 140 öre (about 12 and 24 cents).

ULTRASONIC PROBES—NEW TEST INSTRUMENTS

An ultrasonic detector is being used to locate breakdowns in a series of 80 capacitors in 12-foot long, 2-million-volt flash X-ray pulser assemblies.

The equipment was designed by Lyman Davidson of the Field Emission Corp. in Oregon. According to its developer, it gives immediate indication of the breakdown's nature and locates it to a module of four capacitors among the 80.

Engineer checks for point of greatest noise in 2-mev flash X-ray system.

The device, known as the Delcon Ultrasonic Translator, is the size of a small camera, and consists of two interchangeable probes that respond to signals between 36 and 44 kc, plus equipment that translates the ultrasonic signal into the audible range and amplifies it for headphones.

The internal arcing caused by discontinuities in the encapsulating resin of a capacitor releases 40-kc energy which, when translated and amplified, is recognized by technicians as the sputtering, frying sound of corona.

NEW YORK HI-FI SHOW BUCKS NEWSPAPER STRIKE

The 1965 New York High Fidelity Music Show, held Sept. 29 through Oct. 3, drew sizable crowds in spite of the fact that only two of New York's six major daily papers were being published, and therefore publicity was limited.

The extensive display of home high-fidelity equipment, which covered four floors of the New York Trade Show Building, was sponsored by the Institute of High Fidelity.

With the 1965 show, transistors have finally gained the upper hand over tubes. While many manufacturers are still using tubes primarily, all are now producing transistor equipment. Marantz, one of the most steadfastly conservative manufacturers in the matter of transistor design, presented an all-solid-state stereo control center which its president, Saul Marantz, described as "a transistor version of the model 7." Dyna, another holdout, announced its first transistor stereo power amplifier, which was to become available some time early in 1966.

Shure displayed a transistor headphone-only amplifier, the first of its kind, and McIntosh introduced a tube-and-transistor receiver—the first such beast from that company.

Newer manufacturers, children of the solid-state era—Acoustech, C/M Labs and Hadley—also showed new transistor units.

The show also featured seminars for the public, designed to acquaint them with component high fidelity and its advantages over "package" or "furniture" systems.

"MONGOLISM" LINKED TO RADAR

Mongolism, a form of mental retardation in children in which a fanciful resemblance to Mongol facial characteristics is noted, may be caused by radar exposure, according to a report presented to the annual meeting of the American Public Health Association held recently in Chicago.

A four-year study by Johns Hopkins University researchers shows that a significant number of mothers of mongoloid children had been exposed to larger than usual doses of radiation and that some of the fathers had a history of working around radar equipment.

German measles during the early part of the mother's pregnancy is considered the chief factor inducing mongolism.

H. A. HARTLEY DEAD

H. A. Hartley, loudspeaker designer and audio-high-fidelity author, died late in August. He had a sudden heart attack while vacationing.

Mr. Hartley's name is associated with Hartley speakers and with the "Boffle" (box/baffle) enclosure. He was the author of the Gernsback Library book *Audio Design* and of other books on a variety of subjects, as well as numerous articles in RADIO-ELECTRONICS and other magazines.

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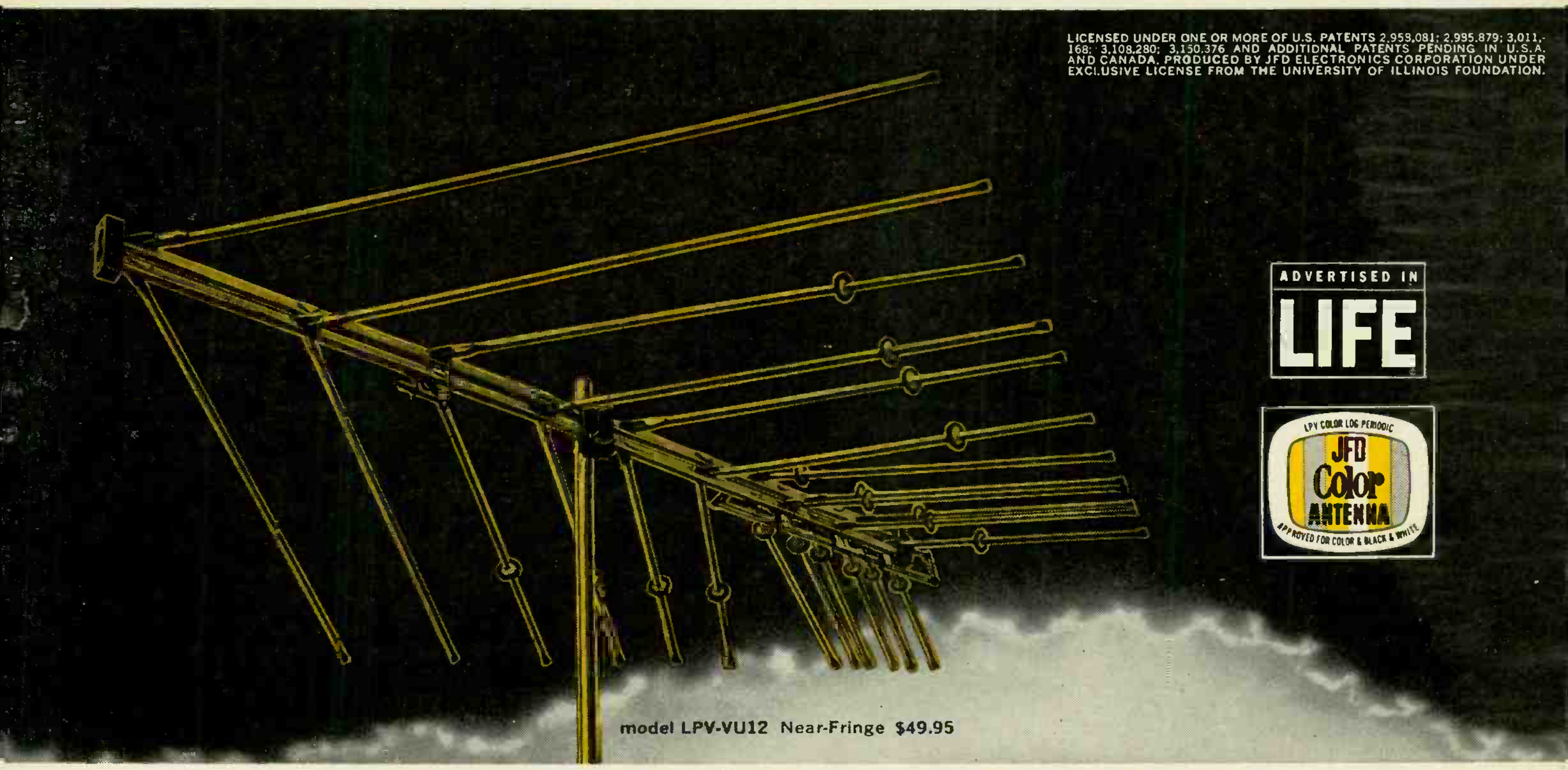
america's no. 1



VHF/UHF/FM ANTENNA!

Because it delivers best 82-channel TV performance—COLOR or black/white—plus FM/Stereo—using only a single downlead!

No other antenna works like the 82-channel JFD LPV-VU Color Log Periodic...

- **Only** the JFD LPV-VU is designed according to the patented **log periodic** design of the **University of Illinois Antenna Research Laboratories.**
- **Only** the JFD LPV-VU utilizes **capacitor-coupled Cap-Electronic** dipoles for **higher** mode operation that achieves **higher** gain, **narrower** beamwidths on VHF channels 7 to 13 and UHF channels 14 to 83. (Our competition's copies of the JFD LPV-VU use only **fundamental** mode which resonate as simple dipoles with consequently limited gain.
- **Only** the JFD LPV-VU offers true **frequency-independent** performance that insures brilliant **color** on any channel.

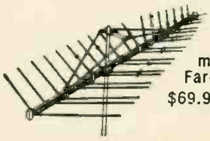
JFD® LPV®-VU Color LOG PERIODIC

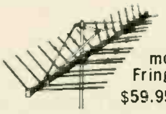
You **bet** you can have everything you want in **one** antenna—VHF, UHF, FM—with a **single** down-lead, too! Start teaming up JFD 82-channel **LPV-VU** Color Log Periodics with all the 82-channel TV sets in your area—see the difference in profits and performance. Call your distributor or write for brochure 806.

32 million readers of LIFE will be seeing spectacular JFD LPV Color Log Periodic advertisements all season long. This unprecedented LIFE campaign will be pre-selling JFD LPV antennas for **you!**

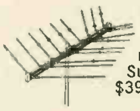
Full-color television commercials will show millions more why the LPV's patented space-log periodic design works best on **any** channel—**color** & black/white.

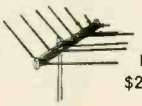
5 GREAT MODELS TO CHOOSE FROM


model LPV-VU18 Far-Fringe $69.95


model LPV-VU15 Fringe $59.95


model LPV-VU12 Near-Fringe $49.95


model LPV—VU9 Suburban-Fringe $39.50


model LPV-VU6 Metro-Suburban $27.50

JFD ELECTRONICS CORPORATION 15th Avenue at 62nd Street, Brooklyn, N. Y. 11219

Circle 6 on reader's service card

CALENDAR OF EVENTS

International Conference on UHF Television, Nov. 22–23; London, England

Fall Joint Computer Conference, Nov. 30–Dec. 2; Convention Center, Las Vegas, Nev.

Philco Service Training Meetings: Montgomery, Ala., Nov. 23, South Ala. Distrib. Co.; **Andalusia, Ala.,** Nov. 24, J. B. Restaurant; **Columbia, S. C.,** Nov. 29, Brown-Rogers-Dixon Co.; **Winston-Salem, N. C.,** Dec. 1, Brown-Rogers-Dixon Co.; **Raleigh, N. C.,** Dec. 2, Brown-Rogers-Dixon Co.; **Chattanooga, Tenn.,** Dec. 13, Philco Distributors, Inc.; **Knoxville, Tenn.,** Dec. 15, Philco Distributors, Inc. For more detailed information, exact times and places, contact the local Philco distributor.

BRIEF BRIEFS

Exact locations of piston-ring blow-by and cylinder scoring in operating engines and compressors are detected with an ultrasonic microphone by a new electronic analytical procedure.

Using an engine analyzer and an ultrasonic detection unit that translates sounds in the 36–44-kc range to audible signals, the electronic inspection gives the maintenance engineer an instantaneous scope presentation of each cylinder's complete stroke.

William Shockley, one of the Bell Lab team that invented the transistor, will join Bell Telephone Laboratories again after an absence of over 9 years. His new title is Executive Consultant on Applied Research and Development of Electronic Components.

A new type of magnetohydrodynamic generator, recently tested successfully by North American Aviation, uses a liquid metal rather than the superhot gas used in previous MHD generators.

US servicemen, according to a poll conducted by the USO in Vietnam, want voice tape recordings from their families for Christmas more than any other one thing. END

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RECENT PROFESSIONAL INSTALLATIONS OF AR SPEAKERS

AR-2x

($89-$102, depending on finish)

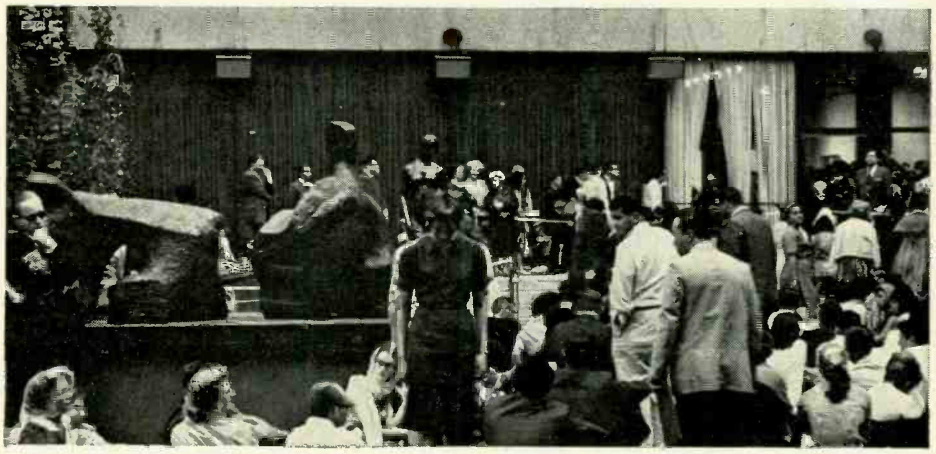
Aeolian-Skinner reverberation system corrects excessively dead acoustics in the chapel of Choate School, Wallingford, Connecticut. Duncan Phyfe, musical director of the school, describes the effect on live pipe organ and chorus as "so natural one is not aware of an electronic reverberation system."

Similar Aeolian-Skinner installations are operating in Christ Church, Cambridge, Massachusetts, and in St. John's Episcopal Church, Washington, D.C. AR speakers were chosen because of their lack of coloration, their undistorted, full-range bass, and their reliability.

AR-2ax

($109-$128)

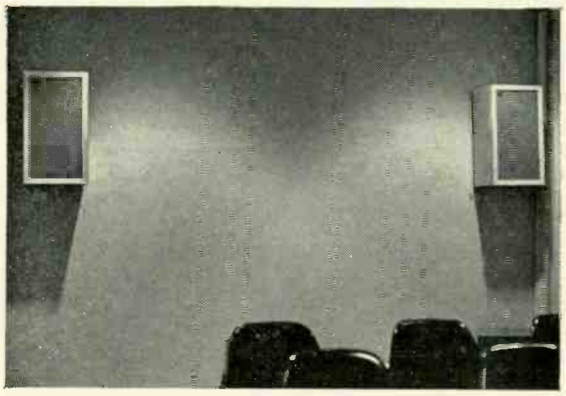
Sound reinforcement system for the summer jazz concerts in the sculpture garden of New York's Museum of Modern Art. Live music had to be amplified without giving the sound an unnatural, "electronic" quality; AR speakers were chosen after testing many brands.



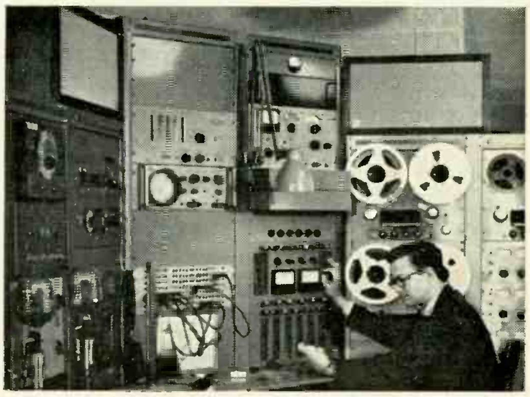
AR-3

($203-$225)

©1965, LINCOLN CENTER FOR THE PERFORMING ARTS



One of the listening rooms in the Library & Museum of the Performing Arts at Lincoln Center in New York City. AR-3's were chosen for these rooms to achieve an absolute minimum of artificial coloration.



Experimental Music Studio of the University of Illinois. Dr. Hiller (seated) writes about the AR-3's, used as monitor speakers: "I wish all our equipment were as trouble free."

AR speakers and turntables are often used professionally, but they are primarily designed for natural reproduction of music in the home. Literature is available for the asking.

ACOUSTIC RESEARCH, INC., 24 Thorndike Street, Cambridge, Massachusetts 02141

Circle 9 on reader's service card

Correspondence

WRONG-WAY DIODE

Dear Editor:

I believe that in the Motorola MC1524 circuit (New Semiconductors and Tubes, Sept. 1965), the diode connected to ground from the base of the transistor with the 20,000-ohm emitter load is in backward. As it is, the diode is reverse-biased and thus isolates the transistor from the rest of the circuit. Hence there can be no transistor action.

GARY LORENZ
Compton, Calif.

[He's right.—*Editor*]

ECHOES EDITORIAL SENTIMENTS

Dear Editor:

The editorial by Fred Shunaman in the September 1965 issue ("End of the Service Technician?") was of very special interest to me, the subject of the editorial fitting my own situation: a "dropout" from the radio-TV field. I am now in industrial electronics. After 9 years in that, I would welcome the company of more electronic technicians of the sort that (to quote Mr. Shunaman) "at least tries to understand what he is doing." I have encountered innumerable responsible people who erroneously blame faulty operation of systems on equipment (namely electronic) that they do not understand. They, pretending to understand, would make adjustments to such equipment, including combustion controls, without considering the possible drastic consequences. In agreement with Mr. Shunaman's statement "I will not touch adjustments on illuminating-gas equipment . . . .", I would add: " . . . . until I understand fully the operation of the complete system."

MYRLE DEPPER
Selinsgrove, Pa.

RESEARCH ON SHOCK DANGER

Dear Editor:

I agree wholeheartedly with reader Piette's statement ("Watch Where You Stimulate!", Correspondence, August 1965) that the probes [of my Muscle Stimulator described in June R-E] should not be used in the chest area or in any way that might cause current to flow through the heart. I also would not advocate placing the probes at one's temples in an effort to induce sleep or electronarcosis. This is dangerous ground for the uninitiated.

I have conducted a brief literature search on the topic of shock. Here is a table from an article in the January 1960 *Electrical Manufacturing* by Edwin Schechter:

The Effects of 60-cycle Alternating Current on the Human Body

1 ma	No sensation
More than 5 ma	Painful shock
More than 10 ma	Local muscle contraction sufficient to cause freezing to the circuit in 2.5% of population
More than 15 ma	Ditto, 50% of population
More than 30 ma	Breathing difficult; can cause unconsciousness
50 to 100 ma	Possible ventricular fibrillation
.01 to 2 or 3 ampere	Certain ventricular fibrillation

Another source, *Electrical Safety* by H. W. Swan, states that an adult male can let go of a 60-cycle circuit as long as the current is 9 ma or less. Women have a lower limit: 6 ma. The "danger zone" given is 20 to 24 ma.

So Mr. Piette's figure of 5 ma for "complete muscle control" seems small; but my unit's 150 volts across 2,000 ohms is 75 ma, and that's enough to warn everyone to be very careful.

SAM BRESKEND
Washington, D. C.

HONEYCOMB COILS

Dear Editor:

I thought you might be interested to know that recently I dug up some old De Forest honeycomb inductances, and, using *one tube*, I managed to breadboard a set and pick up a lot of stations around *10 to 20 kc* (NAA, NSB and many

others). The reception was fine and the news reports being sent were the best. The code sending was very good and in a few minutes I was doing pretty good, after a lapse of many years.

LEROY H. SMELTZER

Greensburg, Pa.

UNIJUNCTION TO DRIVE DEMO CIRCUITS

Dear Editor:

R. E. Baird's "Look Inside an Amplifier" (August 1965) can be a real asset in helping "see" dynamic circuit variations. There is no question that the person who can visualize several complex circuit variations at one instant will be more confident and successful in electronics than one who cannot. Practical demonstrations, as suggested by Mr. Baird, can certainly be helpful during course work.

A simple and economical method to drive such an active demonstration is with the basic unijunction relaxation oscillator. This oscillator is unusually simple, requires few components and will perform at low supply voltages. Sweep rates to a fraction of a second are easily obtained. The unijuncton is presented in Chapter 13 of the seventh edition of General Electric's Transistor Manual.

JOHN F. CLEARY

General Electric Co.
Syracuse, N.Y.

TACHOMETERS MAKE HARD STARTING

Dear Editor:

I have found after constructing and installing several kinds of electronic tachometers that they cause hard starting when the engine is cold.

I went through a long round of troubleshooting and replacement (coil, condenser, carburetor, points) before I decided that the hard starting is due to the fact that a vital but little known function of the capacitor (condenser) across the points is hindered by the low input resistance of the tachometer circuits.

It is common knowledge that one purpose of the capacitor is to prevent arcing across the breaker points when the coil primary circuit is suddenly opened. But another function of the capacitor is often overlooked.

The coil primary is energized by the battery when the breaker points close. When the points break the circuit, the current tends to continue in the same direction, and the stored magnetic energy in the core starts to collapse. The flux cuts primary and secondary windings. The faster the flux can be brought to zero (i.e., the greater its rate of change), the higher will be the voltage induced in the secondary.

With the points now open, the capacitor, which had been shorted (directly across the closed points), now acts itself as a short circuit for an instant as it becomes charged by the current created in the primary by the collapsing field. It thus aids in bringing the induced current rapidly to zero. If the capacitance is correct, it will discharge through the battery and the coil before the points close again.

The reverse flow of energy stored in the capacitor "purges" the coil of flux so there will be no counter-emf to oppose the flow of current from the battery when the points close again. This cycle repeats itself as long as the engine runs.

Any resistance across the breaker points (and hence across the capacitor) reduces the effectiveness of the capacitor and impairs the function of the whole ignition system.

I am eager to hear other views on this subject.

L. E. MUELLER

Philadelphia, Pa.

END

RECEIVE FREE literature and catalogs by mailing Readers' Service Card, page 70.

Circle 12 on reader's service card

Use this check list before you install a home TV distribution system

	COAXIAL VHF	TWINLEAD* VHF	COAXIAL UHF/VHF	TWINLEAD* UHF/VHF AND UHF ONLY
Channels received	2-13	2-13	2-83	2-83 (14-83 for UHF only)
Color reception when properly installed	Excellent	Excellent	Excellent	Excellent
Cable loss: @ channel 13 for VHF only @ channel 83 for UHF/VHF	4 db (foam filled) 6 db (solid)	1.8 db/100 ft. @ Channel 13	9 db (foam filled) 13 db (solid)	5.6 db/100 ft. @ Channel 83
Loss increase when wet	Nil	Negligible	Nil	Negligible
Reception when run near or through small metal areas	Excellent	Excellent when properly installed	Excellent	Excellent when properly installed
Reception when run near or through considerable amounts of metal	Excellent	Not recommended	Excellent	Not recommended
Ease of installation	More difficult	Easy	More difficult	Easy
Extra parts required	Connectors, matching transformers	None	Connectors, matching transformers	None
Performance in strong-signal areas	Excellent	Excellent—fair**	Excellent	Excellent—fair**
Performance in weak-signal areas	Excellent	Excellent	Excellent	Excellent
Cable pickup of interference (ignition, appliances, etc.)	None***	None—slight**	None***	None—slight**

*A high quality, low-loss foam encapsulated cable type **Depends upon local conditions ***Poorly designed accessories will pickup interference.

Once you know the facts—there is one best choice for your home system—Blonder-Tongue. Whether you prefer 300 ohm or a 75 ohm coax system, Blonder-Tongue has the products you'll need. There is only one way you can protect your home TV system against obsolescence when new UHF stations come on the air—that's with a Blonder-Tongue all-channel UHF/VHF system.

Blonder-Tongue products designed for all-channel home systems include: All-channel signal amplifiers (V/U-All-2 indoor and U/Vamp-2 mast mounted); all-channel couplers (A-102-U/V two-set and A-104-UV four-set). Rounding out the all-channel concept are UHF/VHF matching transformers (Cablematch U/V set mounted; MT-283 mast-mounted) and the TF-331-U/V flush-mounted feed-thru.

Take your pick. Blonder-Tongue makes them all—and all are "Color Approved". Buy the line with 15 years of quality leadership. Write for free booklet "How to Plan a Color-Approved Home TV System".

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home TV accessories • closed circuit TV • community TV • UHF converters • master TV

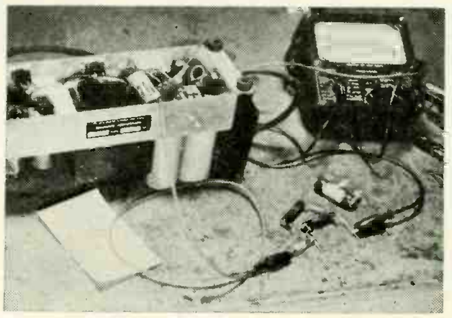
Circle 13 on reader's service card

SERVICE CLINIC

By **JACK DARR** Service Editor

Replacing Weak High-Current Seleniums

The Gulbransen Transistor Organ (and that's all it says on the label—no model number) uses transistor tone generators, and tubes for power amplifiers. The amplifier tubes and the power supply are on a small chassis in the upper right side of the cabinet, from the front. To get at it, and the "works", lift the upper manual, or take out the three big screws along the top of the back panel, and take the top off.



Checking load capability of a supply is merely a matter of hanging on various load resistors and watching what happens to current and voltage.

The trouble in this organ was in the stops. Any *one* would work, but when more than one was pushed, nothing. The stops (which select the different "voices" of the organ) are relay-operated, in an unusual way. Normal-looking relays are used, but instead of closing spring-blade contacts, each one pulls a string! The string causes a long, thin rod to turn 180°. Resting against the rod are very fine wire contacts. Half of the circumference of the rod is insulated; when it turns, the wires make contact with the bare half. There is a total of 14 such assemblies in this instrument.

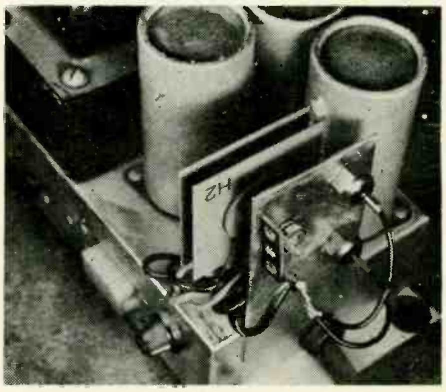
This column is for your service problems—TV, radio, audio or general and industrial electronics. We answer all questions individually by mail, free of charge, and the more interesting ones will be printed here.

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

The relays weren't closing when more than one was used. The voltage fell badly when more than one was switched in. I bridged the big filter capacitors, just in case, but that wasn't it, so it had to be one of the big selenium rectifiers in the power supply.

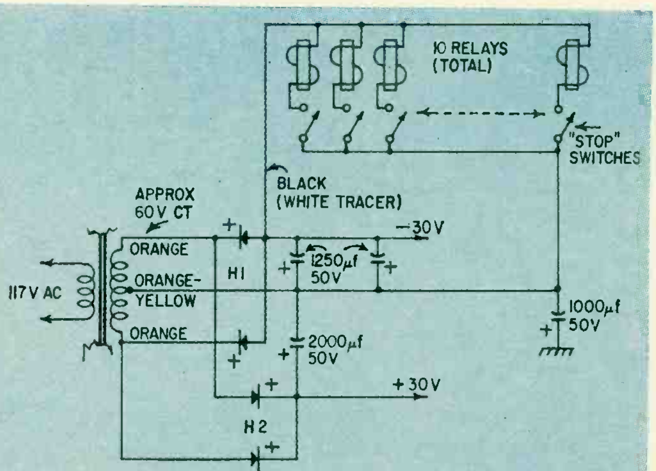
I broke the circuit and inserted a dc milliammeter. Each relay drew 500 ma. So, the rectifier had to supply 7.0 amperes. Bench tests with various load resistors and an ammeter showed that the voltage dropped badly at about 2–3

Continued on page 20



The new silicon rectifiers, mounted with insulating mica washers on a small aluminum plate as a heat sink.

Control power supply of Gulbransen electronic organ. Other electronic organs, especially large ones, have similar supplies.



hy-gain's

DX Roof Topper

for Citizens Band

How many times every day, week or month do you find yourself back-tracking or heading for some distant hill so that you can get your mobile unit within range of your base station? Certainly a lot more times than would be necessary if your mobile unit was equipped with a Hy-Gain "DX Roof Topper". Hy-Gain "DX Roof Toppers" are a breed all their own. In fringe areas where signals are weak using other mobile antennas, signals on both transmit and receive are loud and clear with a "DX Roof Topper". As a matter of fact, with a "DX Roof Topper", you can maintain rock-solid communications with remote areas you never dreamed possible. For less back-tracking or heading for some distant hill to get within range of your base station...to save time, save gas...to get a whole new dimension in 2-way communications, get a Hy-Gain "DX Roof Topper". Guaranteed to out-perform any other mobile antenna for Citizens Band, or your money back. Comes complete with antenna, stainless steel shock spring, "can't leak" roof mount, 16′ of coaxial cable with PL-259 connector and a special adapter plate for replacing any existing roof mount antenna. Model TQRDX .... **$16.95** Net

OTHER TOPPER MODELS—Each one unconditionally guaranteed to out-perform any other CB mobile antenna of comparable length and mounting position:

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- Jiffy Trunk Mount
- Fender Mount
- Shorty Roof Topper
- Cowl Mount
- Marine Topper

free Mobile Antenna Comparison Report No. 15

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Circle 15 on reader's service card

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Shown below is a dramatic, pictorial example of all of the training materials included in just one NRI Course. *Everything* you see pictured below is included in low-cost NRI training. Other major NRI courses are equally complete. Text for text, kit for kit, dollar for dollar—your best home-study buy is NRI.

amps. So, new rectifier needed. Big seleniums are hard to find. I used a pair of stud-mounted silicons, rated at 10 amps each.

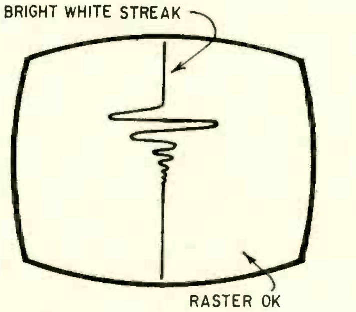
One of the photos shows the mounting of the replacements. The original mounting hole was enlarged and another one drilled; the studs of the silicons (the cathodes) had to be insulated; mica washers come with them. One terminal strip was added, to hold the common negative connection securely.

One final word: if you make load tests with resistors on a new high-current hookup, *don't* pick up the resistors with your bare hands! They get HOT!

A very short Christmas tree

I've got one I don't understand. It's a Motorola TS-579B. It gets a flashing white streak down the middle of the picture (Fig. 1) and there are flashes and pops. Tuner seems to affect this on channels 2 and 6, which are unused. With a strong signal, it flashes only once in a while. Everything else is OK —brightness, contrast, etc. This has been going on for some time.—D. D., Glendive, Mont.

This is actually a "very short Christmas tree" (one that was picked too young?). In other words, your horizontal output (oscillator–damper–output tube–HV-rectifier–yoke)—something in there—is cutting in and out *very* rapidly! If you had a few more streaks, you'd see the regular Christmas-tree pattern.



This could be in any one of the major parts of the horizontal output stage, as listed above. About the fastest way to run it down is to substitute for various sections.

Lift the plate cap from the 6DQ6 horizontal output tube and feed in a "plate-drive" signal from a horizontal sweep tester or from another TV set in good working order. Connect the plate of its horizontal output tube to the plate lead on the Motorola flyback. (*Don't* use an ac/dc TV for this!) Now, turn 'em both on, and see if this cures the flashing. If so, the trouble is *before* this point, in the horizontal oscillator, afc, etc.

If the flashing is still there, then it's in the flyback, yoke or damper circuits of the Motorola. Go over these very carefully, looking for a loose solder joint or small arcover point. You've probably done this already, but replace the damper tube; it's a common cause of such troubles, via internal arcing between plate and cathode or heater and cathode. Take an insulated tool and work over the various connections around this circuit. Poke, pry and jar things, looking for one that'll cause the streak to show up. Don't overlook the socket connections on the damper tube, etc. Be sure they're clean and tight.

The high-voltage rectifier doesn't cause too much of this particular kind of trouble (you're losing horizontal *sweep:* note the pattern!) but check it in the same way. Shouldn't take too long to find the cause, especially if you use a logical process of elimination and substitute various drive signals from another set. Good luck!

Another mystery set

The owner says this is an RCA TV set. The only numbers I can see are 'K66132' Uses two 5U4's; the power transformer has "ET101B" on it. Can you tell me anything about this set?—E. H., Winchester, Va.

I can tell you one thing: it isn't an RCA! From the numbers, it is most apt to be a "Mattison" (Macy's, Mirrortone, Artone, etc.) Many of these were made by Hallicrafters for different mail-order houses.

Get a catalogue from one of the transformer makers: Triad, Merit, Stancor, etc., and go through the set, looking up part numbers on the major parts like power transformer, vertical output transformer, and so on. In this way, you can often match up numbers and find out what the set is.

"Open" meter in vom?

My vom suddenly quit working. I opened the case and checked the meter movement itself. It seems all right. It's one of the printed-circuit-board types. Do you think this is a PC board break, or what?—F. D., Yuma, Ariz.

Suggestion, from an experience I had once: loosen the mounting nuts on the meter terminals, which hold the PC board in this instrument. Clean these connections and retighten, and see if the vom doesn't work fine again. These instruments are moistureproofed by varnishing, and once in a while this varnish gets between the terminals.

If this doesn't work, disconnect the meter movement and, with another vom, check back from the meter terminals to the ohmmeter jacks. This will give you an idea of where a possible open circuit could be: bad switch contacts, etc. END

OUR STANDARD ABBREVIATIONS

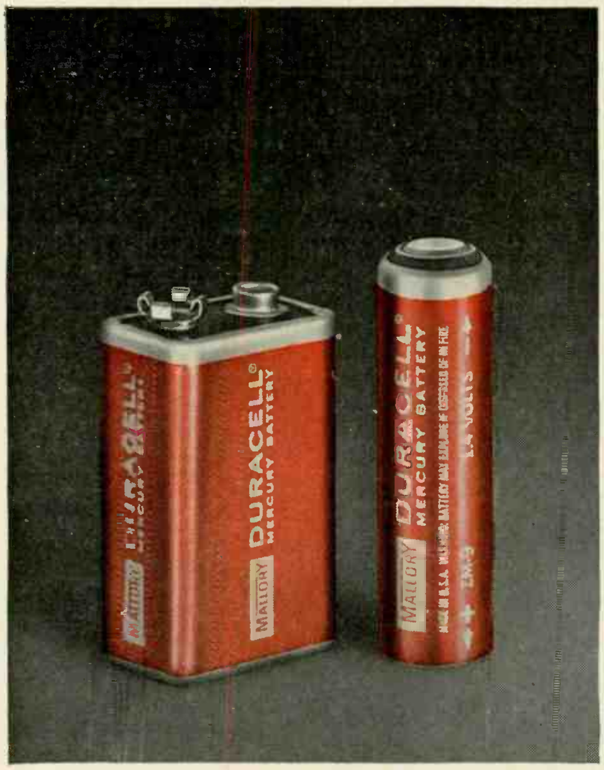
RADIO-ELECTRONICS has always tried to maintain a consistent style in the abbreviations used in text and artwork (diagrams and photo "callouts"). New abbreviations are developed as new terms are added to our electronic vocabulary. We are printing this revised list of abbreviations to bring our old readers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

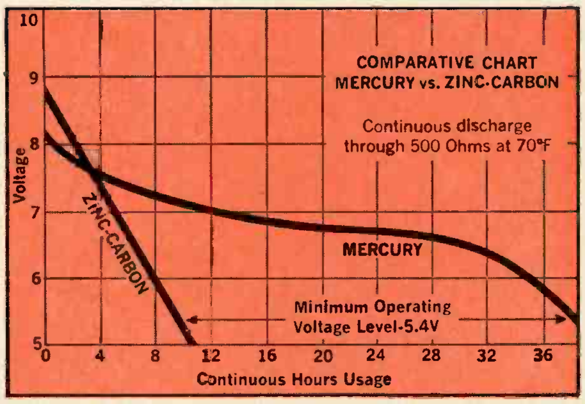
The abbreviations are indexed by symbol with Greek letters treated like English phonetic equivalents. Many of those listed are always spelled out in the text and are abbreviated in our artwork. Terms used only in artwork—and those capitalized in text—appear in capitals. Abbreviations in lower-case letters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

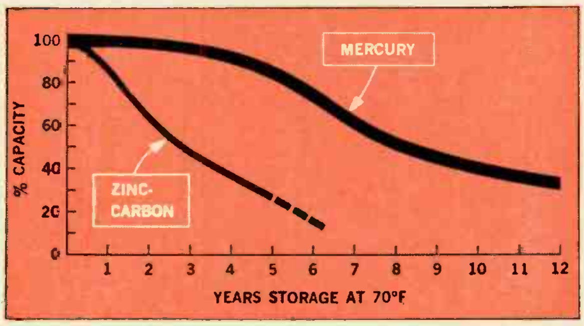
ABBREVIATION	ELECTRONIC TERM
A	ampere(s)
ac	alternating current
acc	automatic chroma control
ADJ	adjacent, adjustment
af	audio frequency
afc	automatic frequency control
AFT	audio-frequency transformer
agc	automatic gain control
AM	amplitude modulation
amp	ampere(s)
AMPL	amplifier
ANT	antenna
apc	automatic phase control
ATTEN	attenuator
AUTOTRANS	autotransformer
avc	automatic volume control
AWG	American wire gage
b or base	base (of transistors)
BAL MOD	balanced modulator
BALUN	balanced-to-unbalanced transformer
BATT	battery
BCI	broadcast interference
bfo	beat frequency oscillator
BO	Barkhausen oscillation
BTO	blocking-tube oscillator
c	collector (of transistors)
C, CAP	capacitor (capacitance)
CALIB	calibrate
cath (K on tube diagrams)	cathode
CATH FOLL	cathode follower
CATV	community-antenna television
CB	Citizens band
CCTV	closed-circuit TV
CENT	centering
CH	choke
CHAN	channel
CHG	charge
CKT	circuit
CKT BKR	circuit breaker
coax	coaxial
COM	common
COND	conductor
CONN	connector, connection
CONT	control
CONV	convergence, converter
counter emf	counter electromotive force
C-R	cathode-ray (tube, etc).
CRO	cathode-ray oscilloscope
CRT	cathode-ray tube
CT	center tap

MALLORY Tips for Technicians

Why New Duracell® Mercury Batteries last even longer in transistor radios







The best way to explain why mercury batteries are *better* is to compare a typical transistor radio with a standard 2 cell flashlight. The vast majority of flashlights use zinc-carbon batteries. The bulb draws about ½ ampere. And the flashlight is used only a minute or two at a time. Therefore the zinc-carbon battery does a reasonably adequate job.

But a typical transistor radio draws only 10 *milliamperes* . . . (the flashlight draws *50 times* as much current). And the radio is used for hours on end. What's needed here is a battery which supplies power in small doses over a very long period of time. There *is* such a battery and it was invented by Mallory. Over the years, it has been improved so much we've given it a new name . . . the DURACELL Mercury Battery. The DURACELL crams *more useable power* into *less volume* than *any other battery system* available. Strangely enough, you'd expect to pay more, but it is actually more economical.

Want proof? Okay, the new TR146X is the 9 volt size that fits most transistor radios. It will run a typical transistor radio at *least* 37 hours. The zinc-carbon equivalent goes for only 9 hours, or less than ¼ as long. (We're talking about top-quality domestic zinc-carbon's here . . . not cheap imports with *very* short life.)

What does this mean to the pocketbook? The zinc-carbon costs 69c while the TR146X $1.95 . . . but don't let that fool you. Divide 69c by 9 and you'll see that it costs you 7.67c per hour to use the zinc-carbon. Now divide $1.95 by 37 and you'll see that it comes to only 5.27c! That's a bargain! In the penlight size, the ZM9 DURACELL gives 4.8 times more *life* for only 3.8 times more money . . . another bargain.

Forget the money! Think of performance. Mercury battery voltage stays *constant* while the zinc-carbon fades fast. This means that B+ voltage stays where it belongs for *days longer* rather than dropping into the distortion range.

Forget the money! Forget the performance! Think of storage life. Zinc-carbon batteries die in a few months *whether they are used* or not. Mercury batteries can sit around for 2 or 3 *years* and still provide instant power.

There's more, too . . . *dependability*. The same dependability and safety that makes the heart pacer possible.

If you need *more proof*, try a new DURACELL Mercury Battery in *your* radio or any electronic gadget . . . you can get 'em at your Mallory Distributor. Mallory Distributor Products Company, a division of P. R. Mallory & Co. Inc., Indianapolis, Indiana 46206.

Circle 21 on reader's service card

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

—END—

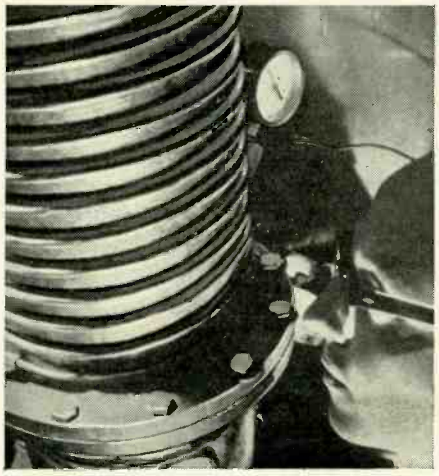
696,000 TECHNICIANS NEEDED BY 1970!

Government Report* Points Out Rapidly Growing Job Opportunities: Need for Trained Electronics Technicians An Important Factor

By Bill Gordon, RCA Institutes, Inc.

President Johnson Emphasizes Need. In his 1964 annual manpower report, President Johnson indicated that the demands for manpower are expanding most in, among other fields, service and technical (including technician) occupations. This expansion is the result of a handful of causes underlying today's big changes in the occupational picture: (1) increasing complexity of modern technology, (2) trend toward automation of industrial processes, (3) growth of new areas of work, such as in the field of atomic energy, earth satellites and other space programs, and (4) data systems analysis and data processing. Indicative also of the growing importance of the use of technicians is a recent revision of the "List of Critical Occupations" published by the U.S. Department of Labor in which technicians are listed for the first time by the U.S. Government.

Salary Levels for Trained Technicians Rising Fast. Beginning salaries for graduates of top level technician education programs have continued to go up during the past five years, at a faster rate than salaries of similar types of jobs. In fact, a U.S. Labor Department projection based on the figures shows that by 1970, technician salaries will average an all-time high.

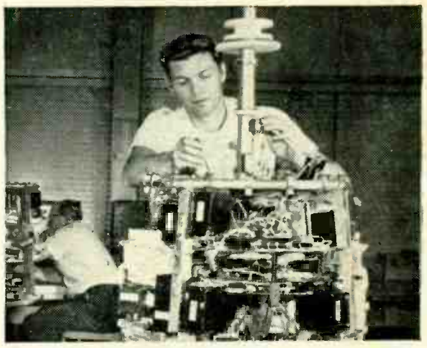


Nuclear Instrumentation

Technical Education is One of Today's Best Investments. Today, a person interested in becoming a technician can choose Home Training or Classroom Training to begin building his career. One of the nation's largest schools devoted to training electronics technicians, RCA Institutes, offers a wide variety of courses in both categories. In addition, the RCA "AUTOTEXT" Programmed Instruction Method is helping people learn faster and easier so they can get started on their careers in the shortest possible time. Dramatic proof comes from the success stories of countless graduates who find profitable positions in government, industry, or in their own businesses.

Of the total 696,000 technicians needed by 1970, it can be estimated that electronics technicians at all levels will form a vital core in today's major job picture.

*"Scientists, Engineers, and Technicians in the 1960's" U.S. Department of Labor, Bureau of Labor Statistics.



Space Electronics

RCA DEVELOPS AN EASY WAY TO LEARN ELECTRONICS AT HOME

New "Career Programs" Help Train You For Expanding Job Opportunities. RCA "AUTOTEXT" Instruction Method Speeds Learning

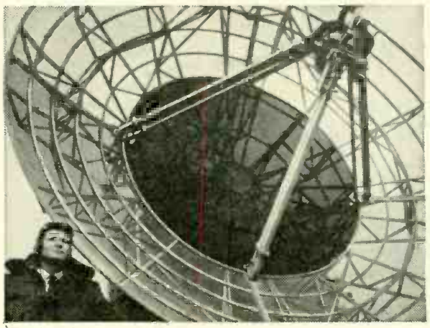
Choose an RCA "Career Program" that will train you for the job you want in Electronics! No time wasted learning things you'll never get to use. "Career Programs" answer the need for today's growing job opportunities for trained Electronics Technicians. They can help you get the job you want faster and easier than you ever dreamed possible!

And each "Career Program" starts with the amazing "AUTOTEXT" Programmed Instruction Method—the scientific way to learn that's almost automatic! "AUTOTEXT" helps even those who have had trouble with ordinary methods of home training in the past. This is the "Space Age" way to learn everything you need to know with the least amount of time and effort!

Choose a "Career Program" now. Each one is designed to train you for a specific, rewarding career in one of the following exciting fields:

- TELEVISION SERVICING
- FCC LICENSE PREPARATION
- AUTOMATION ELECTRONICS
- AUTOMATIC CONTROLS
- DIGITAL TECHNIQUES
- TELECOMMUNICATIONS
- INDUSTRIAL ELECTRONICS
- NUCLEAR INSTRUMENTATION
- SOLID STATE ELECTRONICS
- ELECTRONICS DRAFTING

In addition to these "Career Programs" RCA Institutes offers a wide variety of separate courses on many subjects—from Electronics Fundamentals to Computer Programming.



Radar Microwave

VALUABLE EQUIPMENT INCLUDED

And, with your RCA Training, you receive top-quality equipment to keep and use on the job. When you train with RCA Institutes, you never have to take apart one piece to build another. You'll get the new Programmed Electronics Breadboard which provides limitless experimentation...and, with which you construct a working signal generator and a superheterodyne AM Receiver.

SPECIAL BONUS—
OSCILLOSCOPE and METER KITS

Valuable Oscilloscope and Multimeter Kits are yours at no additional cost when you enroll in any one of the RCA Career Programs..."must" equipment for electronics technicians in almost all jobs.

LIBERAL TUITION PLAN

Only RCA offers you this most economical way to learn. You pay for lessons only as you order them. No long term contracts. You may stop your training at any time without owing a cent.

CLASSROOM TRAINING ALSO AVAILABLE

If you prefer to learn in a classroom, RCA Institutes maintains one of the largest schools of its kind where the latest classroom and laboratory training is available in day or evening sessions. You may be admitted without any previous technical training.

Preparatory courses are available if you haven't completed high school. Coeducational classes start four times a year.

FREE PLACEMENT SERVICE

RCA Institutes records prove that in a recent class 9 out of 10 Resident School students who used the Free Placement Service had their jobs waiting for them when they graduated. And, many of these jobs were with top companies in the field—IBM, Bell Telephone Labs, General Electric, RCA, and radio and TV stations, and other communications systems throughout the world.

SEND THE ATTACHED POSTAGE PAID CARD FOR COMPLETE INFORMATION WITHOUT OBLIGATION. NO SALESMAN WILL CALL. VALUABLE FREE BOOK INCLUDED. CHECK HOME STUDY OR CLASSROOM TRAINING.

Computer Programming

RCA INSTITUTES, Inc., Dept. ZRE-D5
A Service of Radio Corporation of America
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THE MOST TRUSTED NAME IN ELECTRONICS

"AUTOTEXT"—An RCA Trademark

Circle 24 on reader's service card

Be super-critical.

Whether you're looking for the fun and economy of building quality kits or you want ready-to-use factory-wired equipment — before you buy, examine carefully. Compare EICO with anybody else — feature for feature, chassis for chassis, part for part. The more critical you are, the more you'll see for yourself that your best buy is EICO.

EICO

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RE-12

1945-1965: TWENTY YEARS OF LEADERSHIP IN CREATIVE ELECTRONICS

Circle 25 on reader's service card

FUEL CELLS

. . . The fuel cell was discovered in 1839, but its use has only begun . . .

The fuel cell was discovered by Sir William Grove in 1839. Fifty years later, Ludwig Mond and Carl Langer experimented with a similar device and coined the name "fuel cell." But the dynamo was then becoming a cheap and convenient means of generating electricity, and fuel-cell development was pushed into the background. It did not receive any serious attention until F. T. Bacon started work with his hydrogen–oxygen cell in the early 1930's. The present-day fuel cell had its first important use in the Gemini spacecraft this year.

Fuel cells produce power from a continuous supply of fuel. They weigh far less than other batteries of comparable power output. Modern tests on fuel cells have shown no sign of wearout in more than 7 months of continuous operation.

The General Electric fuel cells which have been used in spacecraft contain an anode and a cathode which are in contact with a solid electrolyte that permits the exchange of hydrogen ions between the electrodes. The key to the modern long-life cell lies in the new solid polymer electrolyte which is extremely resistant to chemical oxidation at high temperature.

The fuels commonly used are hydrogen and oxygen. The hydrogen fuel is introduced on one electrode and the oxygen on the other. By the aid of a catalyst the hydrogen atoms give out one electron each, forming ions which migrate through the solid electrolyte to the cathode. There they combine with oxygen to produce electricity and, as a byproduct, potable water, which is carried off by capillary action in wicks to a collection point.

The unusual feature of fuel cells is their high efficiency: they convert between 50% and 70% of their energy to electric power. A fuel cell produces uninterrupted electrical power directly from a continuous chemical reaction, as long as the fuel and oxidant are supplied. Normally, fuel cells have no moving parts and therefore need little or no maintenance. They are silent and give off no fumes.

The principal components of a typical fuel-cell power system are: the fuel supply system, the battery of fuel cells, water and heat removal, setup electrical control. Fuel consumption is approximately 0.9 lb per kilowatt hour.

The fuel cells used in the Gemini craft operate at a voltage of 0.73 to 0.9, delivering up to 73 watts per square foot of cell.

Fuel cells are, of course, never recharged as are storage batteries, but work by the use of fuel only.

One of the latest developments of the G-E fuel cell is centered in the solid polymer electrolyte already mentioned. This design is characterized by the use of a tough, thin sheet of polymer plastic. An ion exchange membrane forms the electrolyte. By binding a simple catalytic electrical structure to each side of the sheet, it becomes possible to construct a fuel cell of unique simplicity and light weight. As the membrane rejects water above a fixed amount, that byproduct of operation can be easily removed by condensing the vapor on cool wicks, which carry it off by capillary action.

G-E scientists have also announced development of a fuel cell that operates from hydrogen and air, and also one that operates from hydrocarbon fuel and air. Furthermore, the 8-day Gemini project proved that fuel cells can provide spacecraft power under almost all space conditions, irrespective of the space-gravity conditions.

Fuel cells are connected in series and parallel to obtain the necessary power output. In the Gemini unit, 32 cells are connected into modules, with three modules electrically in parallel in each fuel-cell battery. The complete Gemini fuel-cell battery system is composed of two batteries, each in a container about 2 feet long and 1 foot in diameter.

When operated together, these two fuel-cell batteries produce up to 2 kilowatts peak power, and give 1 pint of water per kilowatt hour of operation. The complete system weighs 135 lb, exclusive of fuel.

On preliminary tests, one fuel-cell battery completed a 6-week test run of 1,100 hours, equal to more than 750 orbits; in other words, five times to the moon and back.

These are only the bare facts about the fuel cell, which is still in the early stages of its development. What may we expect from it in the future? It would seem that in most cases where storage batteries are used the fuel cell will be able to do the job much better. First, we have replacement for ignition batteries. Wherever weight is of not much consequence, the fuel cell can do the work better and often cheaper. It is true that the usual storage battery gives 2 volts per cell whereas the fuel cell gives only slightly less than half of this. Yet, if all factors are weighed, the fuel cell will come out on top.

Where power is concerned, the fuel cell will often prove much cheaper and much lighter than storage batteries. It may in many instances replace the gasoline engine.

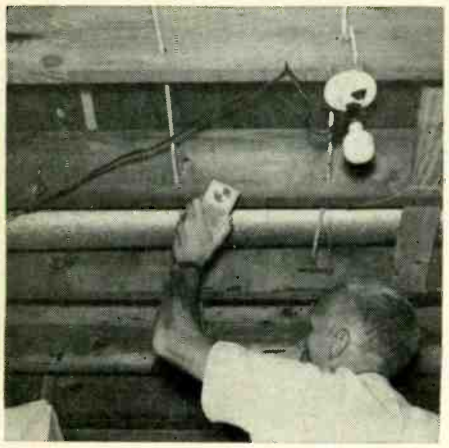
The fuel cell may often prove more advantageous than an isolated electric plant which requires an internal combustion engine to furnish power. Wherever it is impossible or impractical to employ an electric line, the fuel cell will find an opportunity.

Delivery trucks, some of which still use storage-battery propulsion, will find fuel cells very useful. The Allis Chalmers Co. has developed an experimental fuel-cell-powered tractor.

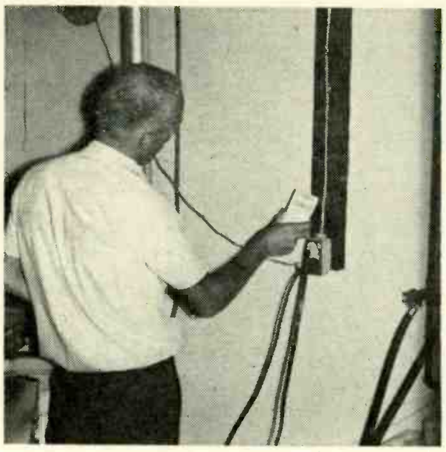
Because fuel-cell power units can be stored for long periods, they promise many other industrial applications, including power supplies for remotely located commercial equipment, TV repeater stations, beacons, etc. —H.G.

Merry Christmas—Happy New Year

The Staff of RADIO-ELECTRONICS



Chase it along the cord . . .



to the outlet box . . .

through the breakers . . .

HOW TO TRACK INTERFERENCE

A small transistor portable, moved along suspected wiring, can guide you to the source of the noise or snow

By THOMAS R. HASKETT

INTERFERENCE IS ANY SIGNAL THAT interferes with a radio listener's or a TV viewer's enjoyment of his desired program. This includes reception of CB, amateur and two-way radio, as well as all entertainment sources. Before you can eliminate interference, you have to identify the source, localize the source and track it down.

While it won't *always* help, if you can identify the source, you can often go straight to it and remedy the trouble. For example, if you hear CB or a ham operator coming in on your TV or broadcast receiver, write down the call letters. Amateur radio call signs consist of K or W followed by a numeral from 0 to 9 and two or three letters. The letters A, B or N may be inserted between the first letter and the digit. Examples of amateur call signs are W2PWG, KAØXKC, WN2HTW and WB7XAZ. Older Citizens band licensees have call signs consisting of one or two digits, one or two letters, followed by four digits. All other two-way radio stations such as fire, police, ambulance and taxi cabs and CB stations licensed since January 1962 use call signs consisting of the letter K followed by two letters and three or four numerals. Examples of these are 2W3056 and KEC863. If it is an amateur or CB station you may be able to contact the operator through the local amateur or CB club. If you can't identify the station, send the call letters to the FCC or call the FCC field office in your area. Once you contact the operator, you can take it from there. While he may not be at fault, he can (and usually will) tell you what frequency he's operating on, and thereby enable you to try trapping out his signal. If you know what you're looking for, it's usually easier to search. Except for atmospheric static, which we won't consider here, interference sources fall into three categories.

1. **Nonradio, manmade sources:** Electric motors, fluorescent lights, oil burners, blinker or traffic lights, old long-filament light bulbs, neon signs, arc welders, thermostats and the power line itself. The point to remember here is that these sources make clicks, pops, buzzes and other peak noises, that identify them as nonradio in origin. They are actually rf, but they don't originate from what's usually considered radio equip-

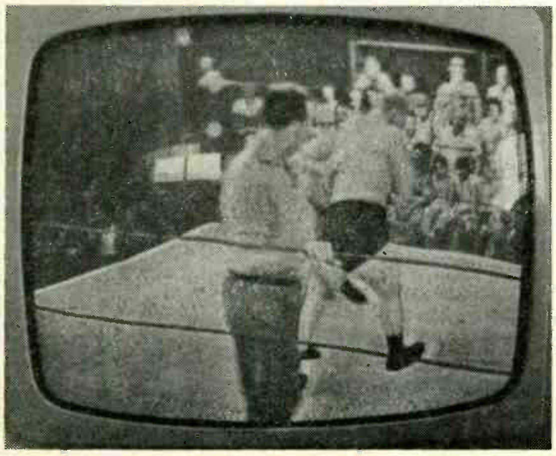
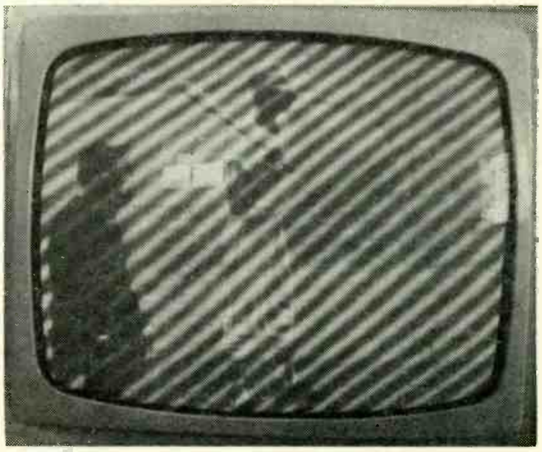


Fig. 1 — Irregular white flecks are usually motor noise— —caused by sparking brushes.

Fig. 2 — Heavy oblique bars often result from beat between video carrier and some other unmodulated carrier near it in frequency.



up the service drop . . .

along the power lines!

ment. Sometimes they radiate through free space; most of the time such interference enters a receiver via the power line. An example of the video pattern produced by one of these noises is shown in Fig. 1—the source is dirty brushes in an electric drill motor, brought into the TV set through the power line.

2. **Transmitters:** Broadcast, amateur, police, CB and other transmitters can cause interference, but often **not** at their fundamental frequency. Every transmitter is a harmonic generator. Although FCC rules require harmonics to be suppressed, rigs sometimes become defective. At times the fundamental of one transmitter cross-modulates the fundamental of another; the resultant sum or difference frequency can pop up in the middle of a TV channel. When an FM station is heard through a TV set on one channel only, cross-modulation is often the cause.

Sometimes a transmitter puts such an intense signal into an area that it causes rectification and spurious signal generation in such things as conduits, air ducts, drain pipes, metal laths and stove pipes. Seldom a problem in new houses, this trouble is usually found in older construction.

Strong fundamental frequencies from nearby transmitters also get into battery chargers, electronic control devices, and even audio amplifiers, wheresome nonlinear element produces beats and reradiates this interference. Since this type of interference consists of a radio wave, it appears as a steady carrier, sometimes with identifying modulation, but often without.

Figs. 2 and 3 show what happens when a strong rf carrier gets into a TV, producing the familiar herringbone pattern characteristic of a steady carrier. In this case, it was the third harmonic of a CB transmitter interfering with channel 6. In Fig. 2, the presence of few bars tells you the interference is located *close* to the video carrier on 83.25 mc. In Fig. 3, the presence of a fine-mesh pattern of many bars indicates the interference is located well *away* from the video carrier. Of course, similar results would be produced by interference getting into the video i.f. in either the 20- or 40-mc range.

An oft-reported type of interference produces "strange voices" from the electronic organ in a church or funeral parlor, from the PA system at the stadium or the sound system at the movie house. This occurs when a strong rf signal—usually from a hf or vhf transmitter—gets into audio circuitry and is rectified. The interfering signal can come from a TV, FM, CB, ham or any two-way radio transmitter. This problem is generally caused by direct pick-up of a fundamental signal and is solved by installing rf filters and shields in the audio circuits. If the signal is intermittent ask the station operator to help when testing or adjusting the rf filter.

Remember that some transmitters carry no modulation or only raw ac—such as diathermy equipment, some radio-controlled garage-door openers, mercury-vapor germicidal lamps, and rf heating equipment. Remember also that cross-modulation often occurs in the receiver's rf or mixer stage. The rf amplifier may be overdriven by strong interference, and thereby operate on the nonlinear portion of its plate-characteristic curve, producing heterodynes; the mixer is already nonlinear and will readily produce other beats.

3. **Receivers:** They can interfere with each other and with themselves. Nearly all contain a local oscillator. TV's also contain horizontal and vertical oscillators, and their respective output-amplifier stages. These are usually operated class-C and have high harmonic content. The vertical is seldom troublesome, but the horizontal output is a buzz-saw that can mar reception across the broadcast band and well into the 80-meter ham band. Local-oscillator interference usually consists of an unmodulated carrier that rides in over a desired station (in radio) or produces a herringbone (in TV). Occasionally a receiver interferes with itself. An example is Barkhausen oscillations, consisting of vertical stripes down the left side of the raster, produced by a harmonic of the horizontal scanning output, picked up by the TV's own tuner.

Localize

If you cannot go directly to the source, eliminate the negatives and concentrate your attention on the most likely path for interference.

1. Substitute another receiver, known to be in good condition, at the same location, to prove the interference is not self-generated. If an outdoor antenna is used, as in TV, be sure to attach it to the substitute receiver. It's usually easier to combine this step with the next one.

2. Use a battery-powered receiver at the location of the problem receiver, eliminating the ac line. Open the breaker or fuse box and disconnect the particular branch circuit feeding the receiver location. If the interference disappears, it's being carried via the power line and you can trace it accordingly. If not, try grounding the *load* side of the ac

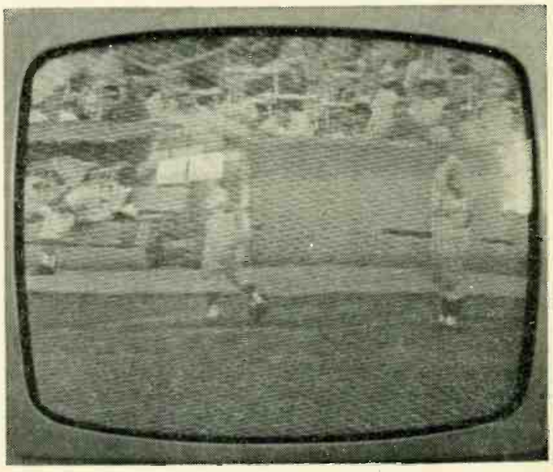


Fig. 3—Light "tweed" pattern is higher-frequency beat, from carrier comparatively far in frequency from video carrier.

line at the breaker box, to see if *this* gets rid of the interference. *Caution: be very careful with that jumper.* Kill the main circuit breaker first. Then attach the jumper to the electrical ground bus, which will have white wires connected to it. Finally, touch the jumper to each branch circuit in turn (Fig. 4) and see if the interference disappears. When finished, remove the jumper, replace the protective panel, and restore the main breaker. If you can't kill the interference by grounding the power line, chances are it's coming in through space.

Track

1. If the interference is coming via the power line, it won't be too difficult to run it down. First determine if it's inside or outside the building. Pull the main breaker at the breaker box, follow the power line up the service drop, and out to the street, with a portable receiver. If the interference is gone, it must be generated within the house. Put the main breaker back in and throw off all branch circuit breakers but one, listening on the receiver to see if the interference reappears. After you find the offending circuit, trace wiring to outlets, unplug appliances, until the trouble disappears. You may have to crawl into an attic or basement fruit cupboard to dig out an all-but-forgotten outlet. Sometimes old radios, TV boosters or heating pads are ignored and left on for years. They can radiate over a wide area.

If the interference enters the building via the power company's service cable, it may be due to the power line itself. In many cases it won't go much beyond a pole transformer, and it's a good idea to take the portable receiver as close to the pole as possible. Check service drops to other houses. If in doubt, call the power company and have them send out an interference-tracing crew. They are usually quite cooperative and will take any reasonable steps to get rid of interference caused by their own equipment. Cracked or open insulators on lines will generate buzz and crackling noises. Sometimes lines sag and intermittently touch grounded objects.

2. If interfence is not being received through the power line, it must be traveling by free-space radiation. The only way to track it is by using a portable receiver with a directional antenna. The usual portable AM radio has a bidirectional loop, and the signal nulls (points of minimum reception) are at right angles to the plane of the loop. Some portable FM and TV receivers have monopole antennas, which are useless for direction finding. Get rabbit-ears and connect them in place of the monopole. You will then have a simple

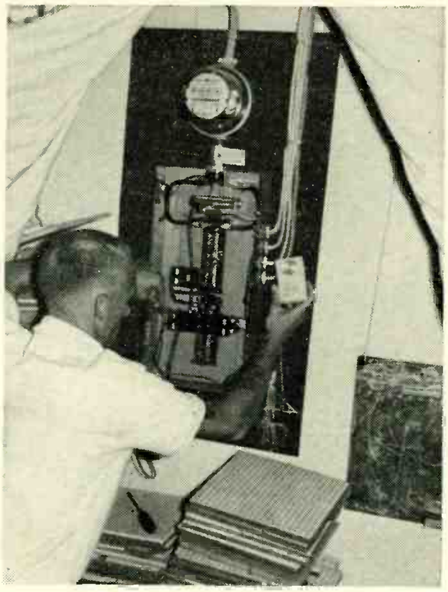


Fig. 4—Transistor portable traces interference on power lines. Be very careful! Pull main breaker or fuses before beginning this test.

dipole antenna, which has its nulls along its length. The reason for using nulls is that they offer sharper indication than lobes (points of maximum reception).

Nulls pinpoint direction, but to determine whether the interference is getting better or worse, it's necessary to use lobes. It might be supposed that receiver avc or agc defeats the attempt at direction finding, but this isn't true. You aren't concerned with the *absolute* field strength of the radiated interference—you're interested only in the *ratio* of undesired to desired signal, and avc won't alter that, provided you are still getting a clear pickup of signal from the desired transmitting station. Each time you take a bearing, note which way the nulls point, and move one way or the other along this line. If the interference gets worse, you're going in the right direction.

It is sometimes possible to speed up the tracking process by using an automobile. Whatever the method, you can usually determine the interference source. The owner can be politely asked to remedy the situation. If it's not his fault, you can at least determine the frequency or frequencies the radiation is emitted at, which will then allow you to use traps or filters to keep it out of the receiver. It is usually more desirable to correct the problem at the source, for then you clean up many receivers. Besides, once the interference gets into the vicinity of a receiver it's difficult to eliminate it entirely. Remember that where the interference source is clearly at fault, and a polite request to investigate the problem doesn't produce any action, you can always report the matter to the FCC, either in Washington, D.C., or their nearest district office. END

ARE WE REALLY MAKING PROGRESS?

I WAS CLOSING MY CADDY WHEN SHE said, "Wait a minute. I have something else for you to look at."

She came back a minute later with an old radio in a wood cabinet. I could spot the vintage by the bay window that housed the speaker. I also knew the tubes with top caps were not 6BQ6's.

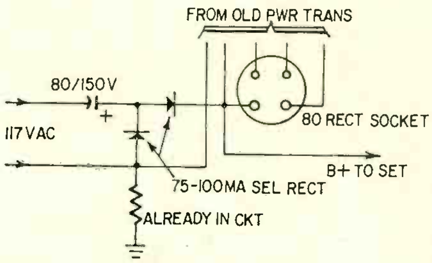
"This old set has the best tone I ever heard, and I would like to get it fixed. It also has a sentimental attachment. My first boy friend gave it to me."

It was the light in her eye as she said this that made me tuck it under my arm and promise to try.

The next day I dug it out and plugged it in. There was not a sound.

I slipped the chassis out of the cabinet. The voltmeter revealed no B-plus. Touching a screwdriver from the plates of the 80 to chassis indicated no ac on them. The ohmmeter showed the secondary of the power transformer wide open both sides of center tap.

I was thinking in terms of forgetting it right then, but I remembered the twinkle in the eye and decided to go a step further.



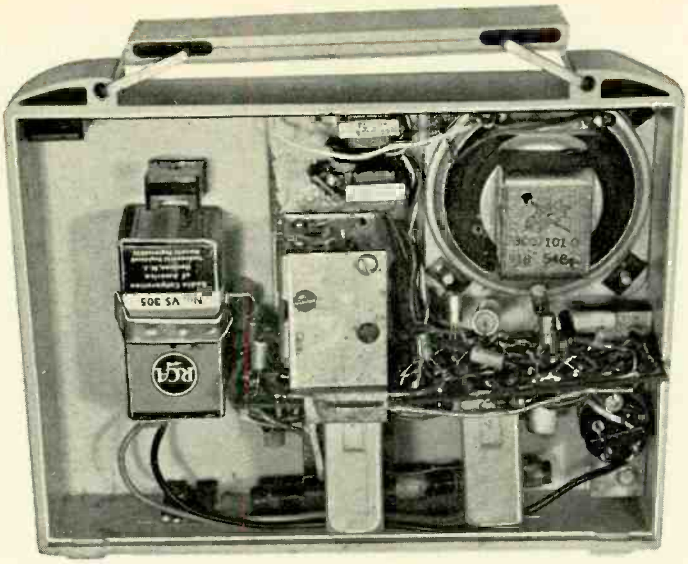
I rigged up a voltage-doubling circuit with two seleniums and an 80-uf 150-volt capacitor, just lying on the bench. When I touched the positive to the 80 filament connection, the volume seemed up to normal and the tone was good. (It sounded almost like a hi-fi.)

I flipped the bandswitch to the short-wave position just to see, and was really surprised to pick up a Britisher and a bunch of Spaniards, even though the antenna was only a few feet of wire lying on the floor.

I installed the voltage-doubling circuits permanently (no trouble finding space) and slid the chassis back into the cabinet. The solid wood case rounded out the tone to a point that left nothing to be desired.

A check of tubes revealed that all were at least 15 years old. None needed replacing.

As I fastened the back on I couldn't help but wonder—Are we *really* making progress?—*Harold Davis*



Wide-open space around battery is where bulky A- and B- batteries of tube set used to be. When you do your conversion, you might want to shuffle the parts around and install a bigger speaker—or twin speakers.

TRANSISTORIZE Your Tube Portable

We don't normally like the word "transistorize", but we really mean it here! You can rebuild your old tube portables to use transistors, and save a lot in tube and battery replacement!

By JAMES E. PUGH, JR.

Practically every experimenter has wondered whether it might be practical to convert old portable tube radios—now universally discarded as uneconomic—to transistors. Until now the low input impedance and medium output impedance of transistors would have required replacing or drastically altering all rf, i.f. and oscillator transformers.

But now you can do it—with only the simplest rewiring. A flexible way to get high input and output impedances makes it possible to connect transistors directly to unmodified tube-type rf, i.f. and oscillator transformers. All you add are suitable transistor biasing networks and a few turns to the oscillator transformer.

This circuitry can, of course, be used to convert any tube-type broadcast set—table, console or auto, as well as portables.

The basic circuit is an *emitter-coupled amplifier.* It uses two transistors per stage, coupled together across a common-emitter resistor—R in Fig. 1. Q1 is a common-collector amplifier (high input impedance and very low output impedance). Q2 is a common-base amplifier (very low input impedance and high output impedance). Considered together as one stage, this emitter-coupled pair has an input and output

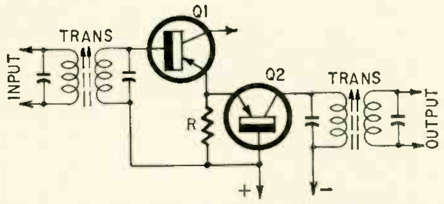


Fig. 1—Basic emitter-coupled amplifier has tubelike input and output impedances.

impedance much higher than normal in a transistor stage.

The input impedance is slightly lower than optimum, but the output impedance is high enough to give no perceptible deterioration in performance. Input capacitance is slightly higher, and output capitance slightly lower, than that of the tube which the transistor pair replaces. Overall power gain is slightly greater (theoretically) than from a well matched common-emitter stage. Voltage and current gains are about the same.

Fig. 2 shows a complementary p-n-p/n-p-n pair in the same kind of circuit.

Fig. 3 is the complete circuit diagram of a converted radio. The basic emitter-coupled circuit is used in the rf section, but with one high-impedance input section (the rf amplifier) and *two* high-impedance output sections (the oscillator and mixer). In this stage Q1 is direct-coupled to Q3 across R1 to form a pair like that in Fig. 1.

Since the oscillator is a common-base section with low input and high output impedance, it too can be coupled into the mixer at the low-impedance point (R1) through capacitor C3, putting a negligible load on transformer T1. This section has its own emitter resistor, and the signal injection into the mixer is determined by the size of C3.

This circuit not only gives conventional oscillator and mixer action, but also an rf amplifier with about 15 db gain.

The i.f. amplifier is essentially the same as the basic circuit in Fig. 1. It uses double-tuned transformers for very good selectivity (four tuned circuits) in just one stage. Avc voltage from the detector (D1) is applied to both sections of this stage as well as to the rf and mixer sections.

Although all these transistors obtain their base and collector voltages from a common source, separate decoupling filters are not used in the i.f. afc lead or in the collector return of any transistor. Where possible, all such parts were eliminated to keep conversion costs to a minimum. But if your set has two i.f. stages, you will have to add decoupling and possibly neutralize both stages to prevent oscillation.

The audio amplifier is conventional except that it uses an inexpensive germanium diode (instead of a thermistor) that not only compensates for temperature, but also extends battery life by automatically regulating the base-bias voltage for Q7 and Q8 to minimize crossover distortion as the battery voltage drops off with age.

Since this particular case is roomy, I used a large 9-volt battery for economy. It should last about 200 hours with a 9-ma drain, while the conventional 2U4 would last only about 35 hours. Of course, I could have reduced cost by

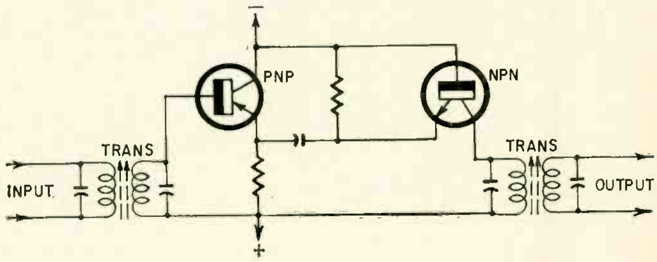


Fig. 2—Basic complementary (p-n-p/n-p-n or vice versa) emitter-coupled amplifier.

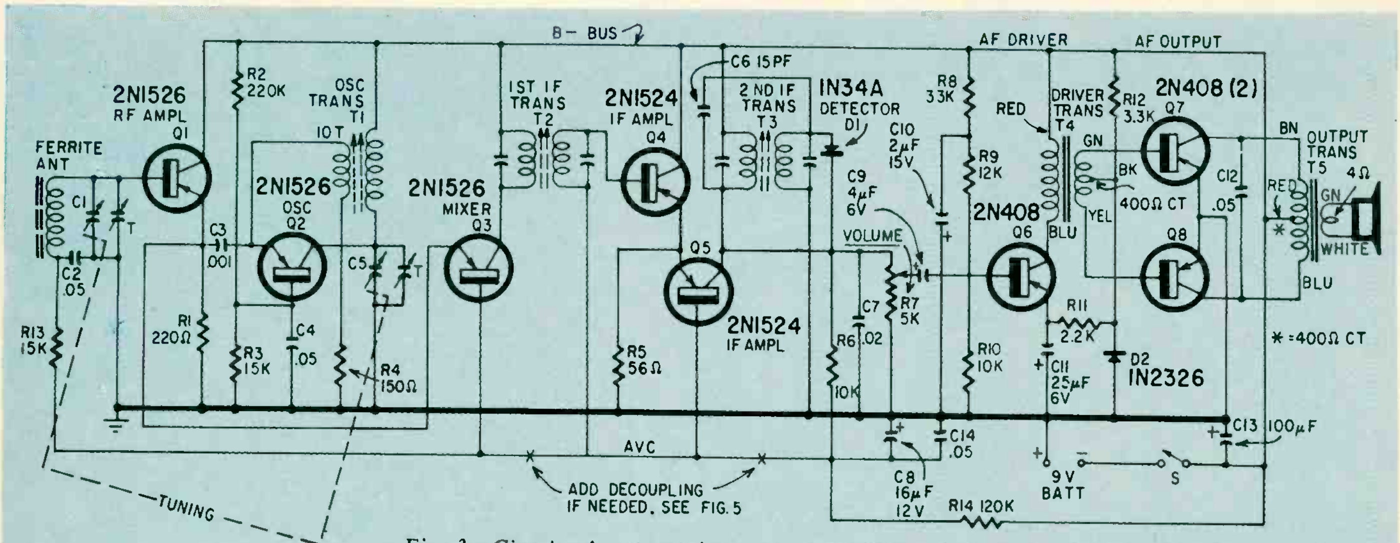


Fig. 3—Circuit of converted portable. Antenna, oscillator coil and i.f. transformers of tube set are all retained, as are tube sockets and chassis.

C1, C5—tuning capacitor*
C2, C4, C12, C14—.05-μf, 100-volt paper or Mylar
C3—.001-μf ceramic
C6—15-pf ceramic
C7—.02-μf, 100-volt, paper or Mylar
C8—16 μf, 12 volts
C9—4 μf, 6 volts
C10—2 μf, 15 volts
C11—25 μf, 6 volts
C13—100 μf, 15 volts
C8, C9, C10, C11, C13 are electrolytic
D1—1N34A or equivalent
D2—1N2326 (RCA)
Q1, Q2, Q3—2N1526 (RCA)
Q4, Q5—2N1524 (RCA)
Q6, Q7, Q8—2N408 (RCA)
R1—220 ohms
R2—220,000 ohms
R3, R13—15,000 ohms
R4—150 ohms
R5—56 ohms
R6, R10—10,000 ohms
R7—volume control, 5,000 ohms, audio taper
R8—33,000 ohms
R9—12,000 ohms
R11—2,200 ohms
R12—3,300 ohms
R14—120,000 ohms
S—spst switch*
T1—oscillator transformer*
T2—i.f. transformer, input*
T3—i.f. transformer, output*
T4—audio transformer, 10,000 to 2,000 ohms ct (Stancor TA-35 or equivalent)
T5—audio transformer, 500 ohms ct to 4/8/16 ohms (Stancor TA-21 or equivalent)
SPKR—3.2 ohm speaker*
*** parts retained from tube circuit**
BATT—9-volt battery (RCA VS-305 or equivalent)

using 6 type-C flashlight cells.

The conversion

The first step in making your conversion is to determine what changes, if any, will be necessary in the circuit shown in Fig. 3. If you use two i.f. stages, add the second one to the diagram. Make it identical with the one shown, but add decoupling filters to the first stage.

Next, remove all parts that will not be used, leaving only the rf, i.f. and oscillator transformers, the tuning capacitor, and the tube sockets if you want to use them for tie points. Also, remove all wiring. If it is an etched-circuit board, existing conductors can, by careful planning, be used with only minor changes. Although the original volume control can be used, the value shown gives better results.

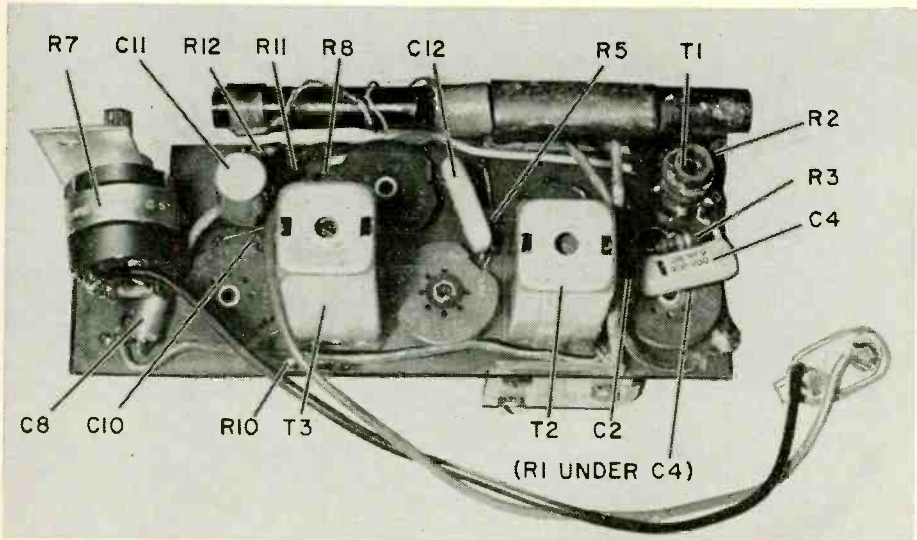
REPORT ON TRANSISTORIZED PORTABLE

R-E checked the converted set 25 miles from New York City. 18 stations were received with fair volume, and more could be received with careful tuning. One exceptional night, Bonaire in the Netherlands West Indies was received. Tone quality and selectivity were about the same as those of a similar tube portable. A tendency to drop off at the high-frequency end was noticed—all stations were received at 1400 kc or below.

The next step is to plan the layout of all parts. Unused portions of foil conductors can be cut out with a sharp knife, and any necessary bridges between sections made with short pieces of insulated hookup wire.

Solder all parts in place (transistors last, of course), and then wind 10 turns of enameled wire (about No. 32) adjacent to the present oscillator coil. Fasten it in place with coil dope or melted wax. Connect the battery and momentarily bridge a milliammeter across the switch (with switch off). The current drain should be about 8 to 10 ma if everything is satisfactory.

If current is normal, remove the meter, turn the switch on, and set the tuning capacitor to the high end of the band. Now peak the i.f. transformers at 455 kc. Start with the last and work toward the mixer. If double-tuned transformers are used, the primaries and the secondary connected to the detector should not need much adjustment. Any secondary connected to the base of a transistor will need to be retuned more. Back out the slug or loosen the capacitor to peak the transformer at 455 kc. If the i.f. amplifier oscillates, try grounding the transistor cases. A very fine wire can be soldered quickly to the case and then to ground without damaging the transistors. If this doesn't stop oscillation, try



Top of converted chassis. Several turns of the antenna winding have been pulled toward end to lower total inductance.

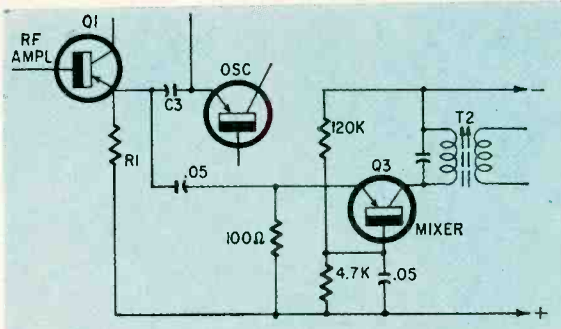


Fig. 4—Mixer with fixed base bias.

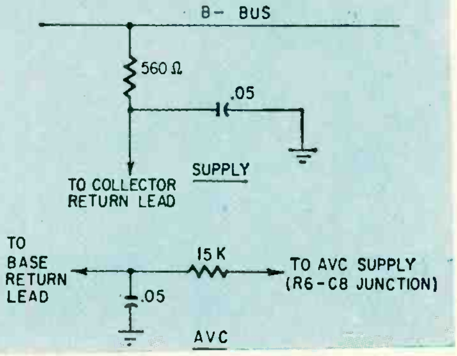
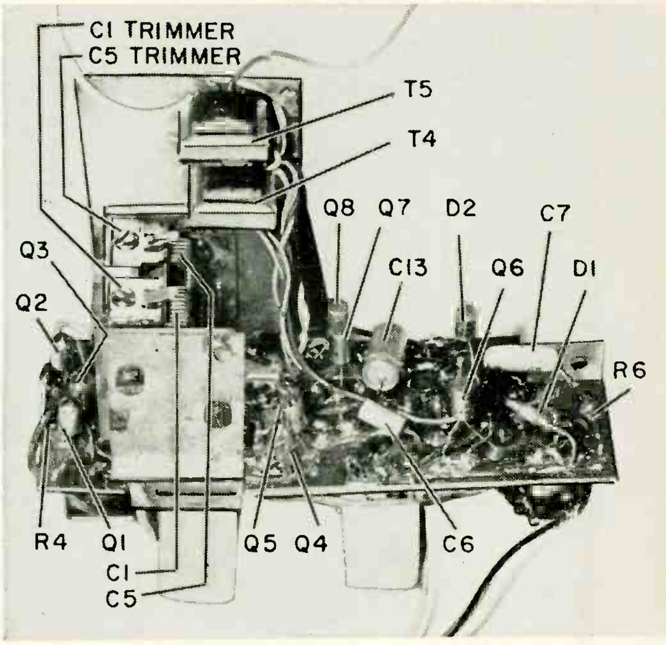


Fig. 5—Optional decoupling filters for supply and avc leads.



Underside of chassis displays most of the small parts.

neutralizing each stage.

Next, see if you can hear any stations. If not, reverse the two leads from the added oscillator winding. Then adjust the oscillator tuned circuit to cover the broadcast band. If a slug-tuned oscillator transformer is used, adjust the slug to give correct tracking at the low end of the band, and use the trimmer on the tuning-capacitor oscillator section to adjust the top end of the range. The trimmer adjustment should be adequate in most sets that do not use a slug-tuned coil. If not, the coil inductance can be changed by removing turns from the secondary to shift the low-end coverage up, or by adding turns to shift it down.

When you get the oscillator perking, tune up the antenna circuit by sliding a few turns of the antenna winding toward the end of the ferrite core for maximum response at 600 kc. Next, adjust the antenna trimmer for maximum response at 1400 kc, and check to see if any touchup is required on the low-frequency end. Sets with antennas that can't be adjusted may require a slight readjustment of the oscillator frequency to peak the response at 600 kc. Go over these adjustments two or three times to get the best alignment. There is always some interaction between oscillator and antenna circuits.

Possibly you will want to use some of the parts that were removed in this economy program, so you can be sure of top performance under all conditions. Fig. 4 shows what's needed for a separate bias network to the mixer. The separate emitter resistors and a coupling capacitor are necessary for maximum isolation of the mixer from the avc circuit. Otherwise the avc voltage will pull the mixer circuit.

Decoupling filters for avc and battery supply leads are shown in Fig. 5. Simply add them as needed for the required stability.

If your set needs to be neutralized, keep in mind that both the common-collector and the common-base amplifier have no phase inversion between input and output; thus there will be no phase inversion in the emitter-coupled stages used in this set. Since the feedback voltage must be 180° out of phase with the input voltage to neutralize any amplifier, a method like Fig. 6 must be used. In this circuit the i.f. transformer supplies the 180° phase shift when the feedback is taken from the correct end of the secondary. If oscillation increases, simply reverse the connections to *either* primary *or* secondary.

Fig. 7 shows how the oscillator transformer can be used without changes. Connect the windings as shown, and reverse the leads of either (if necessary) to get oscillation. This circuit is good, but adds slightly more capacitance across the oscillator's tuned circuit than is desirable for full coverage of the broadcast band. It can be used if you want the utmost simplicity at the cost of a slight reduction in coverage at the high-frequency end of the band.

If your set uses the older loop antenna without a ferrite core, you may want to replace it with a ferrite type for increased performance. Make sure the inductance of the new antenna is right for your tuning capacitor. Mount it at least 2½ to 3 inches from the chassis and not too close to an unshielded oscillator coil. If necessary, put a shield between oscillator coil and antenna. END

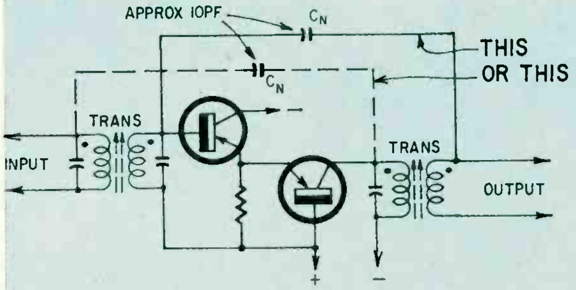


Fig. 6—Two ways to neutralize emitter-coupled amplifier.

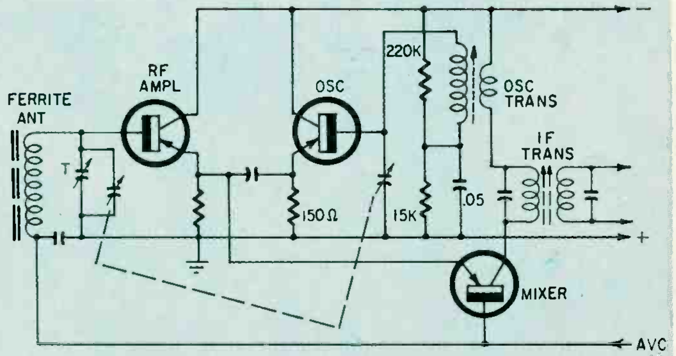
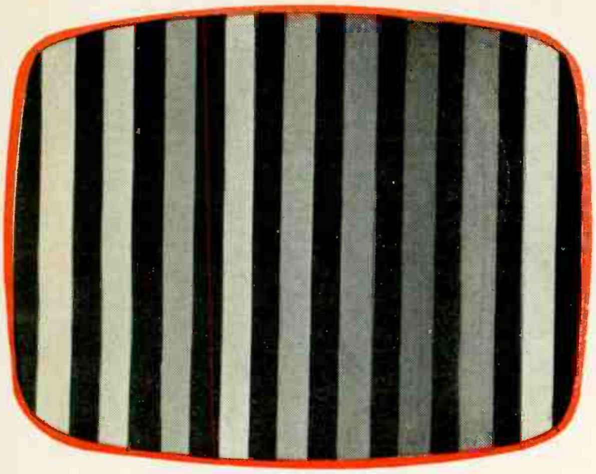


Fig. 7—Common-collector oscillator circuit avoids need to modify coil.



Service Color TV Traps and Pitfalls

Three sections of a color receiver worth special attention

By MATTHEW MANDL

THE SPECIAL CIRCUITS IN COLOR RE-ceivers need special care in service. Even then, some results may be highly unexpected to the man who is used to black-and-white. The best way to localize any fault in any electronic equipment is to understand the circuit and apply logical checks to pinpoint a defective component. The really tricky circuits are those that have a dual purpose, and can affect several others.

The sound trapping in color sets is more elaborate than in black-and-white, so there often isn't enough sound signal at the output of the video detector to use the conventional sound takeoff found in black-and-white sets. An additional detector circuit is used.

A typical dual detection system is shown in Fig. 1. It is used in the Admiral color chassis D11, 1D11, 2D11, etc. Here the 6JC6 third pix i.f. feeds two diodes as shown. The sound detector mixes the sound i.f. and video carriers, and heterodyning produces the 4.5-mc sound i.f. signal. The video detector demodulates the picture signal but at the same time does what it does in a black-and-white receiver—that is, produce a 4.5-mc signal. The sound signal is then trapped out completely before it can reach the first video amplifier stage.

Because we have two diode detector circuits here instead of the single one used in black-and-white, possibility of trouble is doubled. Note that the sound detector also supplies the signals for the sync-separator and agc systems. Hence, defects in the sound detector circuit will also affect sync and gain control.

With no sound (but with picture) the usual continuity and component checks used for black-and-white receivers are a good start. The 10,000-ohm resistor shunting the diode detector is its load resistor and you can connect a scope there to check for a signal. (Don't expect to find audio here—only the 4.5-mc i.f. signal, which must still be amplified and detected later.) Check for a leaky coupling capacitor between the plate of the 6JC6 and the crystal diode. A voltage leak can affect detector operation and kill the sound.

Note the adjustable traps in the video detector circuit. The coupling transformer from the 6JC6 to the video detector is also a 43.8-mc resonant circuit—part of the overall i.f. tuning system. Above this is the 41.25-mc sound i.f. trap, and an additional sound-rejection potentiometer is used in this input circuit. A 4.5-mc sound i.f. trap is also included.

Thus, when interference bars show up on the screen (and vary with the audio), the sound traps should be adjusted slightly. If the traps haven't been tampered with, and were correctly adjusted originally, not much retuning should be necessary. Try adjusting the 41.25-mc trap first. If there are still some faint interference lines, adjust the 4.5-mc trap.

If drastic readjustments are necessary (or if tuning doesn't eliminate the interference), check components. Substitute a new video crystal diode when troubles occur. Lack of video (but sound OK) localizes the trouble to the video detector circuit, or the stages after it. (Presumably, if there is sound, all stages before the dual detection system are OK.)

An oscilloscope check for signals at the grids of the two video amplifier stages will help pinpoint the stage that's giving trouble. If the fault seems to be in the dual detector system, remember how the third pix i.f. feeds both detector systems. Trouble in one circuit can influence the other.

Shorted or defective parts in one detector system will often reduce effi-

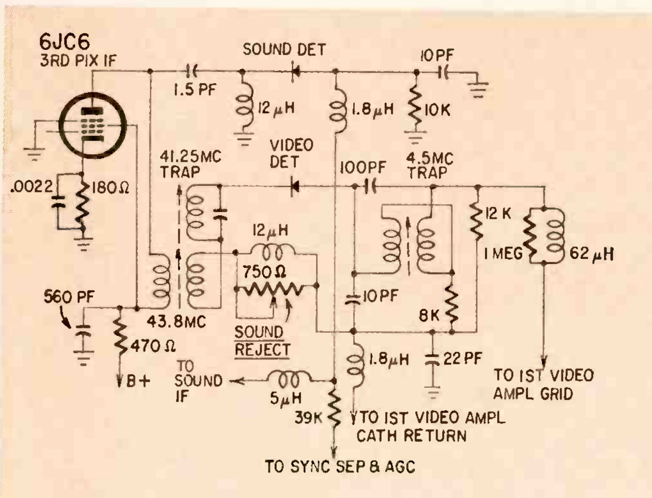


Fig. 1—Dual detectors in Admiral chassis—one for video, one for sound.

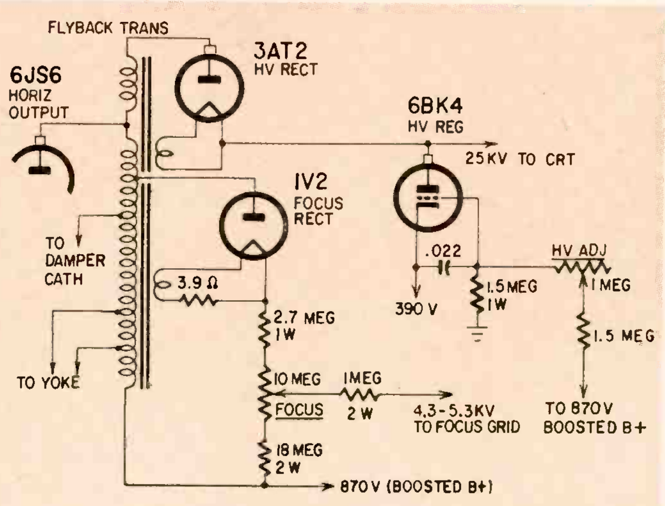


Fig. 2—Focus and high-voltage rectifiers in Zenith 25MC30 chassis.

ciency in the other. Thus, a leaky coupling capacitor in the sound detector circuit could reduce sound output (or produce distorted sound) *and* also reduce picture contrast. Also, a weak third pix i.f. tube will affect both picture and sound. Because the third pix i.f. feeds two detector systems, both low impedance, its gain is not as high as that of the first and second video i.f. stages, and any decline in performance shows up immediately at the detectors.

Focus rectifier and HV regulator

Another circuit in color receivers with a dual function compared to black-and-white sets is the high-voltage system, which most cases includes a focus rectifier to generate a separate 5,000 volts for the focus electrode of the picture tube. There is usually also a shunt regulator for more precise control of the high voltage for the pix tube.

A typical high-voltage system used in the Zenith 25MC30 is shown in Fig. 2. The focus rectifier does the same thing as the high-voltage rectifier, except that its anode is tapped off at a lower-potential point on the horizontal output transformer as shown. A 10-megohm focus control adjusts picture-tube focus.

The shunt regulator is a variable load on the high voltage and tends to keep the output voltage constant, once it has been set by the 1-meg high-voltage-adjust pot. The circuit is designed so that the grid bias for the shunt regulator changes with changes in high voltage. If the high voltage increases, the grid bias decreases and the shunt regulator conducts more heavily. Then it imposes a greater load on the high voltage and reduces it. If the high-voltage decreases, the bias on the regulator increases (goes more negative) and the tube conducts less; thus the load is decreased and high voltage goes up.

Special high-voltage probes must be used here to set voltages to the levels recommended by the manufacturer. If you don't get the right voltages, check tubes by substitution before doing anything else. Next, check resistor values around the adjusting pots. Occasionally a resistor will increase considerably in value. As in all high-voltage compartments, check for arcing. Clean the terminals, avoid sharp bends in the wiring, and cut away pointed pieces of solder. Make sure the damper tube is functioning properly, because it can affect both the focus voltage and the high voltage.

Scope patterns

When you use a scope for signal observation and testing, be careful not to assume that the same signal waveform exists at all points fed from a common point. This is another tricky aspect of trouble shooting often overlooked. Take, for instance, the sync separator and oscillator sections shown in Fig. 3. It would appear that a scope signal at test point 4 on the schematic would look about the same as that at 5, since this is the same feed line with only a 47-pf coupling capacitor between. Similarly, it would seem that the same signal should appear at test-point 8, since it too is fed from test point 4.

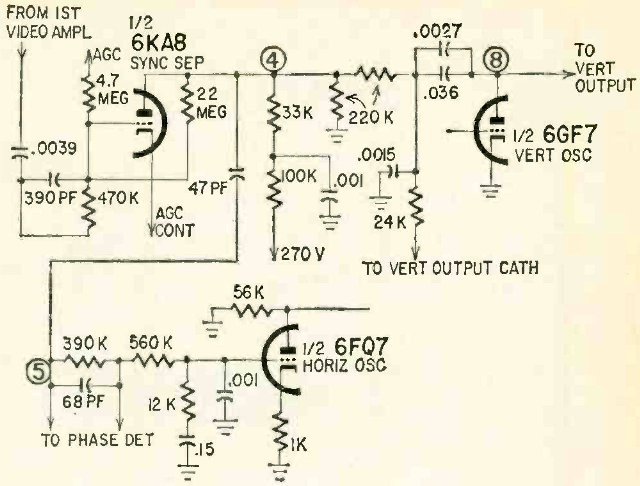


Fig. 3—Sync feed in RCA CTC16. Waveforms at the three test-points are not the same.

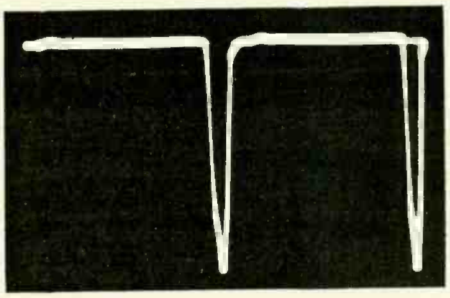


Fig. 4—Waveform at test-point 4 in Fig. 3 (60 volts peak-to-peak).

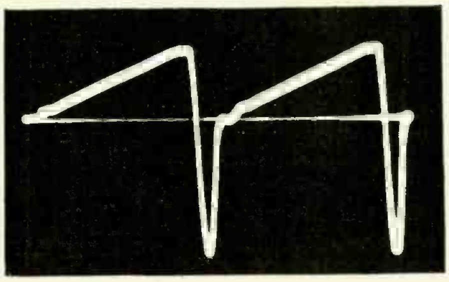


Fig. 5—Waveform at test-point 5 in Fig. 3 (20 volts peak-to-peak).

Actually, however, the waveform at point 4 consists of inverted sync pulses as shown in Fig. 4, but at test point 5 the waveform is a typical relaxation-oscillator type (Fig. 5). At point 4 the peak-to-peak voltage is 60, while at point 5 it is 20. At point 8 the same waveform shown in Fig. 5 will be observed, except that the peak-to-peak voltage is 185, as indicated in the service schematic for this RCA CTC16. Incorrect waveshapes and voltages localize a defective stage immediately. Once the defective stage has been found, the same procedures apply to color receiver circuits as to black-and-white. First test tubes, then components and voltages.

The same basic principles apply to other sections of color receivers. And for circuits virtually identical to black-and-white designs, the same testing procedures apply. For circuits exclusive to color receivers, additional equipment may be necessary (color dot-bar generators, etc.). Signal tracing, scope-pattern observation, and voltage and component testing all follow familiar lines. Take a little extra care, and you'll have no trouble. END

SOLDER SUCKER FOR PC BOARDS

Unsoldering components from printed-circuit boards is a beastly nuisance. For occasions when you have a lot of unsoldering to do, get set with this efficient vacuum-cleaner method.

Take an empty plastic squeeze bottle, such as the kind glue comes in (the 1½-oz size), cut off the bottom and about ⅜ inch of the nozzle. Wash the bottle out, peeling any hardened glue off the inside surfaces. Slip the open bottom end over the vacuum-cleaner hose.

The best way to handle the job is to melt the solder with a clean, hot iron until it flows freely, then quickly cover the terminal with the suction nozzle. The air current will draw the solder up into the bottle. If you don't get all the solder the first time, go back again. When the nozzle gets clogged, poke out the solder—it doesn't stick to the plastic. Any solder that gets into the vacuum cleaner will have hardened, and won't do any more harm than the metal filings you normally pick up with it.—*John H. Hughes*

COVER STORY

WE BUILT AN ELECTRONIC ORGAN!

Heath introduces kit version of Thomas all-transistor electronic organ

By **FRED SHUNAMAN**
MANAGING EDITOR

BUILD AN ORGAN? THE IDEA SOUNDED tempting, but would it even be possible? With the literally thousands of connections, the hundreds of chances for error, could a person ever get it straightened out and debugged? Many years of experience as constructor and repairman had taught me a great deal about bugs and debugging, and it seemed incredible that such a complex thing would start immediately after being hooked up and turned on. And the *time*! I remembered spending all my spare evenings during a whole summer on an automatic audio voltmeter, and this looked several times as complex.

I would have given up the idea—actually I would never have reached it—had I not made the mistake of mentioning it at the dinner table. My 14-year-old daughter was delighted. "Let's build an organ! I'll do the work."

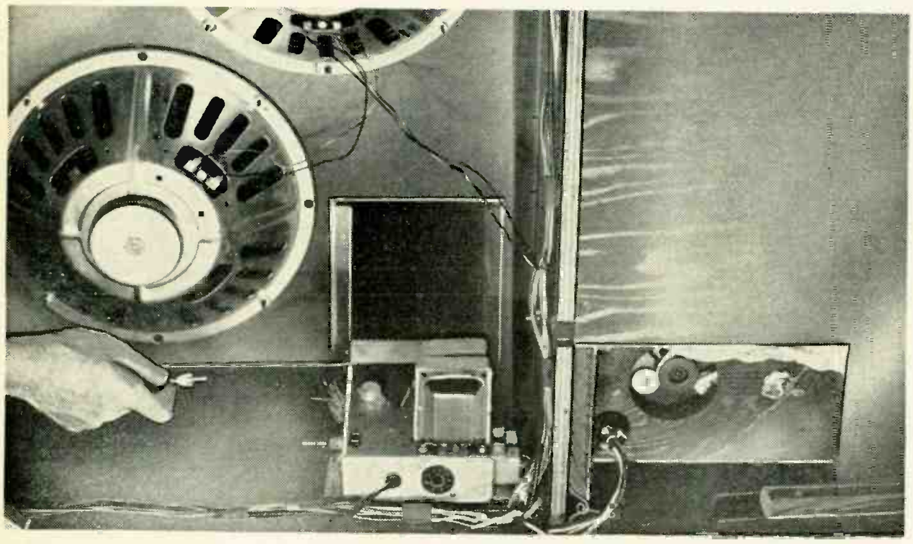
That made it quite a bit easier. I knew that if she would stick to it she could do the soldering. (She had been following kit-assembly instructions on simple pieces of equipment from age 6.) So, after eliciting solemn affirmations of perseverance, we sent away for the kit.

Experience was with me. At least I can boast of having made a lot of the mistakes before. Maybe it wouldn't be necessary to repeat them. When the equipment came—a Heathkit GD-983—every bit of packing was gone over carefully, then religiously saved in the basement against the day we should put the organ into operation. Evelyn and Margery—ages 9 and 6—claimed the big box. It was dedicated as a summer playhouse.

The precautions paid off. A few items were missing, but were turned up as soon as they could be identified properly. But the biggest single unit, the distribution circuit board, was not to be found. Before writing to complain, however, we took one last careful look through all the packing, and sure enough, between two sheets of cardboard which together made a piece just the same size and shape as several other padding strips, we found the slim board. Three keys were also missing, but they had dropped behind some of the equipment and were wedged against a bookcase in the living room. The precaution of not sweeping the livingroom during the assembly period had also paid off!

Wiring went on in a strangely uneventful way. A few things puzzled us for a time, but further progress straightened them out. Every time we guessed, we guessed right. I found no errors in the instruction book. (This is a bit strange, because Heath assured me there were a few. However, it is sometimes as easy to pass over a mistake when the right way is obvious as it is to make an error when the instructions are correct and explicit.)

A little slip of paper mentioned a 220-ohm resistor that wasn't on the parts list and urged us not to be puzzled about it, but there was no mention of a missing 10,000-ohm resistor—maybe it



Almost ready to go . . . connecting audio signal lead to power amplifier. Heath organ, a kit version of Thomas Coronado BL-3, has two 12-inch main speakers and a two-speed Leslie rotating speaker system, for chorus, celeste and vibrato effects.

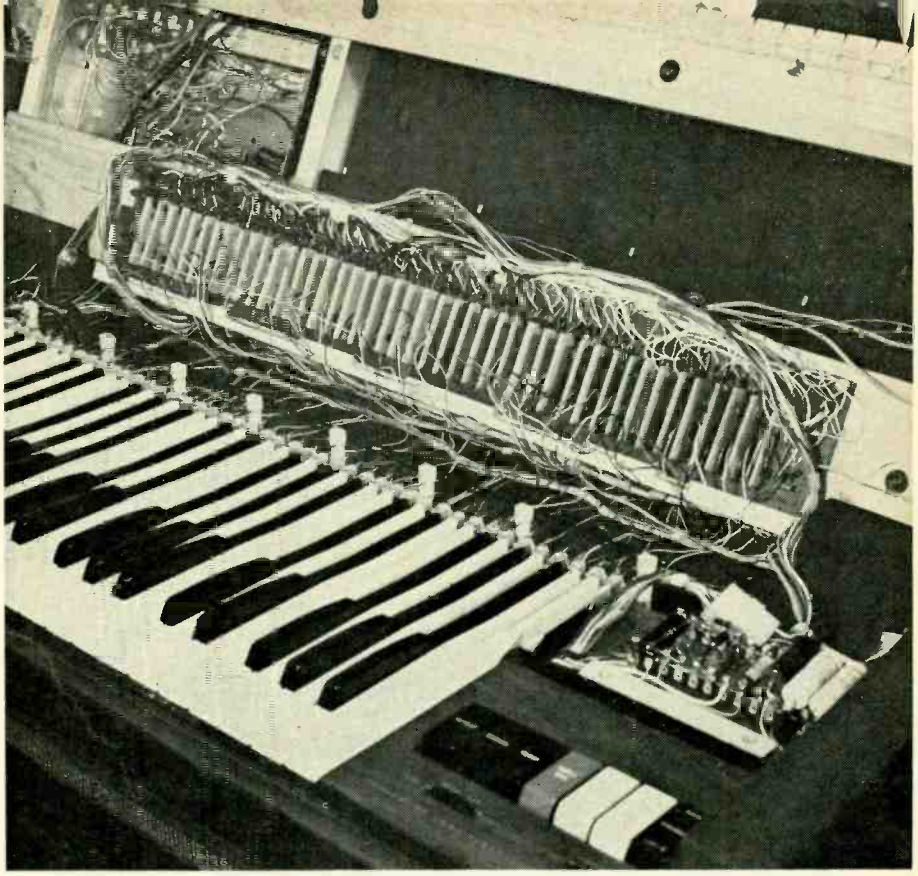
was something else that went out in the packing. And we were terribly startled to have a transistor left over. However, well along in the book we discovered that an extra transistor had been packed, so that straightened itself out.

One other slight difficulty was home-made. We were working 1 hour every evening during the week, and put in as much time as possible over weekends. To make more efficient use of our time, we split our efforts—and consequently the book. After a while it became rather difficult to get the pages in sequence and to find out exactly what we had to do next.

But we triumphed over all these things. Just a little more than a month from the time the equipment arrived, we came to the instruction "Turn the organ on." We did—and got a beautiful sync buzz from the amplifier. Turning it off quickly for fear that overload might blow the output transistors, we checked wiring and joints. Two joints that were not soldered at all, and three that looked dubious, were resoldered.

We put the amplifier back again, but the buzz continued. Tried the expression pedal (volume control). It had no effect. In desperation I used the old radioman's remedy—a sharp blow to the transformer with the flat of the hand. It worked—temporarily—but there was still no sound. We went through circuitry until we were interrupted by smoke rising from the 15-ohm resistor in the circuit to the swell keyboard. It had 15 volts on one side of it, and was supposed to have about the same on the other. Unfortunately, the voltage on the other side was zero.

I was a bit afraid of using ohmmeters on circuits containing transistors, but I dug up an ancient volt-ohm-milliammeter with a shunt type low-volts range made by shorting the ordinary ohmmeter terminals, and connecting the probes directly across the meter.



Keying filters on long factory-assembled printed-circuit board occupy space between manuals. (Upper manual is shown tilted back.) Wiring is orderly and systematic.

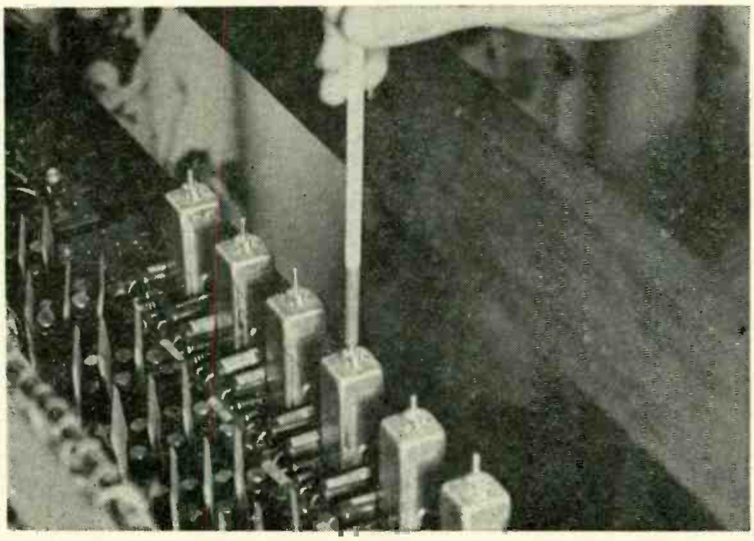
With the zero adjustment set for full scale, the greatest current that could possibly flow was 1.5 ma.

The multitester showed a solid ground on the swell keyboard. Tracing the leads down, I found a washer-head bolt screwed down firmly on top of the bare 15-volt lead that ran along the back of the swell-manual frame. Releasing it made everything normal, and we went ahead, up to the point where the instruction "Press any key near the middle of the great keyboard" started us playing the organ. It worked. We couldn't resist pressing all the other keys, in spite of the fact that this test was not supposed to come for another page or two, and found that everything produced good sound.

Following through with a series of tests as instructed, we found that the SUSTAIN tab killed everything. Ohmmeter checks showed a 15-volt circuit grounded. We carefully traced the ground down to the big swell-circuit distribution board. I had a vision of a shorted diode among the 160 or so on that board.

It was Friday evening, so we decided to leave that job until the next morning. Unscrewing the board and turning it over, we started with the input strip, which ran along the lower edge of the board. Following it down about two-thirds of the way, and looking at each point in turn, we discovered a small solder bridge—a thin thread that was actually above the board rather than on it. A touch of the soldering tip and everything checked normal. It sounded normal, too, when we put the board back again and tried it out. Meantime, the buzz had started up again in the amplifier, and we had to quit everything to attend to it.

The amplifier trouble showed us something about soldering transistor circuits. Old radio and TV technicians have run into many instances of sets that have developed intermittents or absolute opens after years of use, and have cured the trouble with a soldering iron on a dry or rosin-insulated joint. The marvel has always been that the set would work so long without giving trouble. No tech-



After checkout comes tuning. Step-by-step instructions according to an ingenious method make it easy for anyone. No musical or electronic skill is required.

nician is likely to have that trouble on transistor equipment. Where your high voltage is in the order of 15 the rosin joint shows up immediately. And the ancient technique of wiggling, so seldom useful in tube circuitry, *does* work with transistors.

I found that by moving a wire at the ground connection of the two filter capacitors, we could produce or stop the buzz. Careful inspection of the joint showed absolutely nothing wrong, but a good resoldering stopped the buzz entirely, and we could not make it start again by flexing any of the leads or pushing the terminal strip back and forth.

Tuning was quite an experience. Heath supplies one oscillator wired and pretuned, and the others are tuned by comparison with it, using the "beat" method. I think the organ is reasonably well tuned, though I may get an expert in to confirm or deny it, or possibly try to hook the scope up so that I can see the beats instead of trying to count them with a watch. Anyhow, the organ sounds good.

Only one disadvantage—the instrument may introduce complications that we had not bargained for. Ellen is already planning to take organ lessons this year, and her younger sister is demanding to learn with her. And my wife says, "I'm going to learn to play that, too."

For myself, I'm just going to master a few bars of "Oh where and oh where has my Hieland laddie gone" and use it to demonstrate the instrument.

One thing remains to be done—put the back on. Admiring neighbors and friends always like to look at the work and a number of interested people who were going to come watch us put it together are still eager to see it. (They underestimated the time it would take us to do the job.) We are planning to invite them all over some evening and have a big celebration—an orgy, naturally. END

SPECIFICATIONS

Thomas-Heathkit de Luxe Transistor Organ
Model GD-983

Swell Manual (44 keys; F1 through F6).
Voices: 16 ft—Bourdon, Diapason, Bass Clarinet, Trumpet; 8 ft—Flute, English Horn, Violin, Oboe; 5 1/3 ft—Quint; 4 ft—Flute d'Amour

Great Manual (44 keys; F1 through C5).
Voices (all 8 ft): Diapason, Saxophone, French Horn, Cello

Pedals (13 keys, C0 through C2): 8 ft, and 16 and 8 ft pitches

Percussion: medium or short decay, repeatable

Sustain: long or short (short called "reverb")

Amplifier power: 37½ watts music power

Speakers: two 12-in. main speakers; one two-speed Leslie rotary system; headphone jack

Power requirements: 115 watts

Cabinet: walnut finish

Dimensions (overall): 43 x 43½ x 25 in.

Price: $799 including bench

Heath Co., Benton Harbor, Mich.

Home "Message Center" Features Electronic Stop

By ROBERT F. SCOTT
TECHNICAL EDITOR

AN UNUSUAL AUTOMATIC ELECTRONIC stop is used in a new special-purpose tape recorder for personal messages in the home. The housewife can leave messages for her family and domestic help, leave intsructions for smaller children who can't read, and generally use the recorder to replace the family bulletin board and telephone message pad.

When a message has been recorded, a signal lamp comes on to indicate to members of the household that there is a message on the tape. At the end of the message, the tape automatically advances to the beginning so it need not be rewound before it can be replayed or a new message recorded.

This new recorder is the Westinghouse Message Center. The record-play electronics uses four transistors: two voltage amplifiers and a push-pull power-output stage. Dc bias is used on the record and erase heads when recording. There is no on–off switch. The motor turns off automatically at the end of the tape. A 2½-inch pm speaker is the mike for recording. A voltage-regulated power supply stabilizes tape speed.

The messages are recorded on an endless 3-minute tape on a cartridge type reel wound on the outside and unwound from the center. The ends are joined by a short strip of metallized tape which actuates the stop circuit.

Electronic automatic stop

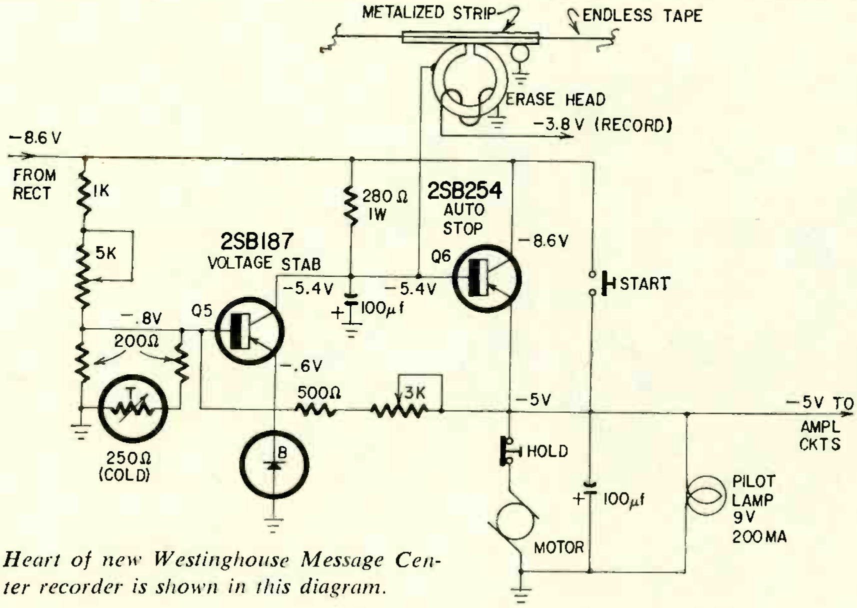
The voltage-regulator and automatic-stop circuits are shown in the diagram. The power supply delivers −8.6 volts from a bridge rectifier. The Message Center is turned on and off by closing and opening the −5-volt line to the motor and amplifier. Q5 is the control transistor that stabilizes the output of Q6, the auto-stop transistor that operates as a series voltage regulator.

A voltage divider across the −8.6-volt line sets Q5's base bias at −0.8 volt. The Zener diode sets the emitter bias at 0.6 volt. Any change in the source voltage changes Q5's bias. This varies the voltage drop across the 280-ohm collector resistor and shifts Q6's bias in the proper direction to keep the emitter (output) voltage constant at 5.0.

Note that Q6's base is connected to the core of the erase head. A grounded tape guide is mounted close to the heads. When the metallized strip reaches the heads, it grounds Q6's base. This removes the forward bias and turns off the motor, amplifier and pilot lamp. (The MESSAGE lamp remains on until the PLAY-button is pressed for playback.) The machine is now ready for playing the message or recording a new one.

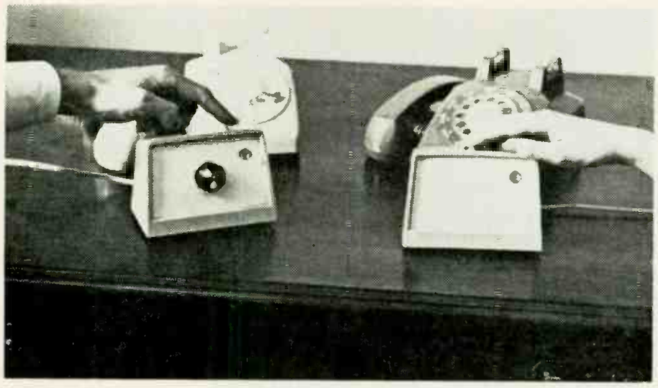
The RECORD button applies bias to the erase and record–play heads, connects the speaker to the amplifier's input and the record head to the output stage, bypasses the volume control and turns on the MESSAGE lamp. This button remains depressed during recording and is not released until the PLAY button is pressed. The PLAY button returns the audio circuits to normal with the speaker connected to the amplifier output and the record–play head to the input.

Pressing either the PLAY or RECORD button momentarily closes the START switch (see diagram) and applies 8 volts to the motor. The motor starts and pulls the metallized tape section past the heads and ungrounds Q6's base. The motor is now supplied from the regulated 5-volt line and continues to run until the HOLD button is pressed or until the metallized section of tape again reaches the heads and turns off the recorder. END



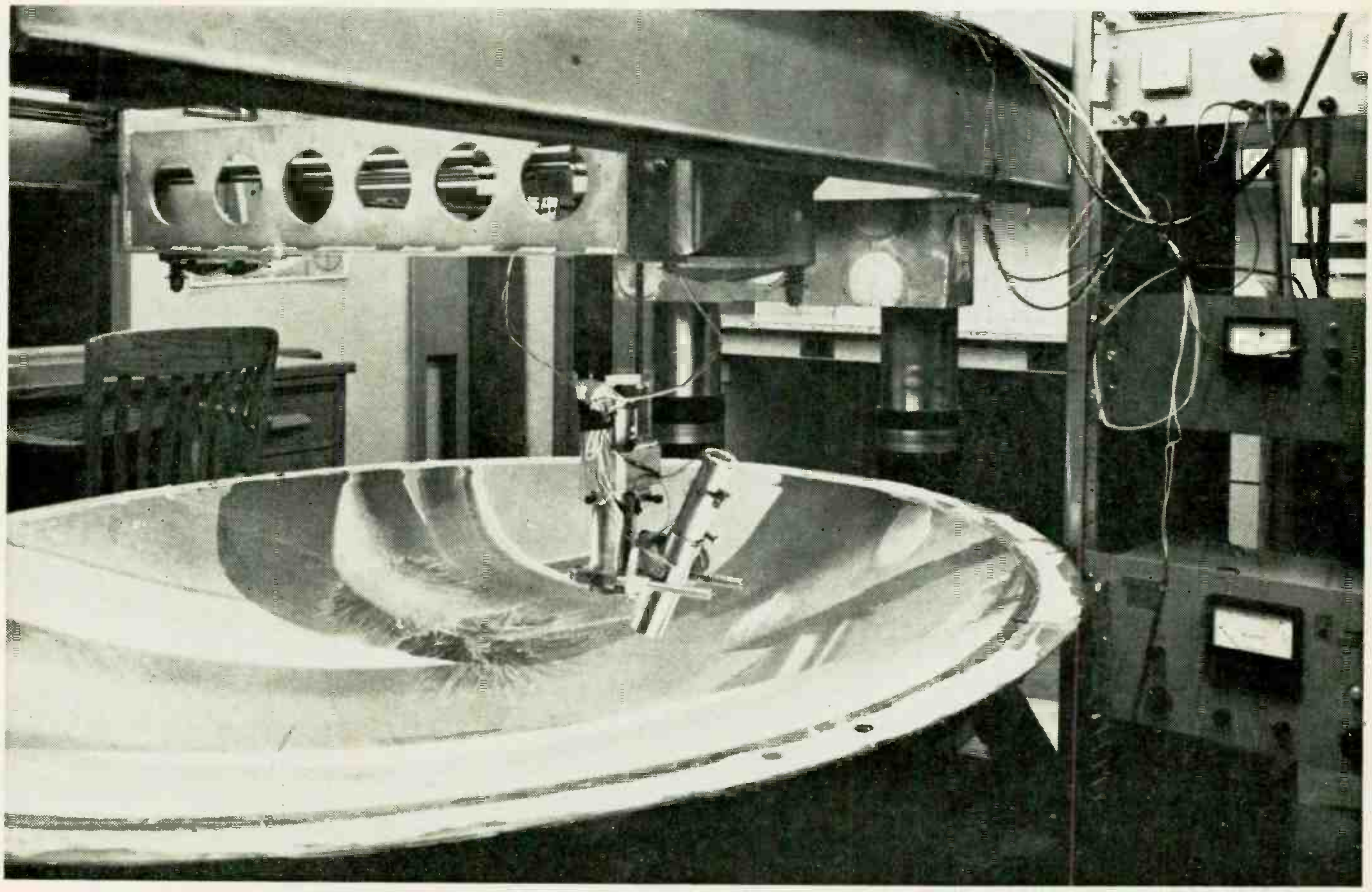
Heart of new Westinghouse Message Center recorder is shown in this diagram.

WHAT'S NEW

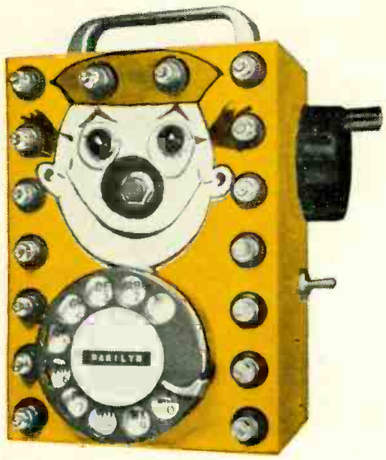


SENSICALL permits deaf people to use telephone by sight or touch. Deaf people who can see can use one kind of Sensicall —the kind that has a light that blinks in time with impulses on the line. Deaf-blind persons can use a kind with a vibrating button, which they must touch. Person at other end of line "talks" by humming, tapping or whistling to make Morse or other code symbols. Users of either kind can easily learn to distinguish between dial, ringing and busy tones. Device was developed by New York Telephone Co.

STREAMERS OF LIGHT graced opening of 1966 Shipstads & Johnson Ice Follies. They're made of Sylvania Tape-Lite flexible electroluminescent ribbon. Excited with ac, tape glows with light ranging from green to blue, depending on frequency. Performers carry self-contained battery-powered inverter, making them independent of external power and free to move any distance. Changes in color and intensity are possible via elaborate radio remote control.



PRECISE MEASURING WITHOUT TOUCHING is the specialty of this device developed by the Boeing Co. for gaging accuracy of extremely fine-finished parabolic mirrors that would be scratched by ordinary instruments. Electro-optical scanner moves above mirror. One of its units projects pinpoint of light, which is reflected into second unit. Servomotors work to keep reflected light centered in prism, and their motions are recorded as variations in surface contour.



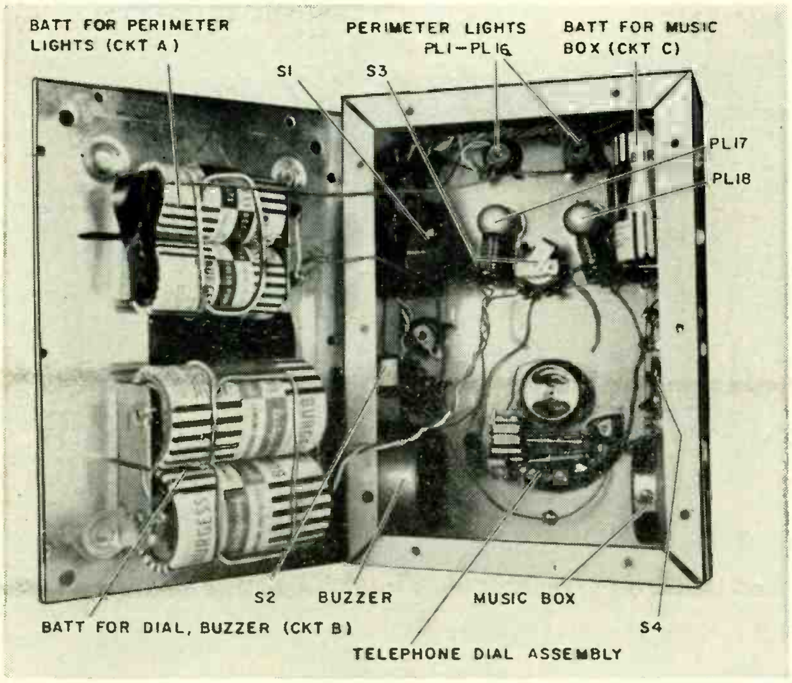
THE BUSY-BOX:

A Thinking Tot's Toy

Build your kids a Christmas toy that does things

By JOHN A. TISO

HOW MANY TIMES HAVE YOU BOUGHT a new toy for the baby or some young friend, only to have it join a host of dust-covered predecessors in the closet after a few hours of use? "Too many times!" you say? Don't despair, you've plenty of company. Young children have a very short span of interest, and, with added competition these days from TV, a new toy just doesn't have the kick it used to have.



Inside, the box is crowded, but a little care in planning will insure success.

The Busy Box is different. It's rugged, has lots of variety and, while primarily intended for 2- or 3-year-old, will also attract the attention of older youngsters. You'll see this toy used and enjoyed long after the other trinkets have bit the dust.

The Busy Box consists of three separate, simple switching circuits, each with its own power supply for maximum battery life.

Circuit A (Fig. 1) is made up of rotary switch S1 in series with toggle S2, and 16 No. 112 miniature lamps, connected in parallel from each pole of S1 to the common side of the 1½-volt battery supply. Note that only 16 of S1's 17 poles are used. Switch S2 is included so the circuit can be turned off, conserving batteries and bulbs.

Circuit B includes the telephone dial, paralleled by pushbutton switch S3 (clown's nose), the buzzer, and the miniature No. 136 lamps (PL17, PL18) for the clown's eyes. Use the 3-volt buzzer specified in the parts list, since imported types were found to be unreliable.

You may have to spend a couple of minutes to determine which terminals to use on the telephone dial. With the dial at rest, the circuit should be open. When a number is dialed, the circuit should close, and, as the dial is released and spins back to rest, the contacts will open and close intermittently. This will make the eyes "blink" accompanied by a series of short "beeps" from the buzzer.

Circuit C is simply the music-box movement wired in series with pushbutton switch S4 and a 1½-volt battery. Use the right polarity here, since the motor must turn in the correct direction.

Construction

It's smart to acquire all the parts before starting. Begin by laying out and drilling all the holes in the aluminum chassis box. Follow the drawing in Fig. 2 as closely as possible—some clearances are tight. Notice that the drawing does not show the exact hole sizes and locations for all the components; because of possible slight variations. The cutout for the telephone dial is an irregular shape,

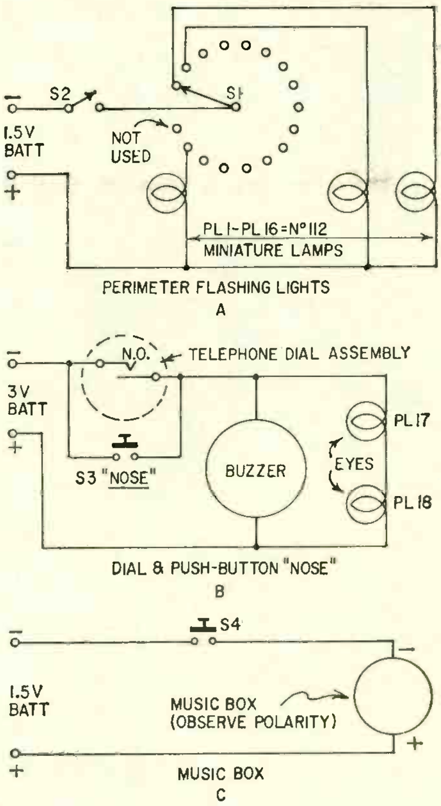


Fig. 1—Busy-Box is made of three separate, simple circuits. Complete details are given in the text.

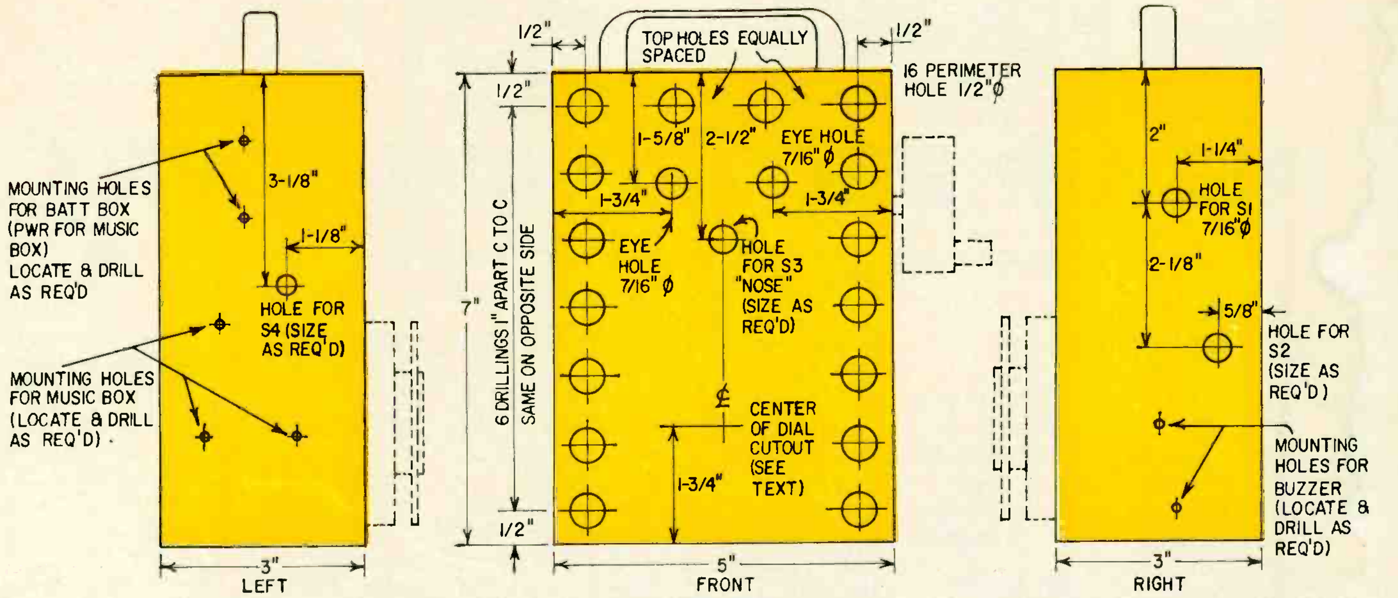


Fig. 2—How to lay out the chassis box. Exact hole sizes and positions depend on particular parts used. Better have them on hand before you pick up the drill!

and will depend on the particular unit you buy. The best way to cut it is to make a trial-and-error template from thin cardboard. Make sure the cutout clears all moving parts of the dial, and locate the mounting holes accurately. Transfer this layout to the aluminum box, then drill and cut.

The miniature lamp sockets around the perimeter of the box are mounted by force-fit in the rubber grommets. Therefore, make the holes for these grommets carefully, to insure a tight fit. As shown in the photograph, two of the battery boxes are mounted on the inside of the rear cover. Be especially careful when locating these boxes so they will not interfere with other parts when the cover is put on.

Smooth all rough edges, and make a trial assembly of the components. With any kind of luck, they will all fit perfectly. OK? Now, remove everything from the chassis box, and you're ready for finishing.

Spray on a couple of coats of enamel or lacquer (don't forget the screw heads which will show), and let dry thoroughly. Next, paint the clown's face. You don't need much talent to do this; a clown's face is supposed to be funny. But, if you're chicken, you can probably find a suitable decal transfer at the local hardware store.

18-month-old Marilyn Tiso, busy discovering the secrets of the Busy-Box.

When the paint is completely dry, you can start final assembly. Put the handle on first, then mount all the parts on the face of the box. The miniature sockets for the perimeter lamps PL1-PL16 are forced into the rubber grommets after the grommets have been installed. A little rubber cement will make this operation easier, and hold the sockets firm. Now wire the "common" lugs for these lamps together, and bring out a lead to be connected later to the batteries on the rear cover.

Rotary switch S1 comes next. It must be wired before being installed. Multiple-conductor telephone cable is good for this, since the wires are very thin and color-coded. The switch on the unit shown here was wired for consecutive operation, so that the lights create a rotating effect, but a random pattern might be even better. However you decide, cut each lead to approximate length, and twist the resulting bundle of wires tightly together. Bring a lead out from the fixed or "hot" pole, to be connected later to switch S2. Now mount S1 where shown, and wire the leads from each of the 16 poles to the "hot" lugs of PL1 to PL16. At this stage, push all wiring out of the way into the corners of the chassis, and see that S1 rotates freely.

All the remaining parts on the sides of the box, as well as the battery boxes on the rear cover, can now be installed and wired, following the schematics and photographs. When all wiring is completed, install the batteries, bulbs and spinner knob, and carefully secure the back cover, checking for shorts. Bare No. 16 wire wrapped tightly around the ears of the battery boxes, as shown in the photograph, will keep the batteries from falling out when jarred. The No. 112 miniature lamps are fairly strong but, as an extra precaution, paint each bulb with clear model cement to prevent shattering if broken.

Finally, test the operation. The telephone dial and pushbutton nose should beep the buzzer and blink the eyes; S4 will activate the music box; and, with S2 on, the rotary knob will light the perimeter lamps, one at a time.

After you've had your fun with the Busy Box, offer it to the nearest 2-year-old. You'll be surprised how eagerly it's accepted, and how rapidly its functions are figured out. Your only problem now is how to deal with requests for copies of the Busy Box from relatives and friends. Maybe this wasn't such a good idea after all? END

PL1–PL16—Sixteen No. 112 miniature lamps with miniature screw-base sockets (Dialco No. 507)
PL17, PL18—Two No. 136 miniature lamps with panel jewel assemblies (Dialco No. 510-121)
S1—Daven SP, 17-point rotary switch (Burstein-Applebee 18C503)
S2—spst toggle switch
S3, S4 — Momentary-contact, normally-open, pushbutton switches
3-volt buzzer (E. F. Johnson type 114-400 or equiv.)
Telephone-dial assembly (available from Radio Shack Corp., Fair Radio Sales, or Olson Electronics)
Aluminum chassis box 5 x 7 x 3 in., with back cover (bottom)
Spinner knob for ¼-in. shaft, 2⅜ in. dia
Battery-operated music box movement (Burstein-Applebee 18B166. Not in catalogs but available through 1966)
3 C-cell battery boxes
6 C-cells
16 rubber grommets, ½-inch mounting hole
Handle, wire, hardware
Burstein-Applebee Co., 1012 McGee St., Kansas City, Mo. 64106
Radio Shack Corp., 730 Commonwealth Ave., Boston 17, Mass.
Olson Electronics, Inc., 260 So. Forge St., Akron, Ohio 44308
Fair Radio Sales Co., 2133 Elida Rd., Lima, Ohio 45802

REPAIR RECORD CHANGERS

First of two parts—What the mechanism does, and how; what goes wrong, and how to fix it

By HOMER L. DAVIDSON

IT IS NOT EASY — NOR PROFITABLE — TO turn down record changer business. More record changers on the market means more record changer repair. Since hi-fi and stereo have come into their own, we've never seen record changer business so good.

The technician will find most of his work organized into three main divisions—cycling, speed and adjustment. Fig. 1 is a top view of a typical record changer, and Fig. 2 shows its underside. When the function control is set at automatic (AUT), speed control at 33⅓ rpm and the reject arm triggered, the changer starts to go through its cycle.

Let's load the changer. Lift the stabilizer arm and place a stack of 12-inch records on the spindle. Pull the arm over on the records and let it rest on them. (Do not pull the stabilizer arm up by its free end, but lift near the back post.) If the arm is hard to pull up or moves jerkily, rub some light oil on its shaft with a cloth.

With the control knob in automatic position, trip the reject button. Underneath, the linkage (Fig. 2) moves the on-off switch, and the motor starts. The opposite end of the control lever actuates the automatic neutral link detent lever, and this engages the drive wheel. The turntable starts to turn. The flanged end of the control lever strikes the tab end of the trip pawl lever. The lever comes out into the path of a flange that rotates with the turntable hub, starting the cycling gear in motion.

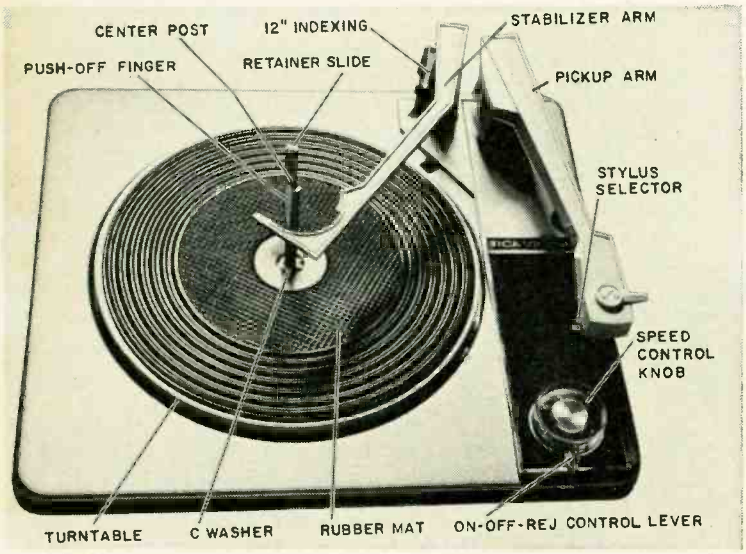


Fig. 1—Principal parts of a record changer above deck.

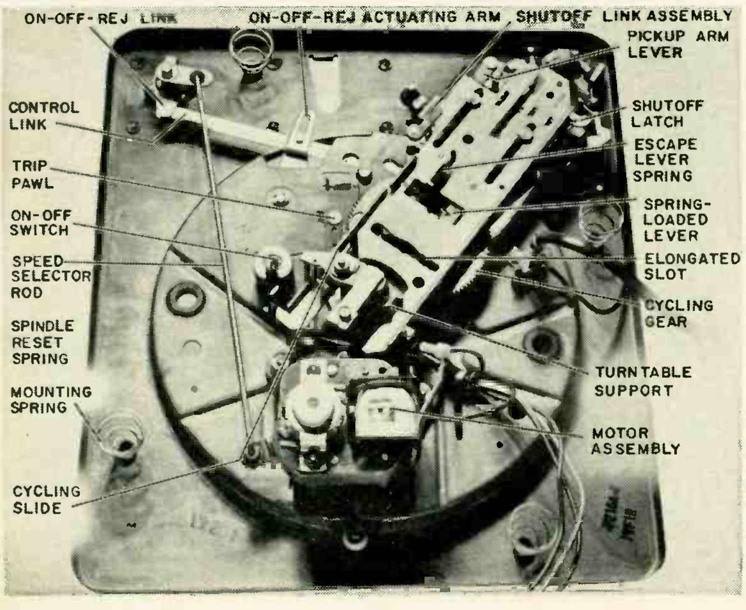


Fig. 2—Proper names for the doodads, thingamajigs and whosises under the base.

When it doesn't work

If the changer does not cycle, check for a bent control lever tab, bent trip pawl lever or a dry trip pawl bearing. Sometimes the small trip pawl lever is dry and will not be pushed out far enough to engage the protrusion on the turntable hub. Lubricate with a light machine oil. If the motor does not turn, check the on-off switch with an ohmmeter to see if the contacts are open. One of the small tips or tabs on the switch assembly might also be broken off. Repair of the phono motor itself will be discussed in the next instalment.

As the cycling gear rotates, the cycling slide (Figs. 3 and 4) moves forward. The cycling gear goes through one complete revolution. A lift pin on the pickup arm rises along the lance of the moving cycling slide, causing the pickup arm to lift. When the flat portion of the lance on the cycling slide is past, the arm has finished rising and has also unlatched the shutoff activator and landing lever (Fig. 5). The pickup arm moves toward the record and contacts the pickup arm lever. The feeler (or cycling slide) reaches its full position and now starts the arm for the correct setdown point, according to the record diameter. At this time the pickup arm is free and can go downward. *The arm should never be touched when the changer is cycling.* When the cycling slide has reached its outermost position, it causes the actuator spring to latch the pickup arm momentarily, until the push-off lever drops another record on the turntable.

The push-off lever activates the push-off finger on the thin spindle and one record falls. The cycling gear is now halfway through its rotation. If the pickup arm moves erratically, check the lift pin for dryness and sharp edges.

One of the biggest changer complaints is "all the records fall down on the turntable at once." This is caused by either a pulled-up retainer slide or too-large holes in the records. If the retainer slide is in its correct position, only one record can fall at a time. Sometimes, when the user plays a load of records, he pulls them up along the spindle to load them again for a repeat performance. If they are not pulled clear off the spindle, the retainer slide will be caught and stay up with them. When the reject button is tripped, all the records will be pushed off and down. Demonstrate this when you sell a unit.

The cycling slide starts the rest of the rotation, and the pickup arm follows the landing lever. Spring force moves the landing lever at this time. When the cycling gear has finished one complete revolution, the pickup arm lands at the starting diameter of the chosen record. The lift pin has gone down the small incline and the engagement pawl is reset by striking the casting on the hub of the turntable assembly. Oil on the landing lever and improper height adjustment will cause erratic landing.

The record has now started to play. If the changer keeps tripping and does not play the record, check the clutch lever and trip pawl. On some changers, this trip pawl may stay stuck out if it is bone-dry, causing continuous tripping. The pickup arm may skate across the record grooves and toward the center. Check for a worn needle and improper leveling of the changer. A defective record will do the same thing.

When the last record has been played, most new changers shut themselves off. The cycle starts to repeat and the shut-off latch is forced inward, missing the shut-off lever. The pickup arm lever and the landing lever remain in position. The stabilizer arm shaft drops to the shut-off lever and triggers the on-off switch.

If the changer is loaded with several records and shuts off automatically before playing the last record when the reject button is tripped, check the stabilizer arm shaft. It may be bent, letting the shaft extend down in front of the shut-off lever.

Another complaint is "The arm of my record changer starts over in the middle of the record." You'll always find this condition (perfectly normal) when only one record is on the turntable, the stabilizer arm is not in position, and there is no 12-inch record on the spindle to fall and trip the 12-inch index lever.

In the next installment, we'll talk about speed troubles, drive slippage and motor overhauling, and cover a few simple adjustments you can make quickly.

TO BE CONTINUED

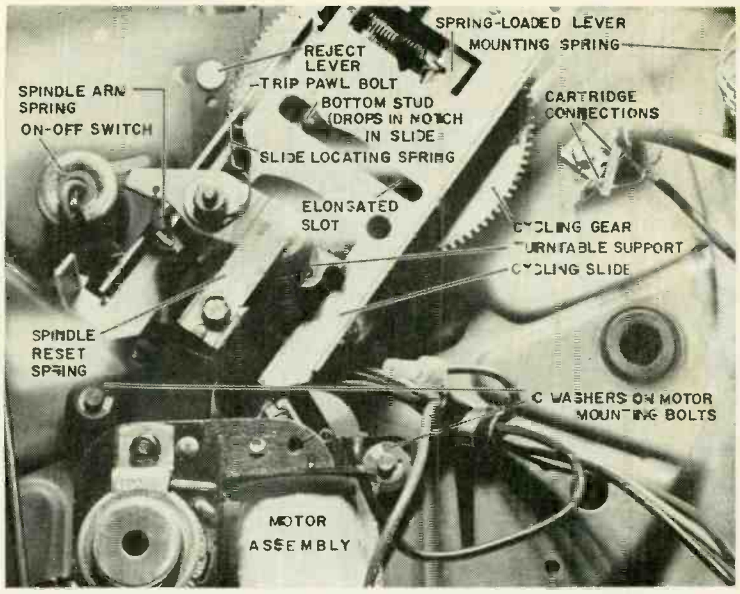


Fig. 3—End of cycling slide near motor.

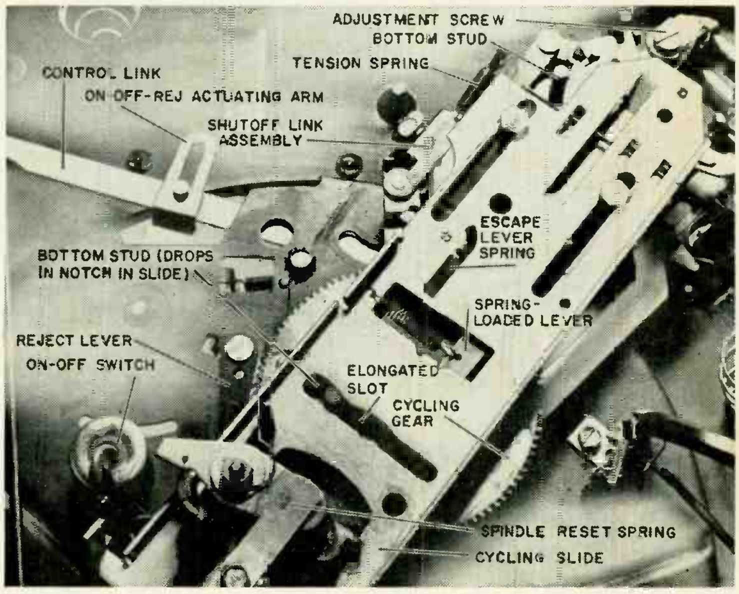


Fig. 4 — The cycling slide's other end.

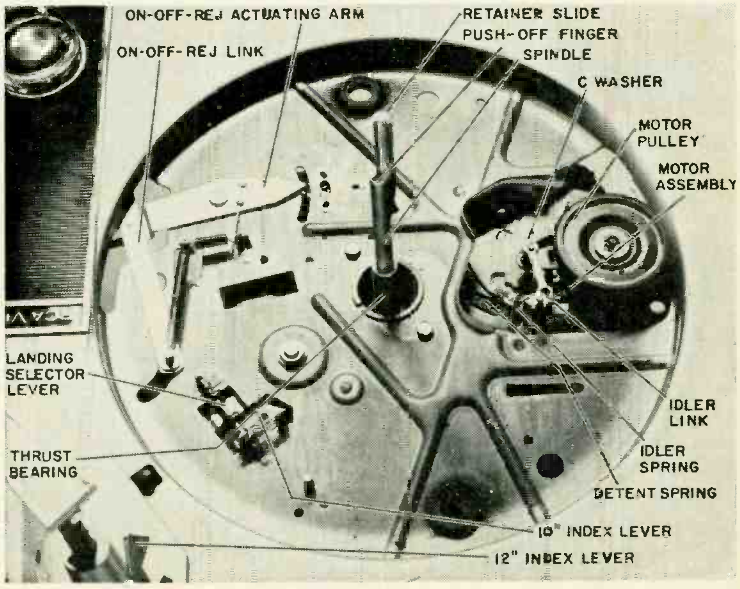
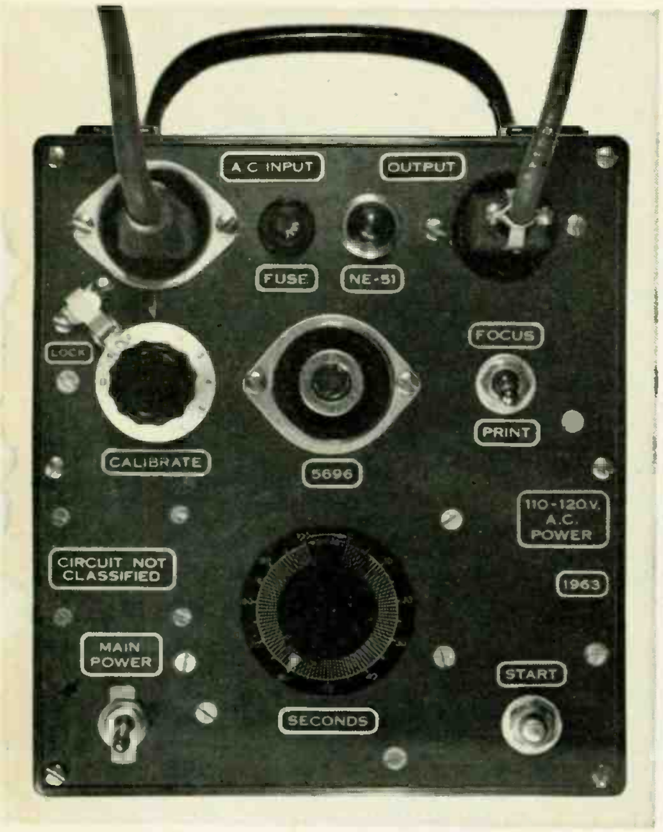
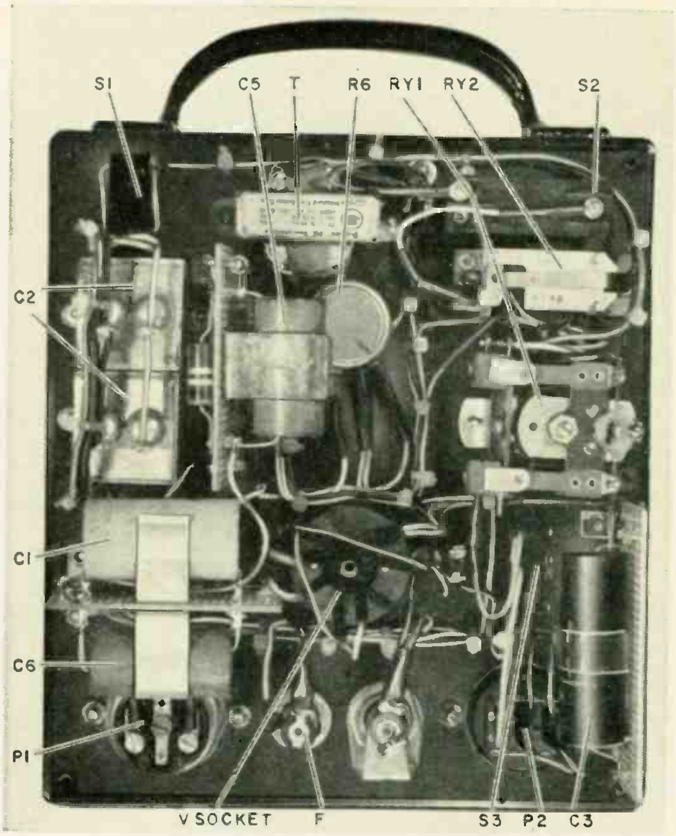


Fig. 5—There are parts even under the turntable.



In use, timer lies flat with handle toward rear. This keeps controls handy, cords out of the way.



Inside the timer. Layout is compact but not crowded. Major components are called out here.

De Luxe Printing Timer

Simple, accurate, versatile darkroom timer assures painless prints

By RONALD L. IVES

THE PROBLEM OF TIMING PHOTOgraphic printing processes accurately and consistently has been with us since the days of wet plates and albumen paper. Until recently most printing processes were timed by guess, even though a variety of mechanical and electromechanical printing timers have been marketed. Although some were most ingenious in design, few were widely adopted. In unhappy consequence, few photographers can produce 100 prints all exactly alike without an enormous waste of paper and time.

Two general types of printing timers are commercially available—the kind incorporating an electric clock movement, as does the Gra-Lab; and the type employing a thyratron tube and an electronic delay circuit, such as the popular Heathkit darkroom timer. Recent improvements of the electronic timer have made it most suitable for photographic work[1], and some changes in the conventional format add to versatility.

[1]R. L. Ives, "Linearizing the Thyratron Timer," *Electronics World*, Vol. 67, No. 5, May 1962, pp. 92-95.

It is now possible to build a printing timer, using standard over-the-counter parts, that will time either contact prints or enlargements for intervals from 5 to 85 seconds, with a maximum error of 1 second and with repeatability to within one-fifth second at any setting.

In normal operation there are only two controls—the time setting (SECONDS), and the actuating pushbutton (START). A panel switch is provided to give continuous illumination (FOCUS).

The circuit is shown in Fig. 1. A 5696 computer thyratron is used here, in place of the slightly less expensive and more popular 2D21, because of its lower grid and heater currents.

General formula for the operation of the circuit is—

$$T = 2.303RC \log_{10} (E_s/E_d)$$

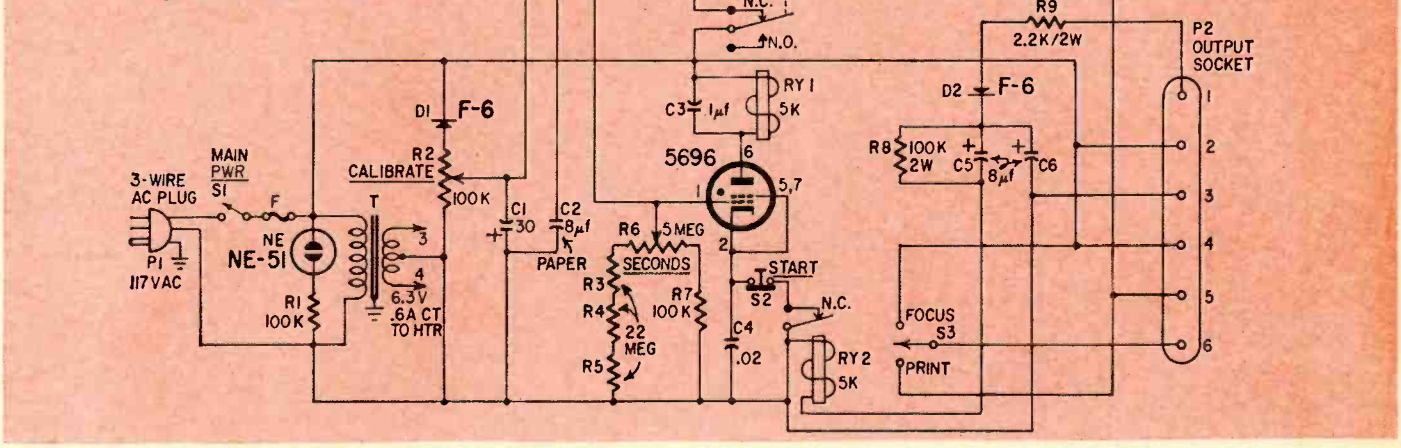
Here, T is the time in seconds, R the control resistance in megohms, C the storage capacitance in microfarads, E_s the calibration voltage, and E_d the extinction voltage of the thyratron. T/R is a constant, so that time intervals measured are exactly proportional to the setting of R, which is the time setting control SECONDS.

How it works

When the timer is connected to the line and the power is turned on, the thyratron tube draws current on each positive half cycle, no holdoff voltage being applied at this time. Plate relay buzzing is prevented by shunt capacitor C3. The armature of the plate relay is held down, so that there is no voltage on contact 5 of the output plug. At the same time, storage capacitor C2 is charged from the line through rectifier D1 and calibration potentiometer R2 to a voltage determined by the calibration setting.

When the START pushbutton is depressed, opening the cathode circuit of the thyratron, conduction stops and the armature of the plate relay is released. This puts voltage on contact 5 of the output plug, disconnects the storage capacitor from the calibration voltage supply and connects it into the grid circuit of the thyratron, providing holdoff voltage, so that the tube does not immedi-

Fig. 1—Circuit of the timer.



C1—30 µf, 250 volts, electrolytic
C2—Two 4-µf, 150-volt paper capacitors paralleled
C3—1 µf, 400 volts, paper
C4—.02 µf, 600 volts, disc ceramic
C5, C6—8 µf, 250 volts, electrolytic
D1, D2—silicon diodes, 400 piv, 150 volts rms (Sarkes-Tarzian F-6 or equivalent)
F—2-ampere fuse
NE—NE-51 neon lamp
P1—3-pin male recessed industrial plug (Amphenol 160 series)
P2—6-pin female plug (Cinch-Jones S-306-RP or equivalent)
R1—100,000 ohms, ½ watt
R2—pot, 100,000 ohms, 2 watts (Ohmite AB-CU1041 or equivalent)
R3, R4, R5—22 megohms, ½ watt
R6—pot, 5 megohms, 2 watts linear (Ohmite AB-CU5052 or equivalent)
R7—100,000 ohms, 1 watt
R8—100,000 ohms, 2 watts
R9—2,200 ohms, 2 watts
RY1—relay, dpdt, 5,000 ohm coil (Potter & Brumfield LM-11 or equivalent)
RY2—relay, spst, 5,000-ohm coil (Potter & Brumfield LB-5 or equivalent)
S1—spst toggle switch
S2—spst pushbutton, normally closed
S3—spdt toggle switch
T—small filament transformer, 117 to 6.3 volts, ct (Stancor P-6465 or equivalent)
V—5696 tube
Case, sockets, tie points (see text), miscellaneous hardware, labels.

ately resume conducting. Initial charge on the storage capacitor, determined by the calibration voltage setting, is E_s of the formula. This declines at a rate determined by the setting of the SECONDS resistor (R6 + R7, Fig. 1) until the voltage is less than the extinction voltage of the thyratron.

Immediately thereafter, the tube again goes into conduction, pulling down the armature of the plate relay and removing the voltage from terminal 5 of the output plug. This completes the timing cycle and prepares the circuit for the next cycle.

The string of high resistances (R3, R4 and R5) across the timing potentiometer (R6, R7) makes the timing circuit slightly nonlinear to compensate for the contact potential in the grid-cathode circuit of the thyratron. It is to keep this contact potential at a minimum that a 5696 computer thyratron is used instead of the cheaper 2D21. The 100,000-ohm resistor (R7) compensates for minor nonlinearity near the zero setting of the pot, and prevents burnout of the pot if the timer is actuated with the SECONDS control set very close to zero.

To permit the use of the internal switch in a standard contact printer, as well as an external START control, control relay RY2 opens the cathode circuit of the thyratron momentarily when contacts 1 and 2 of the output plug are interconnected. By using a rectifier, with a series capacitor and drain resistor, operation of the relay is momentary no matter how long the circuit through points 1 and 2 of the output plug is kept closed. Because of the time constants of the circuit, there is a "dead time" of slightly more than 1 second between the completion of one operation and the beginning of the next. This delay is considerably shorter than the time it usually takes to change paper, so a more sophisticated (and more costly) "instantaneous" circuit is not needed here.

For use with an enlarger, the high side of the printing lamp is connected to pin 6 of the output plug, instead of pin 5 as in the case of the contact printer. For focusing, the PRINT–FOCUS switch (S3) is thrown to FOCUS, and the enlarger lamp stays on continuously. When this switch is thrown to PRINT, illumination begins when the START button is pressed, and terminates at the end of the predetermined time.

External connections

Plug connections for both the contact printer and the enlarger are shown in Fig. 2. Other functions can be added within the capacity of the relay contacts. As here connected, the red pilot lamp remains on continuously. A cooling fan for the enlarger lamp house can be connected in this same circuit.

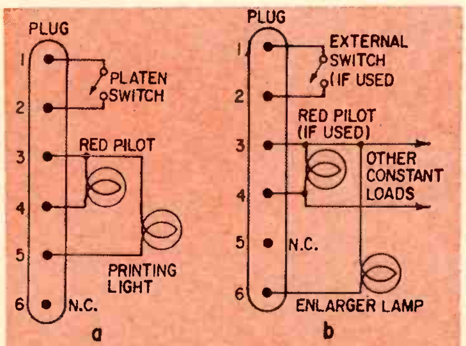


Fig. 2—Connecting the timer to (a) a contact printer, and (b) an enlarger.

Construction

Parts can be arranged to suit your convenience and darkroom space. Careful and rugged workmanship is strongly recommended. "Particular" darkroom work is difficult enough at best, and interruptions due to misbehaving electronics make it even harder.

Because a darkroom is damp, and your hands may be wet, take special care to insure that you cannot come in contact with any "hot" circuit component. Despite folklore to the contrary, 110 volts can kill.

The timer was built in a 7½ x 8½ x 3-inch bakelite instrument case (H. H. Smith No. 2289), with a bakelite cover. The case is fitted with four large rubber feet near the bottom corners, and a large carrying handle (Stanley No. 3) at one end. All electronic components are mounted on the cover for easy assembly and servicing, and to eliminate a tangle of interconnecting wires from case to panel.

The most commonly used controls —on-off switch, time setting and START button—are mounted at the bottom of the panel, nearest the operator. Cable sockets are mounted at the top of the panel so that the cables can be dressed along the back of the bench, out of the operator's way.

The sunk mounting for the 5696 tube is made from a defunct high-voltage socket with a conventional 7-pin miniature socket mounted in the bottom. All other parts are entirely standard, and equivalent components of the same grade can be substituted for those specified.

Most of the minor components are mounted on small sections of punched epoxy board (Vector 85G24WE) with push-in terminals (Vector T-28). To prevent strain on the terminals, all capacitors are also held with clips or clamps bolted to the boards. Wiring is cabled at strategic points.

Although most photographers, used to working in total darkness, operate their equipment "Braille", function labels are most desirable. Those used here are Metalphoto, made and applied by the Kohler techniques[2]. Decals can also be used here, if they are protected against wear and dampness by a coating of clear lacquer.

Connection to printer or enlarger will be easier if the external device is equipped with a plug (Cinch-Jones P-306-RP), wired as in Fig. 2, to take care of the specific needs of the device. Such a connector, mounted on a small contact printer, is shown in a photo here.

Connecting cable between timer and printer or enlarger is a good grade six-wire cable with a male connector (Cinch-Jones P-306-CCT) on one end and a female connector (S-306-CCT) on the other. Pin connections are 1—1, 2—2, 3—3, etc. With this method of connection, the same cable will connect printer or enlarger, and transfer of the plug from one to the other automatically also changes the switching functions of the timer.

Adjustment

When all wiring is completed and checked, insert a fuse in the socket and connect power. Allow the timer to warm up for 15 minutes. Then, with the SECONDS control set at any convenient low value (such as 15), check the operation of the plate relay by pressing the START button and noting if the relay armature releases immediately and pulls in again after a short time (not necessarily 15 seconds). Next check the remote start control by shorting terminals 1 and 2 of the output plug. This should also cause the plate relay to release immediately, and to pull in again after a short time.

Now connect any sort of an indicator, preferably a self-starting electric clock, between terminals 3 and 5 of the output plug. Set the SECONDS control at 30, press the START button and note the time at which the indicator starts. Repeat this process, adjusting the CALIBRATE dial, until the *on* cycle of terminals 3 and 5 is exactly 30 seconds, then lock the calibration dial. Check several times as a safety measure—they will be

Airequipt "Junior" contact printer, adapted for use with timer by addition of six-contact recessed plug, mounted in aluminum box.

right on within about 1 second unless you have either a bad misconnection or a defective timing potentiometer (rare trouble).

This completes the routine adjustment of the timer.

Maintaining a timer of this general type is quite simple, as most of the parts are rugged and pretty much immortal. Timing should be checked about every 100 hours of operation, and the tube changed when either the timing drifts badly or the tube is 5,000 hours old, whichever occurs soonest.

Relay contacts should be cleaned (not filed) about every three months, and the relay hinges very sparingly lubricated with a good grade of clock oil at the same time.

With the exception of the thyratron (5696), which has a life somewhat over 5,000 hours in this type of service, all components have an operating life of 5,000,000 or more cycles.

Performance

This time is one of several built for use in darkrooms where sensitized metal plates are processed. The principal requirement is that plates printed in one production run will exactly match in tone those printed in another production run several months previously. This type of processing calls for rigorous standardization of chemical solutions, uniformity of temperatures, regulation of line voltages for the printing lamps—and standardization of development and printing times.

When used with processes of this type, which are more "particular" than ordinary print processing, this timer is entirely satisfactory in both accuracy and consistency. In ordinary printing and enlarging, it is equally satisfactory, and usually gives good results even with unregulated line voltages. Its timing varies roughly with the logarithm of the supply voltage, making it quite insensitive to ordinary line-voltage fluctuations. END

[2]G. M. Kohler, "Photography Makes Custom Labels" *Electronics*, Vol. 33, No. 1, Jan. 1, 1960, p. 100 et seq.

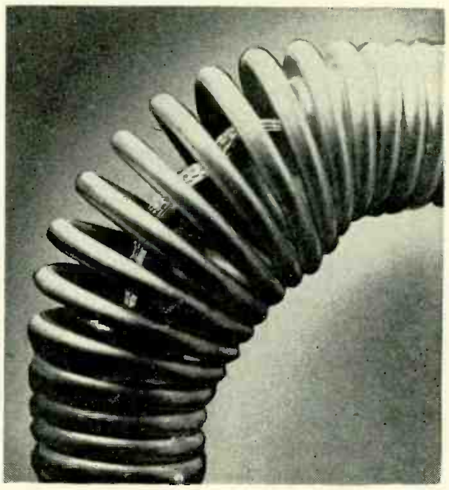
CHECK THAT ANTENNA PIGTAIL

Mobile whip connection can cause erratic transmission or none at all

If the mobile ham rig or CB transceiver works fine when receiving, but the transmitter won't get out or works erratically, check the little braided pigtail inside the base spring of the antenna (photo). Grab the antenna and bend it over to spread the turns of the spring.

That bit of braid is absolutely necessary in these antennas. Without it, the turns of the spring act as a coil, and the movement of the car changes the inductance continuously! This helps the tuning no end, as you can imagine!

To replace a broken pigtail, take the spring off and remove the antenna rod. Clamp one end in a vise and bend the spring over. Some springs have small



Allen (recessed hex-head) setscrews on the side of the end pieces; others have Allen setscrews inside the holes where the antenna rod and base screw into the spring. Remove the setscrews and pull out the old pigtail.

Replace it with a piece of ¼-inch shielding braid squeezed flat except at the ends. Run just a bit of solder into the ends. Now, thread the ends through the holes from inside the spring. Hold the turns open by inserting a small wooden block in them. Push the end of the braid through the hole, and then run the setscrew down on it; this will flatten it out and hold it tightly.

Make a habit of checking this pigtail every time you get near the antenna, and your transmission will be more reliable. END

CAREER OPPORTUNITIES—Third of a series

The Factory Analyzer

Technical men with this specialty are in critically short supply—the field demands high, pays high

By CHARLES R. WHEELER

MATHEMATICS CAN PROVE IT IS IMPOSSIBLE to mass-produce TV sets. What's more, with ordinary methods of statistical analysis, the mathematics would be correct! Yet sets are mass-produced every day. There must be an X factor at work that defeats the mathematics. This article is about the X factor.

What is it? Skilled electronics technicians with special training: factory *electronics analyzers*. Except possibly for service technicians, they constitute the largest group of skilled technicians in the country.

Factory analyzers are usually the best paid technicians in every factory, and their take-home pay is increased by considerable overtime. Their work must be done at high speed; they are respected and essential. Depending on the plant and products, top analyzers make from $6,800 to $9,000 a year.

Why analyzers? Television and similar devices are by long odds the most complex electronic devices mass-produced. The average unit consists of 300 to 500 parts whose characteristics must be precisely controlled. Failure of one part in 500 results in a reject chassis. One human error results in a reject chassis. Uncontrolled, this would result in such a high percentage of rejects that no manufacturer could afford to build anything.

With careful inspection and quality control, the reject level drops to 0.2%. In any other industry, that would be fabulous. For electronics it is not good enough. It would soon choke a plant with rejects, and halt production.

Let's examine a specific case: a printed-circuit-board line running 100 units per hour. Each board carries 300 parts including jumper wires.

This means that, besides the boards, an average of 30,000 parts per hour must be installed. If the combination of faulty parts and workmanship is 0.2%, it is possible for 60 boards out of 100 to be defective, or 60%! (This figure is high for a number of reasons; the final figure will usually come to 15% to 25%.) Imagine: out of a run of 10,000 TV sets, 2,500 would be sitting around needing repairs!

Which part among the 300 on that board is missing? Which capacitor is open? Which resistor is off value? Which i.f. coil has reversed windings? What combination of parts in a network has tolerance runout that throws the unit out of engineering limits and results in a poor i.f. curve?

An inspector is helpless with problems like these. Someone must tell the repair department speedily and accurately what part must be changed so production can move.

Without good analyzers an electronics company is faced with these alternatives: price itself out of the market, or go broke.

An analyzer demonstrates his job

Motorola's enormous new building is on the outskirts of Chicago and is guarded like Fort Knox. I was taken in hand by Bill Mahoney of Public Relations and brought into the factory. The production department is a huge cavern jammed with production lines, conveyors and electrical test equipment. The odor of hot bakelite and resin flux is everywhere.

Thousands of men and women are busily engaged in turning more than a million parts a day into finished TV sets. We pass a TV chassis line. One set a minute rolls off the line for electrical test. And this is only one line—one operation.

Bill introduces me to John Waycuilis, a tall chap with an engaging grin, whose official title is assistant plant manager. He seems to be the focus of an endless number of analyzers and supervisors with problems that won't wait. Finally he settles down for a few minutes and explains the plant analyzing setup.

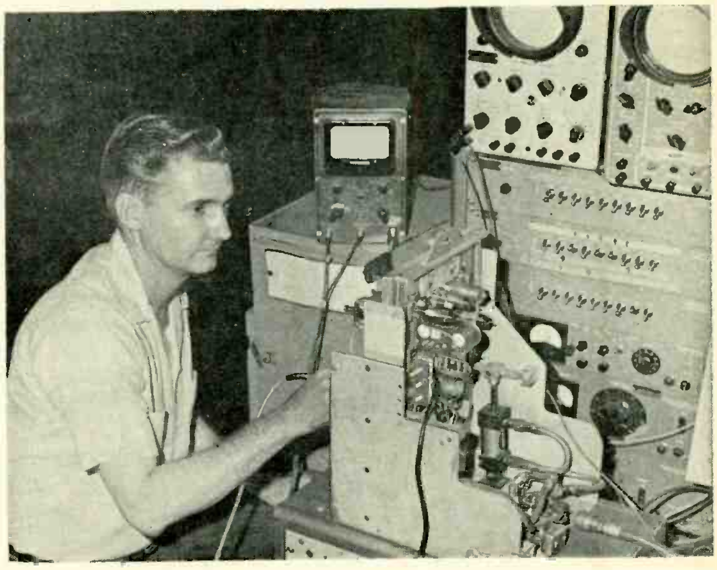
I asked him if analyzing is a function of inspection or of quality control.

"Neither," he answered. "The system that works best for us seems to be an independent analyzing and electrical test department under one head. But this doesn't mean we don't work closely with the other groups.

"Workmanship is the direct responsibility of the inspection department here, and one function of analyzing is to feed back immediately to inspection any deviations from workmanship standards. Inspection takes it from there and has the problems corrected.

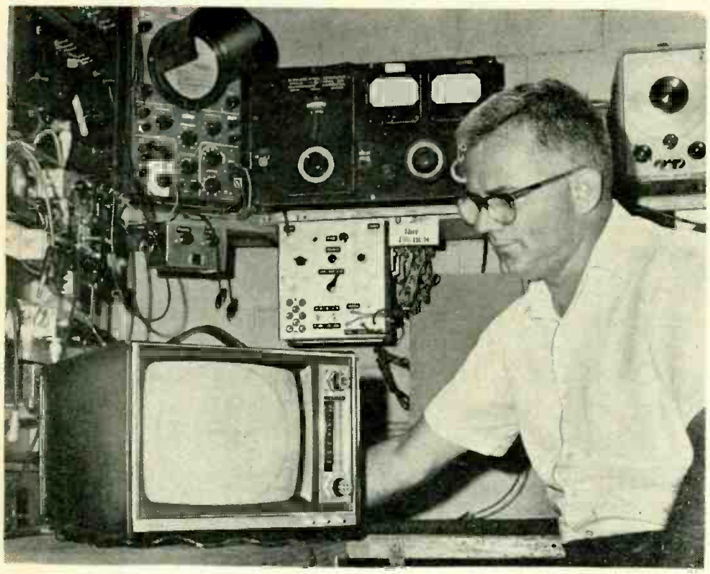
"While parts quality runs high, we always have problems. When you realize the large number of parts per day, supplied by hundreds of outside manufacturers. . . ." I nodded.

"When problems run less than 2% on a given part we handle it as an analyzing function on units in process.



Motorola analyzer Willard Spivey checks reject TV i.f. board on alignment jig. All connections to board are made automatically through pneumatically actuated contact fingers.

Photos by the author



Zenith quality-control analyzer Ray Paluch touches up vertical linearity on model 1290 transistor portable.

This is the cheapest way, because the trouble is usually random or confined to small batches of parts, and tends to correct itself.

"At 2% or up our analyzers will alert us and we get Quality Control on the job immediately. They will 100%-inspect the lots affected or do whatever else they consider necessary.

"Let me take you over to Willard Spivey, one of our ace analyzers. He can show you directly how we operate and let you see some of the operations."

Willard was apparently very busy on the firing line. He was analyzing phasing rejects on an i.f. board fixture. We watched him for a few minutes.

He read the reject tag, glanced briefly at the foil side of the board and slapped it into the fixture to warm up. Meanwhile he checked the top-side parts visually. Then he moved into the affected circuit with a scope and signal-traced to the defective area. After pinpointing, he moved in with the vtvm as a final check. Within 3 to 5 minutes after starting he wrote out the repair tag and bounced the job to Repair.

He picked up another reject. Glancing at the tag, he frowned, then inspected the top of the board. "This is the third board in the last half hour with the wrong capacitor for C104."

Suddenly there was flurry of activity. A supervisor warned the inspector, then went into a huddle with the production supervisor. The production supervisor checked the production operator while the inspection supervisor checked the line from the operator down to the end. Four more bad boards were found and sent to Repair; finally a few wrong capacitors were found mixed in the production operator's bin and cleaned out. A minor crisis was over.

Over coffee in the cafeteria I asked him how he ever got into the analyzing field.

"I came to Motorola 17 years ago and got a job on auto radios. I saw pretty soon that analyzing was the field for me, but I found it very hard to get in. I studied basic electronics on my own, but it wasn't enough. The analyzing information I needed wasn't in books.

"So I took steps to knock out my daily quota early, then went over to the analyzers and rubber-necked. I gradually caught on, and 3 years later I made analyzer. If what I needed had been in books, I could have made it in one year."

"That's hard for me to understand, Willard. I thought everything could be found in books."

"Many articles written for service techs are invaluable. But the greatest flaw in books and articles from the would-be analyzer's point of view is that they always discuss electronics according to how a circuit *should operate*. What the analyzer needs to know is how a circuit works when it is *defective*."

"It doesn't work."

Willard laughed. "I don't mean that. Let me give you an illustration. You saw the little incident this afternoon involving the wrong-value C104. The first one I saw was on the bench of another analyzer. The video amp was cut off. He was a new man. He said he had a 'sneaker'; would I please take a look at it?

"Normally V5-a runs 65 volts on the plate, 30 on the screen and −5 on the control grid. The cutoff stage ran plate 145, screen 145 and grid −25 volts. Plate and screen voltages showed that the tube was not conducting. The high negative grid voltage was clearly the reason. A few simple checks then showed that the stage ahead of the detector was oscillating and generating a high negative voltage through the detector, cutting off V5-a. Oscillation was caused by the wrong value of C104.

"This problem was *not* a sneaker. It was a perfectly simple problem we expect an analyzer to solve as fast as any other. In our work speed is essential if we are to meet production schedules.

"Now, here's the point: this man was not dumb. He passed a very stiff test for basic electronic knowledge before he was hired. Yet he had never been taught tube conduction theory thoroughly. Except for men who have worked in other factories, we always have to teach tube theory to new men on the factory floor. This is one major reason why it costs so much to train new men. It also explains why so many fail to make the grade.

"Regardless of how much a new man knows, even where he has had actual servicing experience, he always seems to be weak on tube conduction theory. The same thing goes for transistors. Another weakness is a lack of thorough practical knowledge of Ohm's law. It isn't just three formulas to manipulate arithmetic with on paper. It is an extremely practical tool for the analyzer to obtain rapid answers to problems in defective circuits."

"OK, Willard. What advice can you give to a man interested in analyzing for a living?"

"First, learn the basic electronics taught in schools and books. Then train yourself to be a good visual inspector, sharp at catching wrong parts and hairline shorts. Get thorough training in using a scope for signal-tracing and pinpointing trouble. Learn to interpret Ohms' law and tube conduction with a thorough mastery of the vtvm. Sprinkle all this with a liberal dose of horse sense and you'll make the grade as an analyzer in any plant in the country."

John Waycuilis had told me that Willard Spivey was always used as lead-off analyzer on major new products. The many projects he had started off at Motorola included the analyzing used for color and transistor TV.

Later that evening I met Willard at his home in Wood Dale near Chicago. He and his wife Jo were planning their vacation trip to Colorado and oiling up their fishing gear. They spanked the kids and sent them off to bed and we settled down for a short visit. I needed a little more personal information about Willard.

While his seniority with Motorola is 17 years, more than 2 of these years were spent as a radio instructor in the Army, at Fort Knox, Camp Pickett and Camp McCoy. He also spent some time in Colorado.

His wife volunteered something Willard hadn't mentioned. In 1955 he started an electronics course at DeVry

Technical Institute in Chicago and achieved the highest grade average the school ever gave: 96.8%.

Another man's view

Zenith Radio Corp. is another Chicago electronics giant on the far west side. Deep beneath the hurly-burly of production runs the same undercurrent —the need for highly trained technical production personnel.

I met Ray Paluch in the office of Ted Kreuger, chief of Zenith quality control. Ray is an analyzer with special duties who works directly for Quality Control. He is specifically charged with liaison between QC and design engineering. In his lab, I asked him in what way liaison between factory and engineering benefited Zenith.

He thought for a moment. "Let's take a hypothetical case," he said. "Assume that a new job is running and production complains that the set breaks into oscillation at a certain stage of alignment. Is the test equipment at fault? Is set design at fault? Is it the man doing the testing? It's my job to find out *what* and *why* in a hurry!

"Remember, engineering specifications are our bible and the set was thoroughly checked before engineering released it. In addition, I myself checked out the first sets as routine before releasing them to Production. So it's my baby!

"The solution to the problem may be changes in alignment procedures or in test equipment. If so, I must see that the changes are made.

"Occasionally, on new models, the design of the set may be involved; some little thing that didn't show up before the production run. First I must prove the cause on my bench to eliminate factory problems. Then I get together with Engineering on the best solution and make up and test samples of the new changes. These are then released to Production."

"Sounds like a good way to work it, Ray," I said. "But you don't have problems like this every day, do you? What is your normal routine?"

"I run electrical checks on five sets a day of every model that runs through Installation. That's enough to catch any tendency in Production or Phasing before it drifts too far from engineering design centers. To save trouble in installation we try to stay well within engineering limits. Steady sampling makes any drift easy to correct.

"Based on what I learn from steady sampling, I also supply production with realistic standards of electrical performance. For instance, Engineering sets the specifications on a job based on a history of past average parts runs. This spec we must meet or we cannot ship to distributors.

"But often it's possible to better these specs considerably if parts averages permit. We can take advantage of this by setting factory standards higher. However, such decisions take nice judgment. The other face of the coin might involve production stalled at costs of hundreds of dollars an hour.

"In my lab there's a duplicate production alignment setup. No set can run in production if it does not align and meet engineering specs on this equipment. If it is necessary to change factory equipment for a specific model, it will be done."

I nodded. "Ray, how did you get into this line of work?"

He grinned and his eyes twinkled. "My godfather gave me a cat's whisker, a Quaker Oats box and a coil of wire!"

"Are you joking?"

"No, sir. Building my first crystal set started me off and interested me in radio. Later I took a 2-year course in radio at Crane Technical High School in Chicago.

"In 1945 I went to work for Zenith as an engineering stock chaser. Of course, I was a greenie, but was in a good spot to see how engineers tackled design problems. You might say I got to be a very nosy stock chaser. The men taught me a lot.

"During lunch hour we practiced code in the engineering lab, and in 1947 I got my ham license—K9IZZ.

"Shortly afterward I was transferred to Zenith Consumer Products as an electrical repairman. There I got my first chance to practice applied electronics and get analyzing experience.

"My taste of the engineering and analyzing approach made me want more of the same. Ham radio gave me the opportunity to upgrade my knowledge. I became a 'home-brew 'artist. Using Q meters, impedance bridges, generators and such in my own design gave me a tremendous advantage over analyzers with only basic theory.

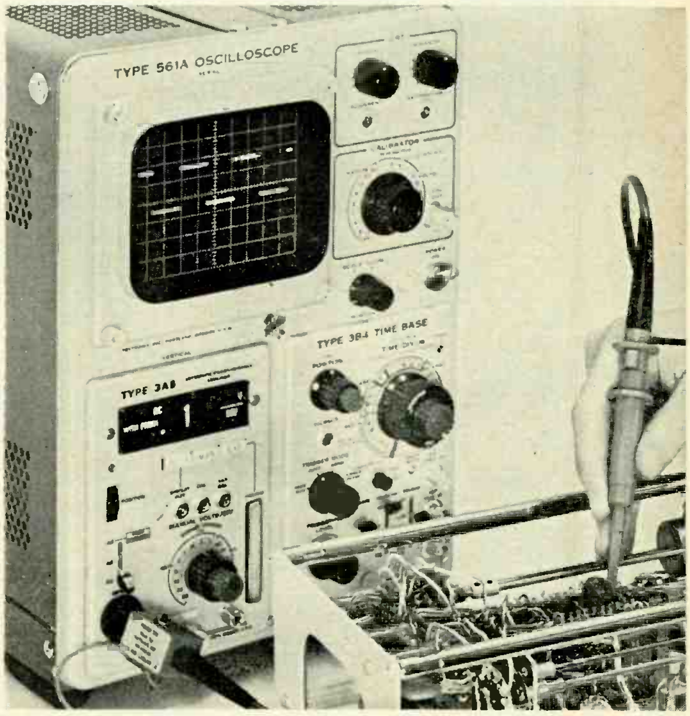
"Many of the projects I designed and built took firsts in ham radio contests, and that gave me an incentive to continue. I directly attribute my first real break at Zenith to my ham radio experience. Forty books couldn't have taught me as much.

"When Zenith Space Command (TV remote control) was under development, I was put in charge of a group of analyzers assigned to that project only. Management felt that my ham radio design background made me the logical choice. This group was in on Space Command from the pilot-run stage all the way to production. The project was a hush-hush first and was quite an experience for all of us."

"Ray, aside from technical knowledge, what one thing will most help a man who tries to become an analyzer?"

"Know the product you are working on. Don't *think* you know it—*know* it! Engrave the schematic and parts layout on your brain! My experience has been that this is the greatest failing of analyzers and would-be analyzers. They do not really take the trouble to know the product." END

Scope Plug-In Unit Seeks Range Automatically



New Tektronix plug-in amplifier for production-line scopes uses transistor logic circuits to eliminate need for resetting vertical sensitivity where signal voltages vary. Range (volts per division of scope graticule) is read out in window at top of plug-in, while the waveform is shown on the screen. In 100 msec, circuits compare signal amplitude with preset reference. If it exceeds reference, pulse from logic circuits fires ring counter, which trips reed-switch attenuator to next higher range. This continues until display is within preset limit on screen.

SCOPE IMPROVERS

Make your scope more useful and convenient. Couple of hours and a few parts are all you need

By ELMER C. CARLSON

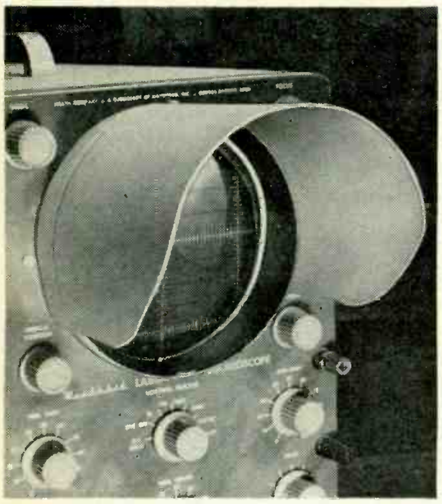


Fig. 1—Light shield over CRT face cuts down glare and confusing reflections.

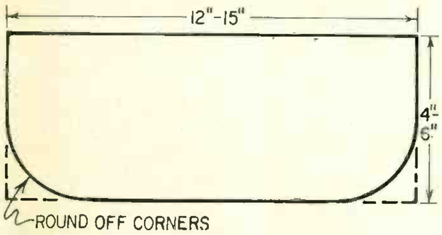


Fig. 2—Sheet metal for light shield of Fig. 1 can be cut quickly with tinsnips.

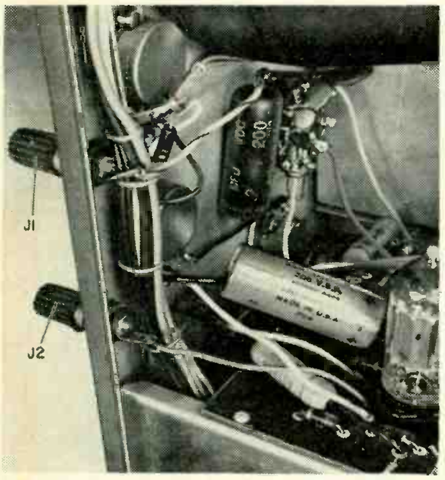


Fig. 3—Two extra binding posts are sawtooth-voltage takeoff point and external capacitance terminal for low sweep frequencies.

CUSTOM-BUILDING A SCOPE EXACTLY THE way you want it is likely to cost more time and money than you can afford. But, as with ready-made clothing, there's a pretty wide variety of designs to choose from, and you can usually select a scope to fill your requirements. But again, like a ready-made suit, your choice needs to be altered to fit just right. Here are a few suggestions for simple modifications that have made my scope more useful.

A light shield

If light reflections make scope waveforms hard to see, make a light shield (Fig. 1) from sheet metal.

Take a piece of aluminum or steel 4 to 6 inches wide and about two-thirds the circumference of the CRT screen (about 12 to 15 inches for a 5-inch CRT). Trim off the corners on one edge (Fig. 2) and bend it around a coffee can about 4 inches in diameter. The spring action of the bent metal will hold this to the scope bezel around the CRT face. A small sheet-metal screw at the top will make a more secure mounting.

Sweeping changes

Two added binding posts on the front panel of the scope (Fig. 3) and two short lengths of wire to connect them to the circuit (Fig. 4) provide a sawtooth source and a terminal where additional capacitance can be connected into the R-C network to increase the time constant, making low-frequency sweeps possible.

Sweep speeds lower than 10 cycles are not often used for servicing but an experimenter may have an occasional need for them. For best waveform viewing, a CRT with a P7 phosphor is required. The normal P1 phosphor has too short persistence with sweep speeds near 1 cycle per second.

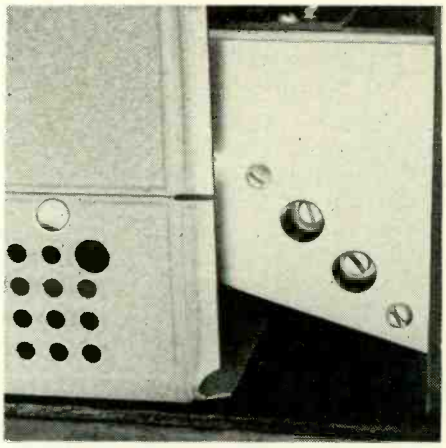


Fig. 5—Holes in cabinet match vertical attenuator compensating trimmers.

Some scopes have a terminal available for taking a signal to allow the vertical input step-attenuator trimmers to be checked. Others just indicate a wiring point or tube-socket pin where such a signal can be found. This often means removing the scope from the case.

If the trimmers are not adjustable from the outside of the scope, it might be convenient to drill two small holes (Fig. 5) through the side of the cabinet. Double-check to make sure the holes will line up with the trimmer adjusting screws before you use the drill.

Follow the scope service-manual procedure for adjusting the attenuator trimmers before attempting to adjust the low-capacitance probe trimmer. Proper and improper traces are given in Fig. 6.

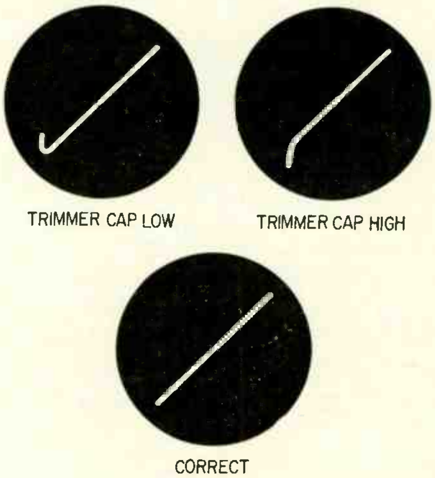


Fig. 6—Sawtooth-against-sawtooth trace checks compensating trimmer adjustment. Follow procedure in scope manual.

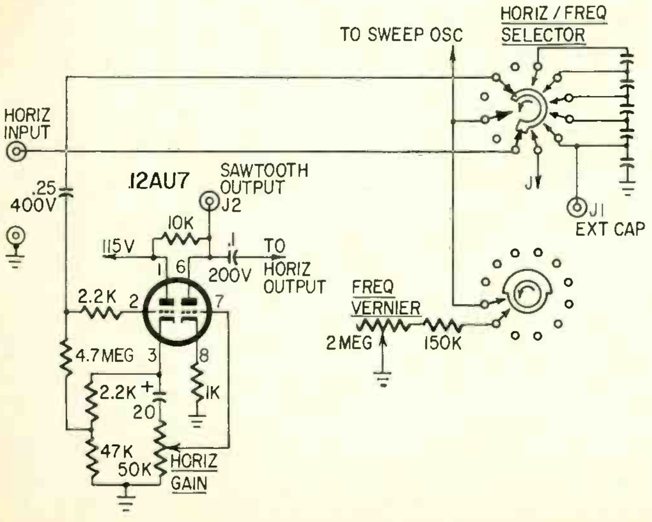


Fig. 4—Partial schematic of horizontal amplifier and sweep frequency selector show where to add binding posts.

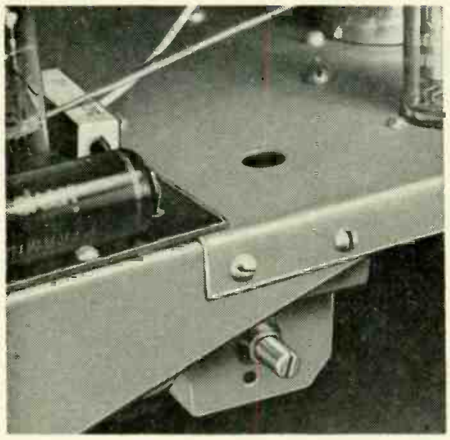


Fig. 7—Mount astigmatism (spot-shape) control were it can be reached easily through a hole in the cabinet.

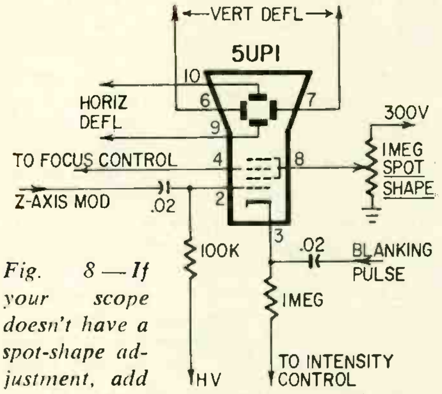


Fig. 8—If your scope doesn't have a spot-shape adjustment, add one like this. You need it for really sharp traces.

While the drill is handy, another hole for the astigmatism (spot-shape) adjustment is useful, particularly where power-line voltages vary considerably. When the voltages to the CRT elements change, spot shape, as well as the focus, is affected.

Many early scopes neglected the astigmatism (spot-shape) control but it is easy and inexpensive to add one once you find a mounting place (Fig. 7) for it. A common circuit is shown in Fig. 8.

A length of tubing slipped over the control shaft will make it easier to find with the screwdriver, if the control shaft end is far from the case wall. Flaring the end of the tubing will make this even easier. This can be done with an inexpensive flaring tool or by an obliging garage mechanic.

Variable-phase 60-cycle sync

The Heath O-11 scope has a 60-cycle *sweep* which is phase-adjustable for use with sweep generators. A simple wiring change (Fig. 9) makes the 60-cycle *sync* phase-variable too.

While the variable sync makes it easy to shift the display waveform of any pattern that is a multiple of the line frequency, it is especially useful for checking vertical sweep distortion in a TV chassis. It allows one cycle to be displayed on the screen for maximum viewing size. Sync can be phased so that the retrace portion of the trace is either at the right, as usual, or at some place near the center as in Fig. 10. END

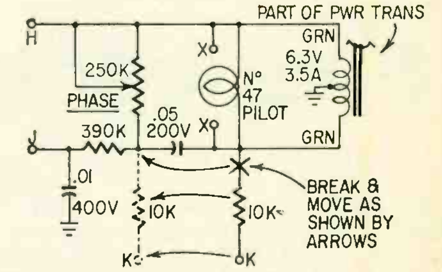


Fig. 9—Phase-variable 60-cycle sync is as useful as sweep. Changing one connection does the job.

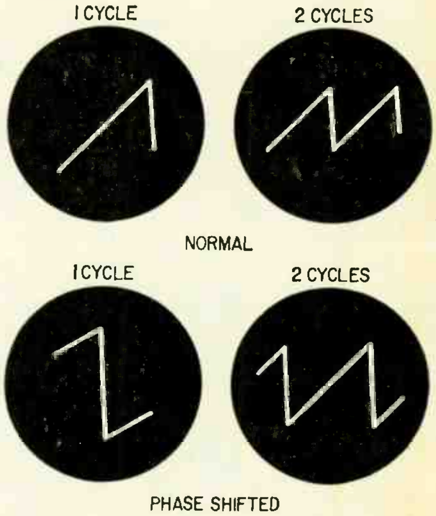


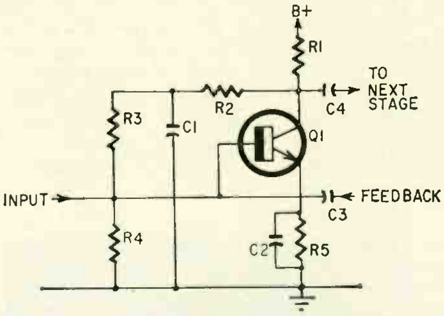
Fig. 10—What you can do with phase-variable sync in viewing TV vertical-sweep waves: center any part of the wave on the screen, and check for parasitics or measure retrace time.

WHAT'S YOUR EQ?

Conducted by
E. D. CLARK

Printed Circuit

Given the following stage from an electronic circuit, find a way to put it on a printed-circuit board without redrawing the circuit.—*William B. Adams*



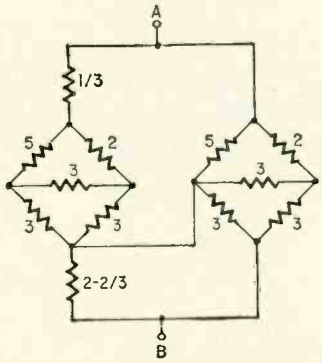
Three puzzlers for the students, theoretician and practical man. Simple? Double-check your answers before you say you've solved them. If you have an interesting or unusual puzzle (with an answer) send it to us. We will pay $10 for each one accepted. We're especially interested in service stinkers or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

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

Answers to this month's puzzles are on page 95.

How Many Ohms?

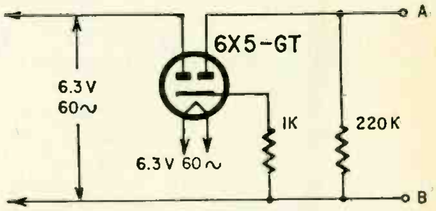
These two unbalanced bridge circuits are tied together at three points.



What's the resistance between terminals A and B?—*E. D. Clark*

Wave-Shaping Circuit

What is the waveform and polarity of the voltage between terminals A and B?—*Kendall Collins*



Wave-Shaping Circuit

50 Years Ago

In Gernsback Publications
In December, 1915
Electrical Experimenter

By Wireless Phone from Arlington to Paris

Audion Bulbs Produce Musical Tones

Vibrating Reed Radio Amplifier

How to Make an Electrolytic Rectifier

By NORMAN CROWHURST

Feedback, Phase & Instability

FEEDING PART OF AN AMPLIFIER'S OUTPUT back to its input out of phase does wonders in reducing distortion and noise and extending frequency response. But it also opens a Pandora's Box of subtleties, which are worth knowing about in some detail if you enjoy designing, modifying, or just understanding high-quality amplifiers.

A feedback loop connected in the most conventional way (Fig. 1) usually contains a phase-compensating capacitor. This is a convenient point at which to make small adjustments in the amplifier's overall response. If the response from input to output is level, then because of the phase-compensating capacitor, the response from the output back to the cathode will have a high-frequency boost (Fig. 2). This means that the loop gain from the grid as input point back to the cathode as feedback insertion point must be given a corresponding high-frequency boost, if the overall response measured externally is to be flat.

In measuring amplifier phase and feedback performance, a very important factor is how the input and output circuits, particularly the latter, are loaded. Change in output loading, from nominal resistance load to open circuit, or to loudspeaker load, either dynamic or electrostatic, can make a tremendous difference to these phase measurements, as well as to the response, as normally measured.

Loudspeakers

Another realm where we hear quite a bit about phase concerns loudspeakers. Measurements can help here too, and may dispel some of the misstatements one hears.

To check the phasing of different units in a multiway system or of complete loudspeaker systems either on single-channel or stereo, apply a suitable frequency to the input of the system, and use it as a phase reference. For multiway systems, use the crossover frequency, so the two units give out the same relative level. For separate channels use a fairly low frequency to avoid ambiguity and, in a stereo system, parallel the inputs to give in-phase operation.

Now place the microphone so it is a short distance, and the same distance, from the units being phased (Fig. 3). Switch off each unit in turn to see what the phase angle of the other unit is and thus check that the phase angle of both are in the same region. It may vary by a few degrees between the two units, but the important thing is to see that the phase difference between them is within a few degrees of 0° and not a few degrees of 180°. More about this in a minute.

We sometimes get statements about the phase *response* of a speaker. This cannot be checked with a microphone because the sound has to travel from the loudspeaker to the microphone, which takes time—an interval which corresponds with a phase angle that is proportional to frequency, and at the high-frequency end is probably many wavelengths (or n × 360°).

The only way to measure the phase performance of the speaker is to use a motion-sensing coil on the diaphragm. A simple way to do this is to cement lightly a turn or two of fine wire out in front of the voice coil, where there will be enough leakage field to indicate direction and phasing of movement by the voltage developed (measured on a scope screen), if not to show the linearity (because the field itself will be nonlinear). With this setup, the phase relation between drive current, or voltage, and voice-coil motion can be measured. Also, a rough indication of the response of the speaker drive mechanism, as distinct from its external acoustic response as measured with a microphone in an anechoic chamber, can be obtained (Fig. 4).

The impedance characteristic of a speaker can be measured, in both magnitude and phase, by a similar technique, by comparing voice-coil current with its terminal voltage. None of these measurements will get beyond a range of ±90°, but phase and magnitude measurements can help in determining the effectiveness of an enclosure in conforming to theory—for example, how a bass reflex achieves its phase reversal.

Equipment and method

So much for the phase measurements that can be made and are useful in audio and high-fidelity work. Now for how to make them. A very simple method uses the comparator ellipse on an oscilloscope (Fig. 5). The "reference" voltage is fed into the "horizontal" terminals of the scope, with the switch in the "external" position. The output, or whatever voltage whose phase relation to the reference is required, is connected to the usual "vertical" input.

A line sloping one way represents in-phase condition, while one the other way represents 180°. In between come ellipses, which can best be interpreted for phase by adjusting the deflection so the height is equal to the width (center group of patterns in Fig. 6). The phase can be recognized by identifying it in the family shown in Fig. 6. If the slope is nearer the in-phase line, the reading gives phase angle direct. If the slope is the opposite way, subtract the reading from 180°.

If the oscilloscope method is used for phasing speakers, adjust the distance of the microphone from the speakers to get a line, or approximately a line trace, rather than something near to a circle. Phase reversal from a circle gives another circle. Phase reversal from a sloping line reverses the slope. So the latter readily permits distinguishing 0° from 180°, which the circle does not.

If the device whose phase is measured produces some harmonic distortion, the comparator method also indicates the phase of the harmonics, as well as the fundamental, although precise evaluation of fundamental phase is a little more difficult. To aid in interpreting "odd shapes," Fig. 7 tabulates possibilities with the simpler harmonics.

Another method is to use an electronic switch with a scope so both wave-

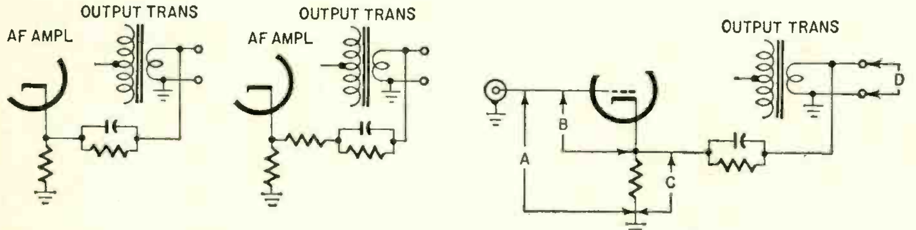


Fig. 1—Different ways in which phase compensating capacitor can be connected in feedback.

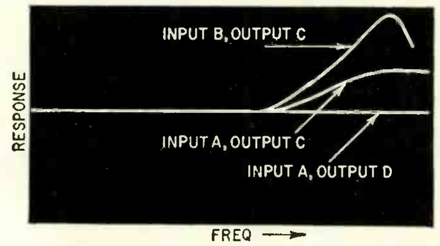


Fig. 2—Why use of a capacitor in feedback means loop gain response must show peaking.

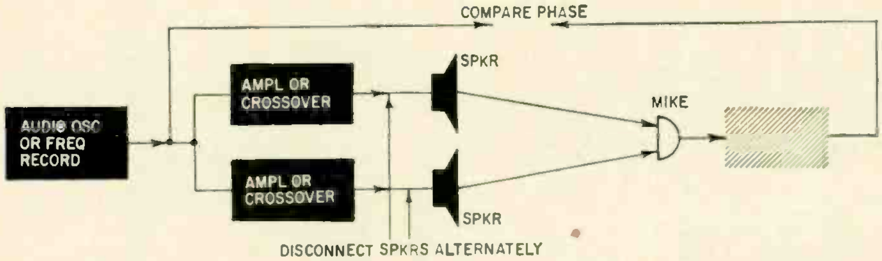


Fig. 3—Using a microphone to check phase of speakers, whether multiway or separate system.

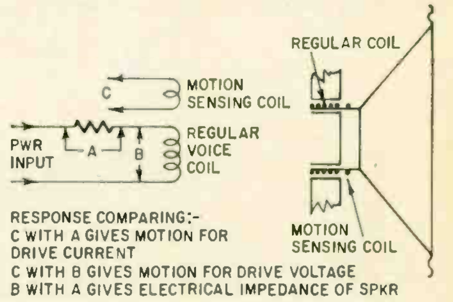


Fig. 4—Using motion sensing coil on dynamic speaker can provide more detailed information about speaker's performance.

forms can be displayed on the same screen (Fig. 8). Then phase is simply measured as a fraction of the complete wave. If both waves are not pure sine waves, it may be difficult to assess precisely the lateral distance representing phase difference on the scope.

Finally, an even more elaborate device has the advantage of being able to measure phase and give a direct indication. This is done by first converting both waves into square waves by clipping, using a circuit known as an automatic mark-space control to make the top of the square wave equal to the bottom. This works on an avc principle. Finally, the square waves are used to control the current in a "gating" circuit. Current flows only for the part of a cycle during which the square waves are opposite. Thus in-phase square waves give no current—zero phase. Out-of-phase square waves give current for a complete half-cycle—180°. Intermediate readings are proportionate, and a simple integrating meter that reads average current will give a direct reading of phase in degrees, independent of frequency (Fig. 9).

One thing should be apparent from this article: phase reading is always relative. You always have to compare the phase of one waveform with that of another of the same frequency related to it. There is no such thing as a 1,000-cycle note coming out of a loudspeaker "out of phase." It has to be out-of-phase *with something else*. This seems obvious enough, but it is surprising how often one reads or hears a statement about phase without any mention of the reference point. END

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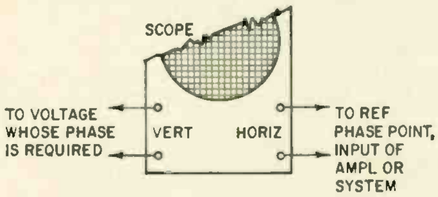


Fig. 5—The oscilloscope comparator method is simple to set up.

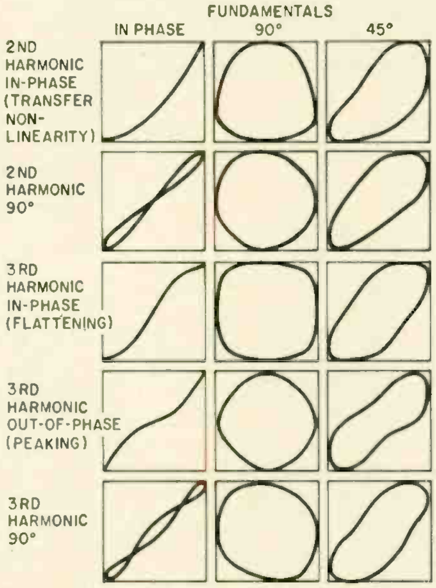


Fig. 6—How phase is indicated using the comparator method.

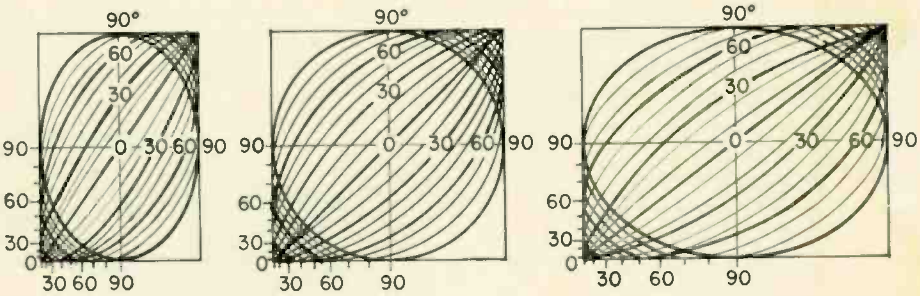


Fig. 7—How presence of harmonics in different phase relationships in output waveform alters trace.

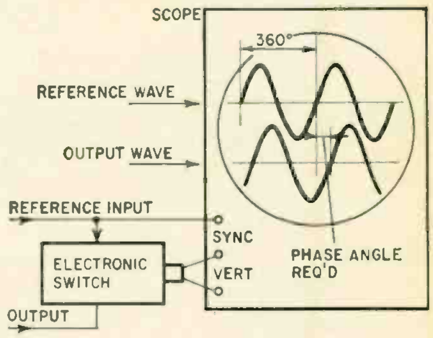
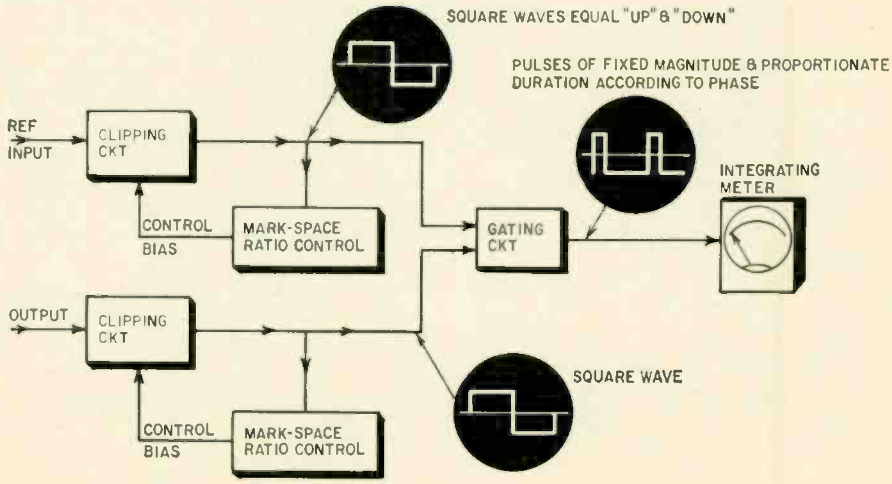


Fig. 8—Method of measuring phase using an electronic switch with a scope.

Fig. 9—Operating principle used in direct-reading phase meters.



Used in industry and in laboratories all over the world, this vacuum-monitoring tube is much like an ordinary triode

THE ION GAGE – A Tube Looking for a Vacuum

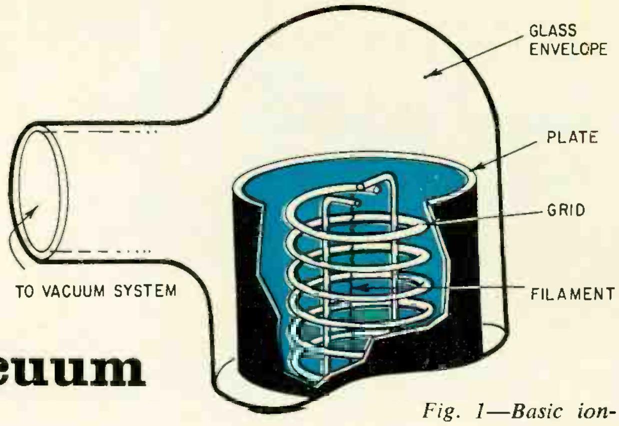


Fig. 1—Basic ion-gage structure.

By T. F. SINCLAIR

EVERY SERVICE TECHNICIAN KNOWS the "gassy" electron tube. When a receiving tube partially loses its vacuum, it acquires drastically different operating characteristics and can no longer work properly in its circuit. Substituting a well evacuated replacement cures the trouble.

A not-too-distant cousin of the common electron tube is *designed* to operate in partial vacuums. The resulting changes in its operating characteristics measure very low gas pressures (vacuums). The *hot-filament ionization tube*, more commonly known as the *ion gage*, is an electronic vacuum gage that has been used by vacuum technologists for several decades.

Measuring vacuum has become particularly important in recent years with the growth of industrial vacuum processes. The preparation of ultra-pure materials for semiconductors and the deposition of thin-film circuits are two important processes carried out in a vacuum. Of course, our tremendous program in space exploration requires producing and measuring extreme vacuums to simulate the conditions of outer space. The ion gage serves as the workhorse of the vacuum industry. Measuring pressures from a millionth of an atmosphere to ones a million times lower again, the ion gage operates over the range most useful to modern technology.

Ion-gage control unit. Meter is calibrated in pressure and in altitude.

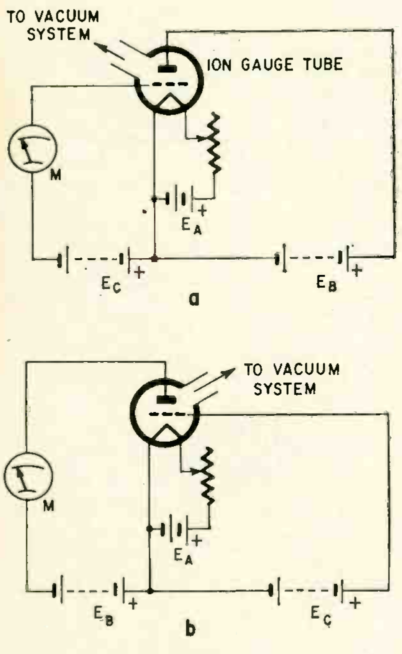


Fig. 2—Simple circuits for measuring vacuum with an ion gage. a—Grid maintained negative. b—Plate maintained negative for greater stability and sensitivity.

How it works

The ion gage has much in common with the familiar electron tube. The arrangement of electrodes in the basic gage is very similar to that in a triode electron tube. In fact, early vacuum workers used ordinary triodes as vacuum gages. The ion-gage structure (Fig. 1) consists of a tungsten filament, centrally placed inside a spiral-wound wire grid. The plate is a metal cylinder which surrounds both the filament and the grid. The electrodes are then enclosed in a glass envelope which connects to the system under vacuum.

When the filament is heated, it emits electrons which are accelerated by the grid toward the plate. These fast-moving electrons have a good chance of hitting a gas molecule between the grid and the plate. If an electron and a gas molecule collide, the energy of the impact may cause the molecule to release one of its own electrons. This process is called *ionization* and a molecule stripped of an electron is a positive *ion*.

The number of positive ions formed is directly proportional to the gas pressure in the gage tube. If the plate is maintained at a negative potential, it will collect the positive ions formed. The ion current which then flows in the circuit is a direct measure of pressure in the gage tube.

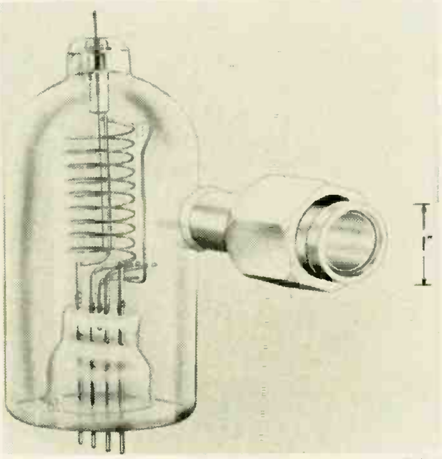
Ion-gage circuits

Two simple circuits which may be used to measure the ion current are shown in Fig. 2. The schematic in Fig. 2-a should be familiar to electronic technicians—it is very similar to a typical triode amplifier. In this arrangement the *grid* is negatively charged and collects the positive ions. Meter M indicates the ion current flowing in the grid circuit and may be calibrated directly in pressure units. Although this hookup is not particularly stable or sensitive, grid current has been used by electron-tube makers to indicate the pressure in sealed-off vacuum tubes.

A more sensitive gage can be obtained if the *plate* is used as the negative electrode, as in Fig. 2-b. Sensitivities are greater by at least a factor of 2 with this circuit. Ion current flowing in the plate circuit is indicated by meter M. The variable resistor in the filament lead is an emission control. This control is adjusted to maintain a constant current between filament and grid for stable operation. Typical operating potentials would be 150 volts on the grid and −45 on the plate.

These simple circuits bring up several problems. The heater current has to be maintained constant manually in a system where the composition and pressure of gas are changing. Also, the ion currents are very small and the sensitivity of the meter limits the range of the instrument. Electronic control circuits and high-gain amplifiers have been developed to overcome these difficulties.

Commercial ion-gage control circuits have automatic emission regulators. In some, saturable reactors hold the emission from the filament constant with changes in line voltage or pressure.

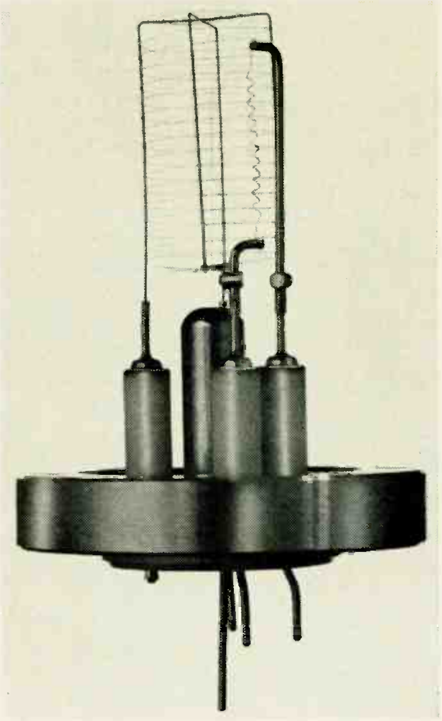


RCA
Fig. 3—Inverted-structure ion gage

The ion current amplifier is usually a multistage, electrometer type circuit with 100% negative feedback. In addition, a safety shutoff feature is often provided that will automatically turn off the power to the filament when the pressure inside the gage becomes too high. Special modifications are also available. The control unit shown in the photo has a readout meter calibrated in altitude as well as pressure.

Limits of operation

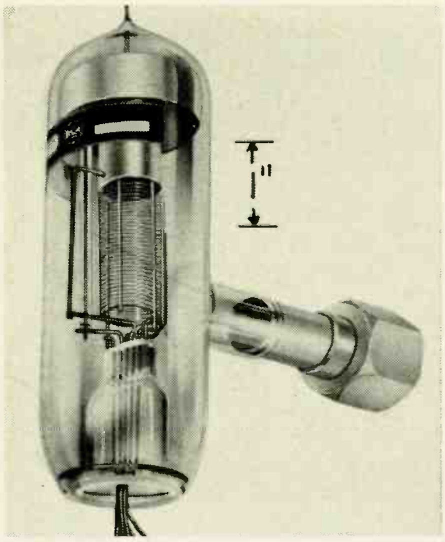
The basic ion gage has limits of operation at both the high and low pressure ends of its range. At gas pressures greater than a millionth of an atmosphere,



Varian Associates
Fig. 4—"Nude" ion gage with inverted structure, for direct insertion into vacuum system. Such a unit can cost $150.

the ion current tends to saturate and levels off at a constant value which is independent of pressure. High concentrations of reactive gases inside the gage cause rapid failure or burnout of the filament. Fortunately, other vacuum gages operating on the thermal-conduction principle perform satisfactorily in this range of pressures.

At the other end of the scale, the measurement of very low pressures is limited by the emission of X-rays, which are formed when the ionizing electrons



RCA
Fig. 5—Suppressor type ion gage with inverted structure, for ultra-high-vacuum measurements.

strike the grid wire. The X-rays fall on the plate and release photoelectrons which cause a current to be produced at the plate. This current is of the same sign as the ion current but it is independent of pressure. At very low pressures the ion current becomes less than the current caused by the X-rays, and the gage has reached its useful limit.

Modifications for lower pressure

The development of an inverted-structure ion gage has extended the lower limit of the hot-filament ion gage by a factor of at least 200. The inverted gage (Fig. 3) has the filament *outside* the spiral-wound grid. The plate is reduced to a single, fine wire suspended inside the grid. The plate is several hundred times smaller than the usual metal cylinder and receives only a fraction of the X-rays produced at the grid. Because of its lower operating limit, the inverted-structure gage has become the standard measuring instrument for workers in the ultra-high vacuum field.

UNITS OF VACUUM

Any pressure less than atmospheric pressure is considered to be a vacuum. While early workers in the field measured vacuum in inches or centimeters of mercury, modern vacuum technologists express low pressures in terms of the absolute unit: *torr*. One *torr*, named after Torricelli who discovered the principle of the barometer, is equal to 1/760 of a standard atmosphere. Therefore, normal atmospheric pressure may be considered to be 760 *torr*. The pressure in a typical vacuum tube is about 1×10^{-6} or .000001 *torr*. The basic ion gage, described in this article, has a useful range from 1×10^{-3} *torr* to about 1×10^{-9} *torr*.

Vacuum technology is closely associated with space exploration. The table here shows the degree of vacuum that would be encountered at various heights above the earth's surface.

Height in miles	*Pressure in torr*
Sea level	760 or 7.6×10^{2}
10	1×10^{2}
100	1×10^{-5}
1,000	1×10^{-11}
Interplanetary space	1×10^{-16}

The walls of the glass envelope and the tube connecting the gage to the vacuum system sometimes interfere with accurate measurements. To overcome these problems, the ion gage is available in an unenclosed or "nude" form (Fig. 4). The electrodes are sealed directly into the vacuum system.

Several other design modifications have been employed to extend the useful range of the hot-filament ion gage. As an example, the gage tube in Fig. 5 has added elements in the form of a suppressor ring and a collector shield, which aid in extending the limits of vacuum measurements.

The common electron tube and the highly specialized ion gage have much in common. The service technician who pulls a "gassy" tube and the scientist who measures high vacuums with an ion gage are dealing with the same problem. They both have a vacuum tube that needs a vacuum. END

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EQUIPMENT REPORT

Sonotone RM-2 Speaker System

Circle 37 on reader's service card

SONOTONE'S RM-2 IS A RECENT ADDITION to what is now a family of three speakers. It all began about a year ago with the RM-1, a midget system with a 6-inch woofer. Now redesigned, the RM-1 is flanked by two newer designs: the baby, whimsically named the RM-0.5, and a big brother, the RM-2, which has an 8-inch woofer and a 3-inch cone tweeter.

Measuring 19 x 12 x 8 inches, the RM-2 cabinet is sturdily built of walnut-veneered chip-and-resin board (great stuff for nonresonant boxes—even better than plywood), with lots of corner bracing. The back is fastened with a generous number of screws (12), spaced an average of about 6 inches around the edges. No rattles here.

This rugged box is completely filled by two thick blocks of glass wool; there is virtually no "empty" air space in the enclosure. The somewhat paradoxical result, as any acoustician will be happy to puzzle you with, is an enclosure effectively quite a bit larger than its actual structural size. This technique, related to that of the acoustic suspension speaker systems, is being used in a large number of bookshelf-size speakers.

The woofer is brought out to the terminals through a coil, to keep high frequencies out of it, and the tweeter is connected through a capacitor (to block lower frequencies) and a potentiometer, which allows its output to be varied between nothing at all and full volume. The nominal crossover frequency is 4,500 cycles; the nominal impedance, 8 ohms.

The RM-2 sounds pleasant and listenable. At the manufacturer-recommended tweeter control setting of 8, the highs are rather steamy, which isn't irritating, because it's smooth, but just a bit unnatural. In any case, the control permits adjustment to suit individual taste. High-frequencies are beamed somewhat, as is typical of most simple cone tweeters.

At low frequencies, there is some doubling below about 80 cycles. This is not a serious flaw. All speakers—even big ones—begin producing more second-harmonic than fundamental eventually, as you go down the scale. Second-harmonic distortion is mild, inoffensive stuff; the ear can tolerate large amounts of it without being disturbed—sometimes without even noticing it, and it gives a satisfying illusion of real bass.

(A popular radio design of the 30's and 40's used an audio amplifier that, with the help of a simple R-C feedback network, generated controlled amounts of second- and third-harmonic distortion, while suppressing the fundamental below about 150 cycles. This predistorted audio, fed to a 5-inch speaker, produced amazingly full sound. It was called *synthetic bass.*)

The RM-2 isn't guilty of a tubby or boxy sound, characteristic of many small systems. What is missing is really only the gut-rumbling bass around 50 cycles that only two or three of the small bookshelf speaker systems can produce. (And they cost more than the RM-2.)—*Peter E. Sutheim*

EICO Model 342 FM Multiplex Generator

Circle 38 on reader's service card

JOINING THE LIST OF LOW-COST, EFFICIENT instruments for testing and aligning FM stereo multiplex circuits as well as complete stereo FM receivers, the model 342 just introduced by Eico proves to be design-lab quality at service-bench cost. The model 342 has extraordinary circuit refinements to insure excellent separation in the composite stereo signal. The measured separation capability of this instrument actually exceeded the 40 db claimed in the specifications. When you recall that the FCC requires only 30-db separation from *broadcasters*, the significance of this outstanding figure can be fully appreciated.

It is perhaps this refinement in design which prompted Eico to offer the model 342 in wired form only. The average kit builder might well find it difficult to calibrate this instrument to the precision that can be achieved in the factory. After subjecting the unit to several hours of continuous use, I noticed absolutely no drift in the alignment of the circuits that produce the composite stereo waveform. The rf signal (available as a convenience in aligning tuners or receivers) did drift during warmup, but this is not serious. Simply tune the receiver under test to around 100 mc until the test signal is found.

The model 342 has both a controlled amplitude composite audio output for direct injection into multiplex circuits (beyond the detector), and the same signal—modulating an FM rf carrier at about 100 mc with controlled deviation (±75 kc)—for connection to the antenna terminals. Either a built-in 1-kc audio oscillator or an external oscillator may be used for left-only, right-only, difference (L − R) or sum (L + R) signals. The 19-kc pilot signal is crystal-controlled and may be switched on and off independently of the composite signal. A signal can also be set up without audio information and only the 19-kc pilot.

A scope sync output offers a choice of either 19-kc sync or 1-kc sync. The 342 also has an input for connecting an external audio oscillator to provide an SCA (background music subcarrier) signal when required.

Another important feature of the model 342 (and one not found on most competitive units) is a pair of inputs and isolation amplifiers for a stereo program source to permit FM stereo demonstrations to customers when there are no stereo programs being broadcast. The amplifiers even pre-emphasize the program material properly (75 μsec), just like an FM broadcast transmitter, so that tone controls do not have to be radically altered from flat when the program is heard on a receiver with normal de-emphasis.

While an rf signal is very handy in evaluating the performance of a complete tuner or stereo receiver, I felt that the signal strength of the 100-mc carrier in the model 342 is so great that it prevents judging a receiver's stereo performance under "weak signal" conditions. Of course, the rf cable can be removed from the antenna terminals of the receiver being tested to approximate a weak signal, but then there is no way of knowing *how* weak the signal is. In other words, some form of calibrated attenuator would have been desirable to allow the unit to double as a general FM rf generator. But in view of its superior performance for aligning multiplex sections of receivers, this minor omission certainly does not detract from the very fine qualities of this compact, well designed instrument.—*Leonard Feldman*

MANUFACTURER'S SPECIFICATIONS

Separation: 40 db minimum from 200 cycles to 10 kc; 30 db minimum from 50 cycles to 15 kc.
Composite signal output: 0–5 v p-p, continuously variable; output impedance 1,500 ohms
Rf output: 200 millivolts; output impedance 50 ohms
Pilot frequency: 19 kc ±2 cycles, crystal controlled
Signal selection: L + R, L − R, L only, R only, 19 kc only, external stereo source
Power requirement: 117 vac, 50–60 cycles
Size: 8½ x 5¾ x 12½ inches
Weight: 10 lb
Price: $149.95 (wired only)

Continued on page 68

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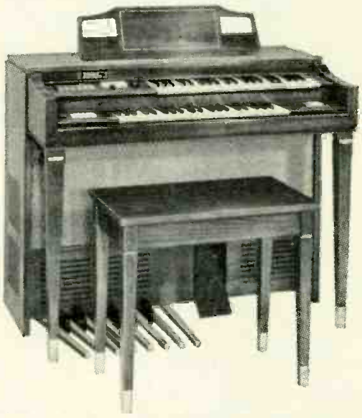
Kit GR-43
$159.95

New Heathkit 10-Band Transistor Portable!

10 bands tune Longwave, Standard Broadcast, FM and 2-22.5 mc Shortwave. 16 transistors, 6 diodes, and 44 factory assembled and pretuned circuits. Two separate AM & FM tuners and IF strips. FM tuner & IF strip are same components used in deluxe Heathkit FM stereo gear. 2 built-in antennas. Battery saver switch cuts current drain up to 35%. Rotating tuning dial. Dial light. 4 simple controls for tuning, volume, tone, AFC and band switching. 4" x 6" PM speaker. Earphone & built-in jack. Optional 117 v. AC converter/battery charger available @ $6.95. Time zone map & "listener's guide." Man size: 13½" W x 5⅛" D x 10⁵⁄₁₆" H. 17 lbs.



Kit GD-983
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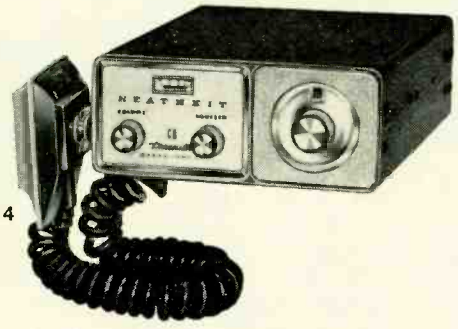


Kit GW-14
$89.95

Assembled GWW-14
$124.95

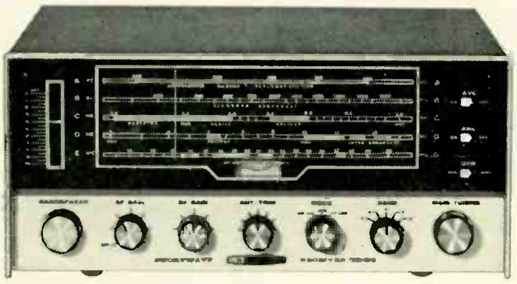
New 23-Channel, 5-Watt Transistor CB Transceiver!

23 crystal-controlled transmit & receive channels for the utmost reliability . . . at competitive prices! All-transistor circuit for instant operation, low battery drain . . . only .75 A transmit, .12 A receive. Only 2⅞" H x 7" W x 10½" D . . . ideal for car, boat, any 12 v. neg. gnd. mobile use. "S" meter, adjustable squelch, ANL, built-in speaker, ceramic PTT mike, aluminum cabinet. 8 lbs. Kit GWA-14-1, optional AC power supply, 5 lbs., $14.95.

Kit SB-100
$360.00

New DeLuxe 5-Band SSB Ham Transceiver

Full SSB-CW transceive operation on 80-10 meters. 180 watts PEP SSB—170 watts CW. Switch select for USB/LSB/CW operation. Operates PTT and VOX; VOX operated CW with built-in sidetone. Triple Action Level Control™ allows greater variation in speech level. Heath SB series Linear Master Oscillator (LMO) for true linear tuning. Mobile or fixed operation with appropriate power supply. 23 lbs. Accessory mobile mount, SBA-100-1 $14.95.



New Deluxe Shortwave Radio

Kit GR-54
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Compare it to sets costing $150 and more! 5 bands cover 200-400 kc, AM, and 2-30 mc. Tuned RF stage, crystal filter for greater selectivity, 2 detectors for AM and SSB, tuning meter, bandspread tuning, code practice monitor, automatic noise limiter, automatic volume control, antenna trimmer, built-in 4" x 6" speaker, headphone jack, gray metal cabinet, and free SWL antenna. 25 lbs.

Kit HD-10
$39.95

New Heathkit Solid-State Electronic Keyer

All solid-state circuitry. Speed range—15 to 60 words per minute. Solid-state switching—no relays to stick or clatter. Adaptable to either right or left handed operators. Convertible to semi-automatic operation. Variable dot-space ratio. Self-completing dashes. Sealed switches on paddle—no exposed contacts to clean or adjust. Built-in paddle—"feel" is adjustable to your fist during assembly. "Hold" switch for transmitter tuning. Transformer-operated power supply isolates keyer from line power. Fused for protection. 6 lbs.

Circle 34 on reader's service card

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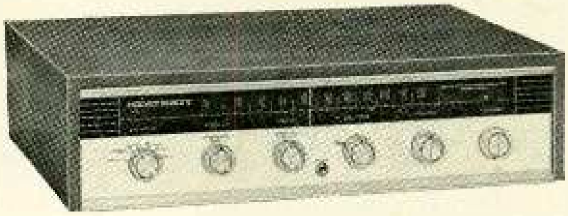
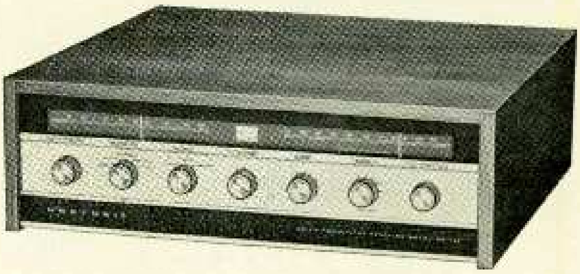
Now Choose From 2 Heathkit® Transistor Stereo Receivers!





New 30-Watt Transistor FM Stereo Receiver . . . Less Than $100!

Features 31 transistors, 11 diodes for cool, natural transistor sound; 20 watts RMS, 30 watts IHF music power @ ±1 db, 15 to 60,000 cps; wideband FM/FM stereo tuner plus two preamplifiers & two power amplifiers; front panel stereo headphone jack; compact 3⅞" H x 15¼" W x 12" D size. Assembles in 20 hours or less. Custom mount it in a wall, or optional Heath cabinets (walnut $9.95, beige metal $3.95) 16 lbs.

Kit AR-14
$99.95
(less cabinet)

66-Watt Transistor AM/FM Stereo Receiver

Just add 2 speakers for a complete stereo system. Boasts AM/FM/FM Stereo tuning; 46-transistor, 17-diode circuit for cool, instant operation and natural transistor sound; 66 watts IHF music power (40 watts RMS) at ±1 db from 15 to 30,000 cps; automatic switching to stereo; preassembled & aligned "front-end" & AM-FM IF strip; walnut cab. 35 lbs.

Kit AR-13A
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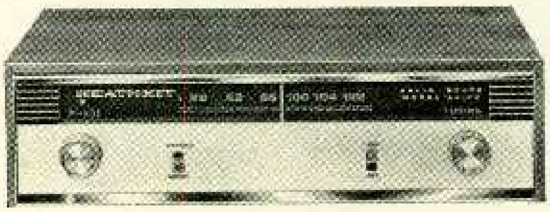

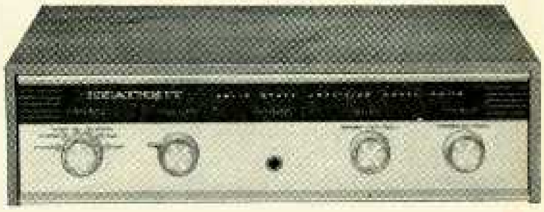

New Transistor FM/FM Stereo Tuner

Heath's easiest to build stereo/hi-fi kit . . . takes only 4 to 6 hours! 14 transistor, 5 diode circuit for cool instant operation, transparent transistor sound. Phase control assures best stereo performance. 3 transistor "front-end" plus 4-stage IF section. Filtered outputs for direct stereo recording. Automatic stereo indicator light. Preassembled & aligned "front-end." Install in a wall or either Heath cabinet (walnut $7.95, beige metal $3.50). 6 lbs.

Kit AJ-14
$49.95
(less cabinet)

Matching 30-Watt Transistor Stereo Amplifier

Assembles in 10 hours or less! 17 transistors, 6 diodes. 20 watts RMS, 30 watts IHF music power @ ±1 db, 15 to 60,000 cps. No audio transformers . . . assures minimum phase shift, extended response, lower distortion. Solid-state power supply plus electronic filter for regulation within 10%. Accommodates phono, tuner, auxiliary . . . 4, 8, 16 ohm speaker impedances. Lighted panel. Installs in wall, or Heath cabinets (walnut $7.95, metal $3.50). 10 lbs.

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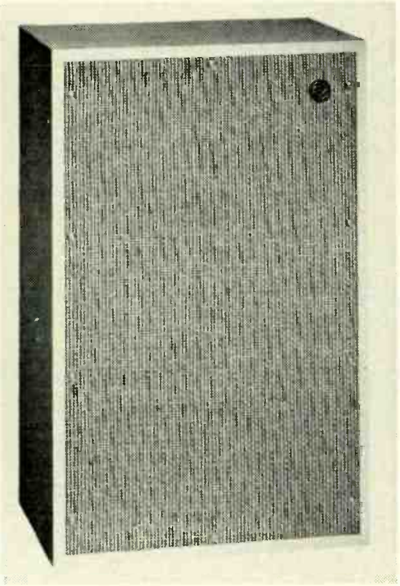
CL-227

Electro-Voice Sentry II Studio Monitor Loudspeaker

Circle 39 on reader's service card

DURING A RECENT TRIP THROUGH THE Midwest, I stopped, among other places, at Electro-Voice. There I was introduced (among other things) to a special kind of speaker I hadn't come upon before. It was Electro-Voice's Sentry II studio monitor loudspeaker. It is, the manufacturer claims, designed for extremely smooth, flat response and lack of coloration, and intended for use as a broadcast or recording studio monitor, rather than to satisfy someone's conception of "what the public wants."



The Sentry II is a big box. It measures 32 by 20 by 13 inches outside, which amounts to an internal volume of about 7,000 cubic inches, or about 4 cubic feet. It contains a 12-inch Electro-Voice SP-12B woofer and a small horn tweeter, with, I would guess, a pretty high crossover point, judging by the size of the tweeter horn. E-V does not specify the crossover frequency. The enclosure, built of ¾-inch stock, is a bass-reflex type with a 6½-inch duct behind the port. About an inch of acoustic padding lines about half the inside surface of the enclosure.

Extensive listening on all kinds of music and on speech showed that the Sentry II is indeed free of a particular "color", and in general has an easy, effortless quality of reproduction that usually comes only from the biggest speaker systems. The high end is bright, and there is a suggestion of either a peak or some harmonic distortion somewhere in the lower treble. (However, I listened to it in a hard, bright room. Broadcast studios and control rooms are usually heavily padded with acoustic tile.) The overall sound is smooth and extremely pleasant.

Bass goes quite low; there is plenty of power at 50 cycles and still some audible output at 30, though much of what comes out at 30 cycles input is really 60 and 90 cycles. About 35 cycles is the "true bass" limit of this speaker. Absolutely no effort has been made, apparently, to firm up the bass end to please a bass-happy public. And the bass is *flat*, praise 'em—no boom, no heavy one-note emphasis.

The Sentry II is at least about four times more efficient than acoustic-suspension and other sealed-enclosure designs. (Studio monitoring amplifiers generally produce between 10 and 25 watts output; the 50-, 60-, 100-watt monsters that have become so common in the hi-fi field are almost unknown in broadcast studios.) Such a high efficiency makes it practical to fill a room with sound from a 5-watt amplifier, or, to look at it another way, almost every high-quality amplifier on the market today would simply loaf along even at high-power orchestral passages. About ¾ (electrical) watt at 100 cycles fed to this speaker makes a loud noise in a 10 x 15 room.

This is definitely not everyman's speaker. (Electro-Voice obviously knows this, for it has not promoted the Sentry II among audiophiles.) But if you think you might be happy with an "austere" speaker—one that doesn't have any "warmth," "color," "sweetness," as such, built into it, and you have room for it, you might want to listen to the Sentry II. Its sound, speaking subjectively, is one of great naturalness on speech as well as on music.

Electro-Voice also manufactures a Sentry I, whose electrical and acoustic specifications are the same as those of the Sentry II, but which has a sloping-front cabinet design for mounting between wall and ceiling or halfway up a corner, between two walls. It measures 17 by 37 by 21¾ inches and its profile is just like that of the popular wooden baffles for wall-mounting intercom or paging speakers.

Both Sentry I and Sentry II come with a built-in transformer that can match the system's impedance (nominally 16 ohms) to 150- or 600-ohm lines. Both come in sanded, grain-sealed, light-colored wood cabinets, ready for painting.—*Peter E. Sutheim* END

MANUFACTURER'S SPECIFICATIONS

Frequency response: 30–20,000 cycles
EIA sensitivity rating: 49 db
Impedance: 16, 150 or 600 ohms
Power-handling capacity: 20 watts
Size: 32 x 20 x 13 inches
Weight: 68 lb.
Price: $159.
Electro-Voice, Inc.

ADD A ZERO-SETTER TO YOUR AC VTVM

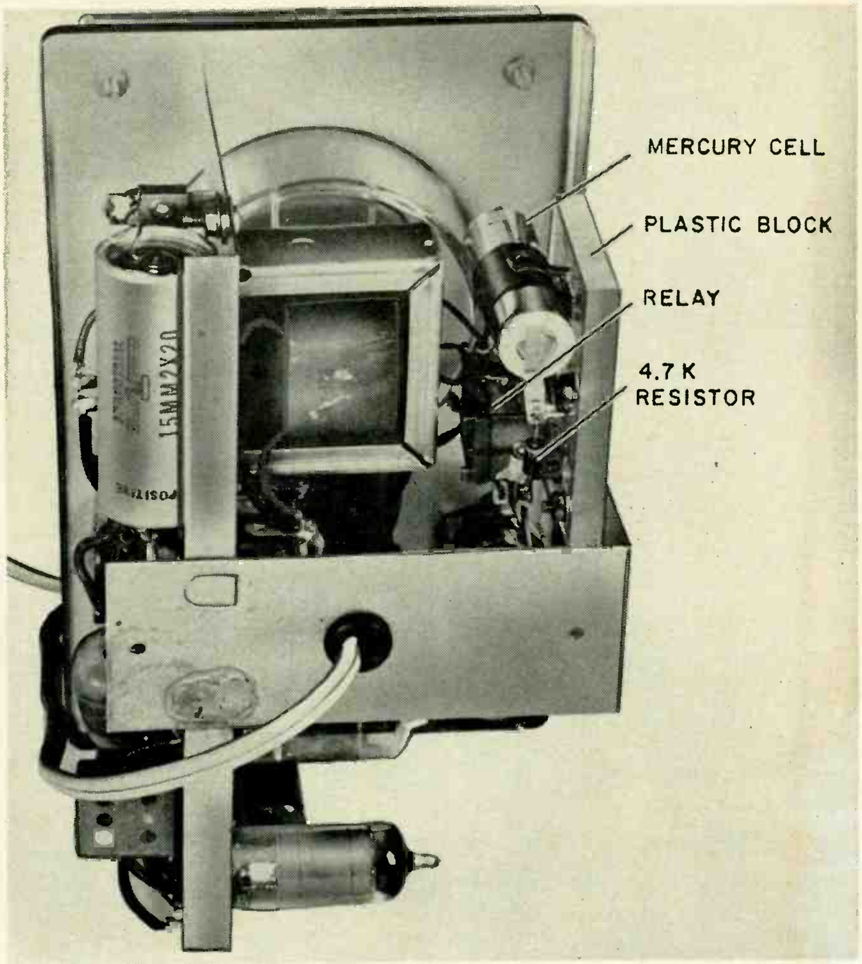
A few parts can stop the nuisance of having to subtract residual reading from your audio meter readings

By LYMAN E. GREENLEE

MANY AC VACUUM-TUBE VOLTMETERS never read zero on any range. There is always a small residual indication from internal hum and noise. This reading increases on the lower-voltage ranges because of increased sensitivity. The slightest leakage through the coupling capacitors will add to this residual reading. It would be difficult to select capacitors with such low leakage that there would be absolutely no residual meter reading.

If we introduce a small voltage of opposite polarity across the meter movement, we can force a reverse current through the meter and return the pointer to zero. I did that on my Heath AV-2. Source for this voltage is a mercury cell that can be wired permanently into the circuit. (Current drain is so small that the battery will seldom need replacing.) The reverse current through the meter can be controlled with a series rheostat (R2), and, if we make the resistance large enough, the battery will be virtually out of the circuit at the maximum setting and almost no movement of the meter can be detected. Resistor R3 must be included in series with R2 to protect the meter from accidental overload as R2 is adjusted.

When the instrument is not in use, the battery should be disconnected. There are two ways of doing this. You can replace the power switch with a double-pole double-throw slide switch, or you can use a relay. I happened to have a miniature 5,000-ohm relay in the odd-parts box. It fitted nicely into the available space. The primary advantage of a relay is that it keeps the meter circuit away from the 60-cycle ac line. A double-pole slide switch puts the two circuits very close together, and there is bound to be some leakage in the switch itself.

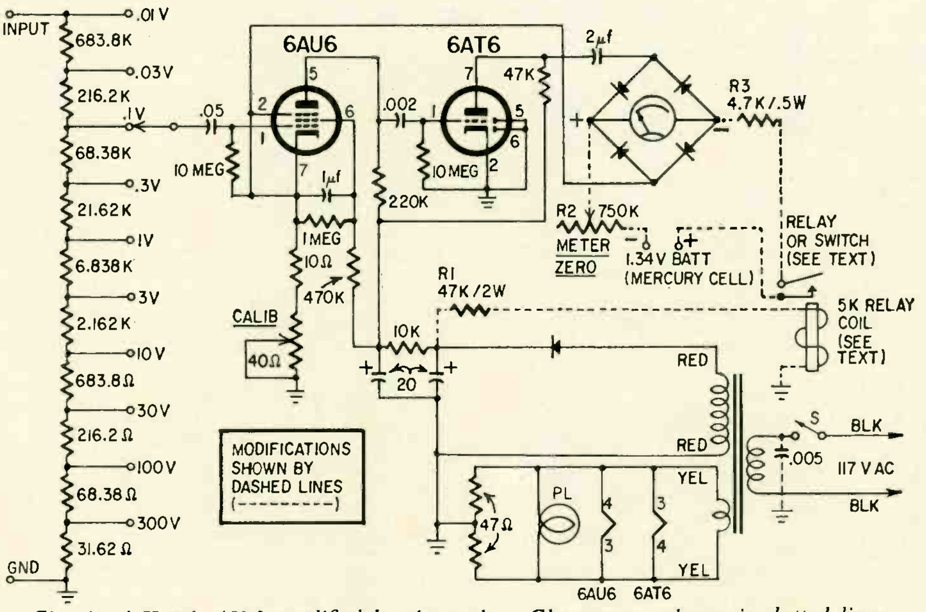


Zero-set parts are mounted on clear plastic block fastened to chassis bracket.

R1 was chosen to allow about 12 to 15 volts drop across the relay coil. The zero adjustment is a 750,000-ohm miniature potentiometer. These miniature "dime size" pots are so small they will fit almost anywhere. The .005-μf ceramic capacitor was added from switch to chassis (ground) to improve the stability on the low ranges.

Set the meter to zero by adjusting the miniature pot with the input terminals shorted. The zero adjustment can also be used to balance out any residual voltage from the circuit being measured; the meter reading will then indicate the actual voltage under observation.

Anyone who goes to the trouble of adding these modifications will find that the results are well worth the small cost and effort. END



Circuit of Heath AV-2 modified by the author. Changes are shown in dotted lines.

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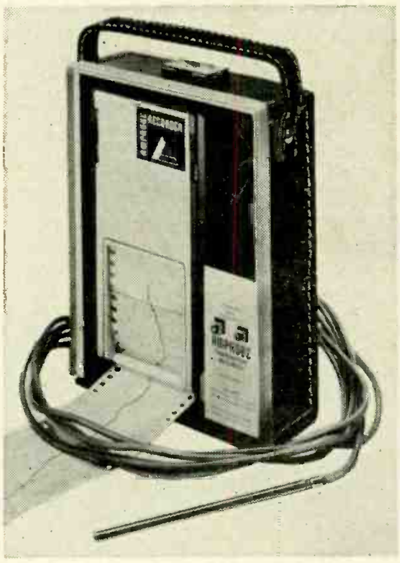
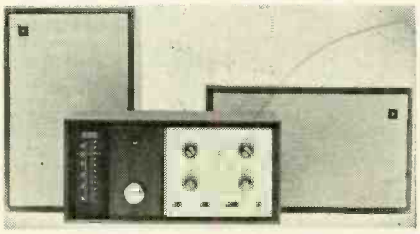


tive strip chart 30 ft long by 2½-in. wide. Leather case; available with 1-, 6-, or 12-in. per hour feed speed.—**Amprobe Instrument**

Circle 46 on reader's service card

AUTO RADIO ANTENNA, the A-85 CB/AM combination, uses encapsulated top-loading coil to get one-quarter-wavelength resonance. VSWR 1.1 to 1. No degradation when used for entertainment radio. Signal divider prevents 27-mc signals from entering AM radio. 47 in. extended, telescopes to 30 in.—**Webster Mfg.**

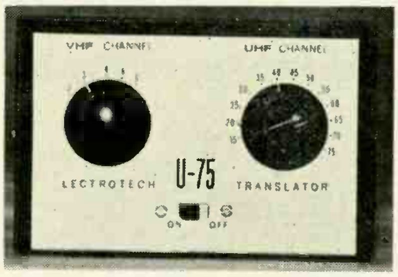
Circle 47 on reader's service card



FM STEREO RECEIVER SYSTEM, the *Stereomaster 2400.* Frequency response 20–20,000 cycles; sensitivity 2.8 μv; distortion at normal listening level less than 0.5%. Walnut cabinet. Tuner/amplifier 12⅞ x 7 x 7 in. Speakers (each) 14 x 8¾ x 5 in. Shipping weight with speakers, 34 lb.—**H. H. Scott, Inc.**

Circle 48 on reader's service card

UHF TRANSLATOR, *model U-75,* converts any rf signal between 55 and 85 mc to any uhf channel between 15 and 75. Requires minimum signal of 2,500 μv.



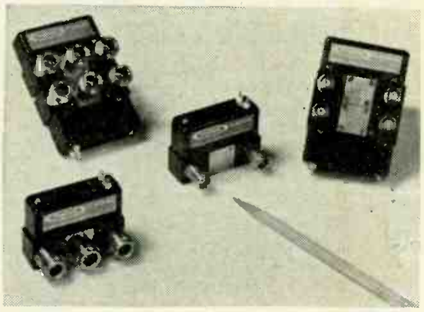
Input for either 300 ohms balanced or 50–75 unbalanced. Uhf dial calibration exact for 69 mc; maximum error ±5 channels. Uses standard 9-volt battery. 6 x 6 x 4 in., 3 lb. For color and black-and-white. —**Lectrotech, Inc.**

Circle 49 on reader's service card

SOUND RECORDING TAPE now available in brown-and-beige library-box packaging. Space on back of box for listing taped selections. Identifying sleeve is removed after purchase of tape; sizes from 625 feet on 5-in. reel to 3,600 feet on 7-in. reel.—**Eastman Kodak Co.**

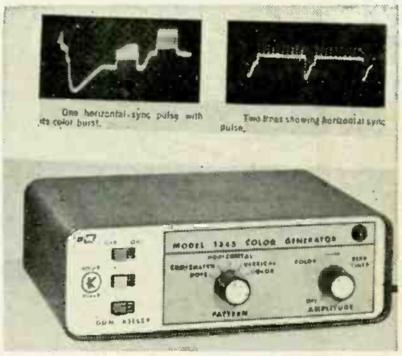
Circle 50 on reader's service card

COAXIAL SWITCHES. New *Dynaform* switch line uses standard modules to produce hundreds of combinations.



Special-purpose switches available in a few days in prototype quantities for breadboarding. Spdt and transfer switches weigh about 4 oz; dpdt types about 8 oz. Gold-plated beryllium copper bifurcated moving-contact blades; area of contact and pressure satisfactory for 500 watts. Mechanical life rating minimum 1 million cycles.—**Amphenol RF Div.**

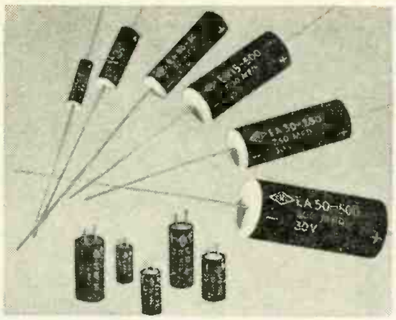
Circle 51 on reader's service card



SOLID-STATE COLOR GENERATOR, *model 1245,* permits accurate setting of color-killer threshold control without waiting for color telecast. Produces all necessary waveforms to station quality standards. Complete blanking of all video information during sync periods. Crystal-controlled keyed rainbow color bar display; dot/crosshatch/horizontal line/vertical line patterns, gun killer controls. Dots are one line high, 0.2 μsec wide. 2⅞ x 8½ x 8⅞ in., 3 lb.—**B & K Mfg. Co.**

Circle 52 on reader's service card

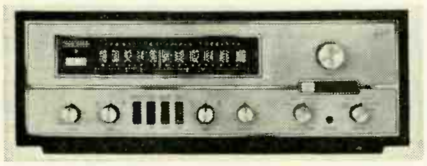
MINIATURE SEALED ELECTROLYTIC CAPACITORS. Operating temperature rating from −20° to +85° C and close tolerance on capacity of −0, +100%. Available capacitances range from 2 to 1,000 μf; voltage ratings from 6 to 50



dc working volts. Molded phenolic plastic case, epoxy-sealed ends. Axial and printed-circuit lead types. Case dimensions small as ½-in. long by ⅛-in. diameter for 25-μf 6-volt unit.—Centralab

Circle 53 on reader's service card

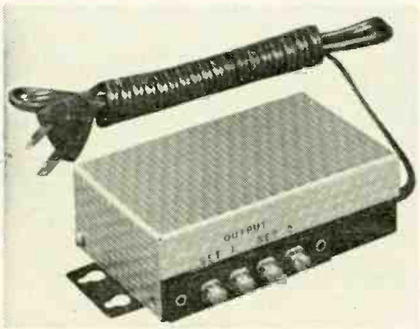
FM STEREO RECEIVER, the *440-T*. 70 watts of music power at 4 ohms; 50 watts at 8-ohm impedance. 2.0-μv sensitivity (IHF). Wide-band ratio detector;



wide-band solid-state i.f. strip; 4 i.f. stages; 3 limiters; d'Arsonval tuning meter; time-division multiplex system; tape and phono facilities; gold-plated front panel. 16¾ x 5⅜ x 12⅜ in., 21 lb.—Fisher Radio Corp.

Circle 54 on reader's service card

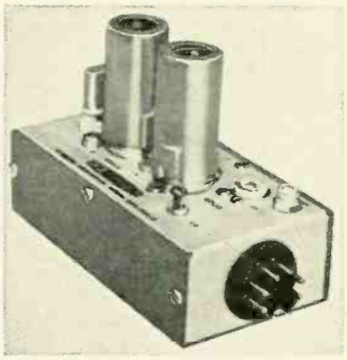
LINE OF COLOR AMPLIFIERS, *Tele-Amp. HVU-3;* up to 18 db gain; noise 4.2 db; 3 transistors. *HV-2;* up to 13 db gain for 2 sets, up to 8 db for 4 sets; noise figure to 4 db; 2 transistors. *HV-1;* for vhf fringe reception with high-pass filter: up to 12 db gain for 2 sets, up to 8 db with all outputs used;



noise 4.5 db; 1 transistor. *HF-1* amplifies FM/FM stereo up to 15 db gain; noise 5.1 db; 1 transistor. *EV-1* for vhf fringe, 2 vhf/FM outputs: up to 17 db gain for 1 set, to 14 db with both outputs; noise to 5.1 db; 1 transistor. *EF-1:* economy amplification; 15 db gain; noise 5.6 db; 1 transistor.—JFD Electronics Corp.

Circle 55 on reader's service card

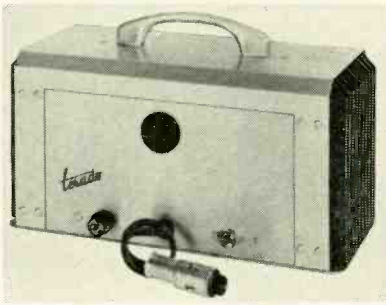
2- AND 6-METER CONVERTER KITS. *Heathkit model SBA-300-3,* the 6-meter model (shown), extends coverage of SB-300 receiver from 48 to 54 mc (50 to 52 mc with crystal supplied), and the 2-meter converter, kit *SBA-300-4,* ex-



tends coverage from 142 to 150 mc (144 to 146 mc using crystal supplied). Each converter uses 6DJ8 cascode amplifier for low noise factor and high sensitivity. Agc provision.—Heath Co.

Circle 56 on reader's serivce card

SOLID-STATE POWER INVERTER, the *Tempest model 50-170.* Changes battery current of car or boat to



117 vac. Capacity 125 to 150 watts. Copper-clad case, carrying handle.—Terado Corp.

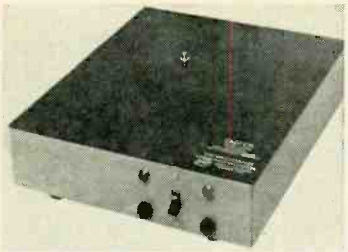
Circle 57 on reader's service card

MINIATURIZED AUDIO TRANSFORMER, the *PIL-50.* 5/16-in. diameter, 3/16-in. high, 1/20 oz. Primary impedance 500 ohms ct; unbalanced dc in primary 3 ma; primary dc response 40 ohms;

maximum level 100 mw; ±3-db frequency range at 1 mw 800 cycles–250 kc.—United Transformer Corp.

Circle 58 on reader's service card

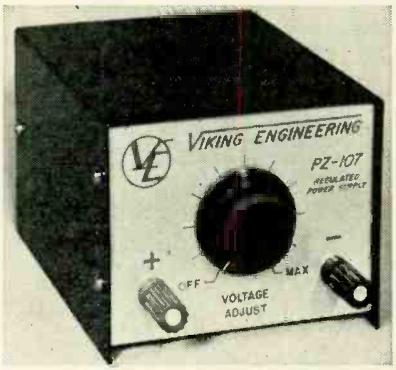
BULK TAPE ERASER, *Cinema type 9205A* for erasing program and residual noise from magnetic tape on 17-in. reel or



films with magnetic sound tracks. Active field area can erase recorded signal to more than 50 db below saturation. Double-pole switches, double-fused with pilot lights; 3-conductor cord with 2-prong plug and ground connector with 6-ft rubber-covered cord.—**Aerovox Corp., Hi-Q Div.**

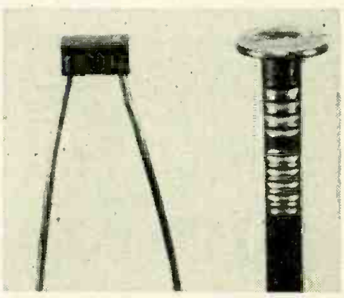
Circle 59 on reader's service card

TRANSISTOR REGULATED POWER SUPPLY KIT, *model PZ-107*, will deliver output continuously variable from 7 to 25 volts at 200 ma dc (30 v at 100 ma dc). Input 105–125 v 50–60 cycles ac.



Load regulation ±0.2%. Line regulation ±0.4%. Ac ripple less than 1 mv. 3¼ x 4¼ x 5¼ in.—**Viking Engineering**

Circle 60 on reader's service card



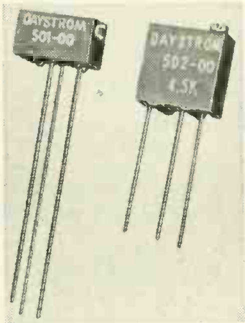
CERAMIC CAPACITOR, *EPCO4 Nailhead*. Capacitance range of 10 pf through .027 μf; case measures 0.2 x 0.1 x 0.1 in. Modified barium titanate dielectric. Available in axial-lead tubular style as well as rectangular case shown.—**Marshall Industries, Electron Products Div.**

Circle 61 on reader's service card

AUDIOMATIC GENERATOR, *model 610-A*. Manual frequency range 25–46,000 cycles in one continuous range. Automatic range by separate control from 0 to 20 kc, markings at 1,000-cycle increments. Accuracy of calibration ± (1% + 5 cycles). Output impedance: 4,000 ohms single-ended and 600 ohms balanced to ground. Output power 100 mw at 4,000 ohms, + 19 db at 600 ohms. Output essentially flat from 50–10,000 cycles. Waveform distortion less than 0.5% over most of range. Ac hum less than 0.1%. 19½ x 11 x 15 in., 48 lb.—**The Clough-Brengle Co.**

Circle 62 on reader's service card

POTENTIOMETERS, *models 501* (back pins) and *502* (side pins) *Squaretrims*, require only .07 cubic inch space. Range 10 to 30,000 ohms. Precision tolerance is ±5%; resolution better than 0.124%. Adjustability 15 turns with slip-

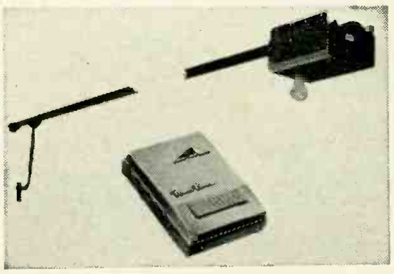


clutch. High power 0.5 watt at 70°C; low noise 100 ohms maximum. Temperature range −55° to +150°C; low-temperature coefficient ±70 ppm maximum.—**Weston Instruments, Inc.**

Circle 63 on reader's service card

CABLE INSULATION STRIPPING TOOL, *model 369*, cuts, slits, strips insulation from cables ranging from No. 1 to 1,000 MCM (Million Circular Mils). Designed to remove insulation without cutting or nicking conductor strands. Guide markings for each cable size. Tool can be used at end of conductor or anywhere along its length.—**Thomas & Betts Co.**

Circle 64 on reader's service card



GARAGE-DOOR OPENER, *model G-670*, which claims to be free from phantom operation by stray radio signals, employs new radio coding system. This unit works via pulse tone modulation, a patent-applied-for technique that makes each radio signal personal, and complies with FCC rules. Transmitter and receiver are all-transistor; motor is controlled by computer logic circuit. Handles metal, fiberglass or wood doors up to 20 feet wide and 8 feet high; works from 117 v, 60 cycles.—**Perma-Power Co.**

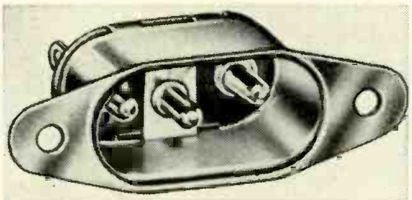
Circle 65 on reader's service card

REGULATED POWER SUPPLY, *model 1030,* has two continuously variable sources: one bias output from 0–150 volts at 2 ma; the other from 0–400 volts at up to 150 ma. The latter output is regulated to .03% for loads up to 100 ma. Change of line voltage of ±10 volts will cause less than 0.5-v maximum change in output. Ripple less than 3 mv rms.

Front-panel connections provide unregulated filament voltages of 6.3 v, with or without centertap, and 12.6 v, all at 3 amperes. 13 x 8½ x 7 in., operates from 117-volt 50–60 cycle line. Power consumption 160 watts. Wired or kit.—**EICO**

Circle 66 on reader's service card

3-PIN AC RECEPTACLES, *part No. AC3* (ungrounded), *AC3G* (grounded), have self-aligning feature which allows movement of pins 1 and 3 in shell to take up off-centering of plug contact locations.



Stationary center pin 2 acts as guide. *AC3G* has metal strap to ground pin 2. Each mates with Belden type PH-243 plugs or equivalent. Both are rated at 115 volts, 7 amperes.—**Switchcraft Inc.**

Circle 67 on reader's service card

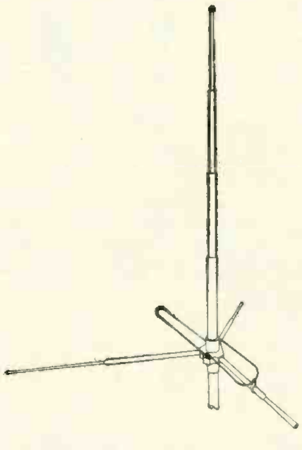
DIELECTRIC STRENGTH CHECKER, the *Insta Test,* gives audio and visual response at breakdown point of windings used in coils, motors, transformers, etc. Selection scale graduated in ranges of 750, 1,000, 1,250, 2,000, 3,000 ac volts. Operates on 117 volts at 50 or 60 cycles. Two high-voltage probes permit quick check across any winding; buz-

zer sounds at potential breakdown point; red lamp lights if part is defective.—**Grand Transformers, Inc.**

Circle 68 on reader's service card

STEREO DYNAMIC HEADPHONE for use in school language labs announced by Koss/Rek-O-Kut. *Model K/R 2 + 2* has boom-mounted microphone, hi-fi sound and special foam-filled ear cushions to prevent outside room noise from disturbing study. Shatterproof plastic is basic material; cord is reinforced.—**Koss Electronics Inc.**

Circle 69 on reader's service card



ANTENNA FOR BUSINESS BAND, the *Dispatcher DP-275,* for 27.23 to 50 mc. ⅝ wave vertical; radial radius of 9 feet and height of 20 feet at 27 mc. Radiation pattern 360°. Coax female connector in radial support assembly. VSWR 1.5/1 or better. Gain 3.4 db over ¼-wave ground plane; 5.9 db compared to isotropic source. Maximum power input 1,000 watts.—**Mosley Electronics Inc.**

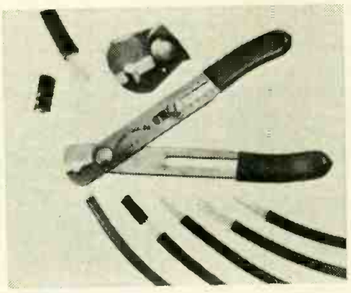
Circle 70 on reader's service card

SOLID-STATE STEREO RECEIVER, *model RA-727*. Tuner sensitivity 1 μv. Image ratio over 30 db. MPX separation 30 db. Amplifier output 44 watts music power. Response: 30 to 30,-

000 cycles. Crosstalk more than —32 db. Distortion 0.5% at 1,000 cycles. Input sensitivity: phono 8 mv. Auxiliary: 300 mv. Brushed-gold panel, 9½ x 5¼ x 12½ in., oiled walnut cabinet.—**Olson Electronics, Inc.**

Circle 71 on reader's service card

COAX CUTTER AND STRIPPER, *stock No. X55F*, is designed to cut and strip RG-59/U coax. Two stripping holes:



larger for removing outer insulation and braid; smaller removes inner insulation. Spring steel, honed and heat-treated cutting edges.—**Hunter Tools**

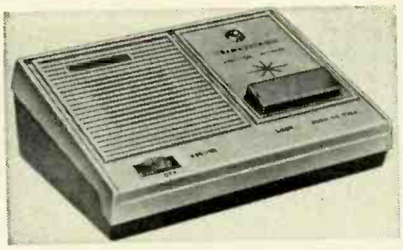
Circle 72 on reader's service card

FM STEREO TUNER, *model 532*. Range 87.5–108.5 mc with 2-μv sensitivity. 800-kc bandwidth; channel sepa-

ration of 30 db. Afc circuit, stereo beacon light, antenna inputs for 75 and 300 ohms. 12⅜ x 7 x 2⅞ in. Power consumption 30 watts.—**Trutone Electronics, Inc.**

Circle 73 on reader's service card

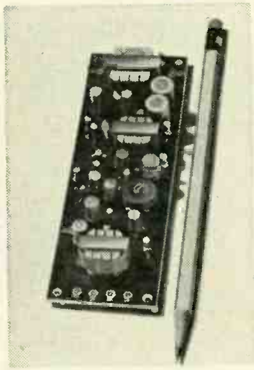
SOLID-STATE WIRELESS INTERCOM, *stock No. 99-4573M*. No wiring required; plug each unit into ac outlet. Each unit is master with volume/on–off control, push-to-talk bar with lock-bar feature for



continuous operation. Plastic case with rubber-tipped base. 6½ x 5 x 2½ in., 2 lb. For 110–120 volts 60 cycles ac.—**Lafayette Radio Electronics Corp.**

Circle 74 on reader's service card

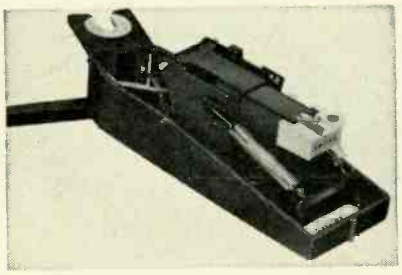
COMPACT TRANSISTOR AUDIO AMPLIFIER, to handle low-level mikes, phono pickups, etc., features: volume control; 5 transistors; 1 thermistor; shielded input transformer with 2 primary



windings for 50 ohms and high impedance; output transformer with 2 secondary windings, 8 ohms (for speakers), 500 ohms (for modulation and high impedance loads). 400 mw push-pull output; 80 db gain; 9-volt dc source. Mounted on printed circuit board 5½ x 1¾ in., 3½ oz.—**Birnbach Radio**

Circle 75 on reader's service card

ELLIPTICAL STYLUS CARTRIDGE ASSEMBLY, the *Gard-A-Matic model M80E*, features retractile safety suspension system and elliptic diamond stylus, plugs into tone arm of Garrard Lab 80 and Type A70 changers. Response: 20–20,000 cycles. Output volt-



age 6.6 mv per channel at 1,000 cycles at 5 cm/sec. Channel separation over 25 db at 1,000 cycles. Recommended load impedance 47,000 ohms. Compliance 25 × 10^{-6} cm/dyne. Tracking force: 1–1½ grams maximum. Inductance 720 mh. Dc resistance 630 ohms.—**Shure Brothers, Inc.**

Circle 76 on reader's service card

TRANSISTORIZED MICROPHONE, *model +2,* has adjustable out-

put level, will increase range and signal strength of any transceiver. Operator can dial output level best for his set; changes output for big or little voice, close or far work. Touch-to-talk or lock on–off switching. Screwdriver adjustment connects terminal wire in base for electronic switching or relay switching. SSB response limited to 300–3,000 cycles. One-piece diecast case.—Turner Microphone Co.

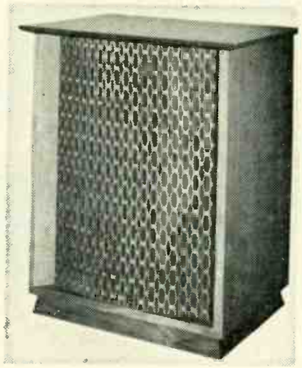
Circle 77 on reader's service card

CAPACITORS, *type P8292ZN,* use plastic-cased metallized paper. Rated dc voltages of 200, 400, 600 based on life test of 1¼ times working voltage at 100°C for 1,000 hours. Capacitance values available from .01 to 10 µf.—Aerovox Corp.

Circle 78 on reader's service card

TAPE SOUND SYSTEM FOR CARS, the *Norelco Car-Mount,* can play back through car radio as well as record and be removed from car for use as portable, separate recorder. Comprises a universal mounting attached below dashboard, plus the *Carry-Corder 150,* a cordless, cartridge-loaded, portable tape recorder.—North American Philips Co., Inc.

Circle 79 on reader's service card



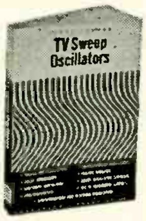
PLAYBACK SPEAKER SYSTEM, the *847A Seville.* Contemporary upright walnut cabinet with Spanish wood fretwork grille, uses less than 2 sq. ft. of floor space. Inside are type 414 12-in. bass speaker, exponential horn, compression high-frequency driver, 2-section 3,000-cycle crossover network. Operates from 8 or 16 ohms; rated at 20 watts; response 40 to 22,000 cycles. 26 x 19 x 14 in.—Altec Lansing. END

Circle 80 on reader's service card

3 New GERNSBACK LIBRARY Paperback books...

TV SWEEP OSCILLATORS

By Harry E. Thomas



TV SWEEP OSCILLATORS is a practical working tool and handy reference book for everyone who fixes TV sets. Written in clear, easy-to-understand language, it gives you all the practical facts you will ever need on the subject. Includes:

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All booklets, catalogs, charts, data sheets and other literature listed here are free for the asking (except where a price is given). Each item is identified by a Reader's Service number. Turn to the Reader's Service Card facing page 70 and circle the number of items you want. Then detach and mail the card. No postage required!

SOLDERING-GUN BROCHURE, *No. 15.* 8 pages of pictures and text on applications of Markel's soldering guns and accessories.—**Markel**
Circle 81 on reader's service card

CINEMA PRECISION AUDIO EQUIPMENT, *Catalog 32-EF.* 8 pages of specs, photos, surves on equalizers, dip filters, transmission measuring sets, power supplies.—**Hi-Q Div. of Aerovox**
Circle 82 on reader's service card

ISO-CURVE THERMISTORS, *Bulletin L-2,* 6-page foldout with 3 data sheets, curves, photos, configurations, resistance vs temperature characteristics table on Iso-Curve line of curve-matched, interchangeable thermistors.—**Fenwal Electronics**
Circle 83 on reader's service card

CAPSULE THERMISTOR COURSES 1 through 10. now collected in one 5½ x 11 in. booklet. Plus glossary.—**Fenwal Electronics Inc.**
Circle 84 on reader's service card

CATALOG, *No. S-323,* of Littel Multi-Switches, series 35000, 36000, 37000, 38000. 10 pages, photos, drawings, specs of illuminated and nonilluminated switches, ganged assemblies, accessories, special functions.—**Switchcraft Inc.**
Circle 85 on reader's service card

CONTROL KNOBS BROCHURE, 4 pages, illustrated, with military specs of the KMS series of knobs.—**National Radio Co., Inc.**
Circle 86 on reader's service card

POWER SUPPLY CATALOG, 48 pages, photos, diagrams, application notes, nomogram of voltage drop, glossary. Supplies indexed by output voltage.—**Kepco, Inc.**
Circle 87 on reader's service card

QUICK-REFERENCE METER CATALOG, *M865,* 12 pages, cross-section of complete line of custom-built panel and switchboard meters.—**Hickok Electrical Instrument Co.**
Circle 88 on reader's service card

CANADIAN MAIL-ORDER CATALOG, introductory *No. 1,* features hi-fi, test equipment, tools, tape recorders, transceivers, etc.—**Gladstone Electronic Supply Co.**
Circle 89 on reader's service card

CB AND HAM EQUIPMENT CATALOG. 12 pages of CB, commercial, amateur antennas; fixed-station, portable, mobile, tone-signaling CB equipment; mobile mounts and springs; accessories (shielding systems).—**Webster Band Spanner**
Circle 90 on reader's service card

SPECTRUM ANALYZER BOOKLET, 8 pages, titled "Getting Acquainted with Spectrum Analyzers." General discussion of the electromagnetic spectrum, nature of signals in various radio-frequency bands, heterodyning, related problems of analysis.—**Tektronix, Inc.**
Circle 91 on reader's service card

DESIGNER DATA BOOK, 45 pages, "Piezoelectric Technology—Data for Designers." Principles of piezoelectricity, characteristics of materials, applications—**Piezoelectric Div. of Clevite Corp.**
Circle 92 on reader's service card

CATALOG *65/66,* 65 pages, photos. Wire, cable, tubing, hardware, switches, radio–TV accessories, components, government and commercial specifications.—**Birnbach Radio Co. Inc.**
Circle 93 on reader's service card

FACTORY PRICE LIST, quantities 1 to 999, of Texas Instruments' semiconductor products. 24 pages, looseleaf-punched, from their distributor in New York, Delaware Valley and Washington.—**Milgray**
Circle 94 on reader's service card

APPLICATION NEWS, *Vol. 3, No. 2,* 15 pages. Contains an illustrated paper called "A New Method for Precise Voltage Regulation for Use with Photomultipliers." Also other gas-tube applications, most contributed by readers.—**Signalite, Inc.**
Circle 95 on reader's service card

TERMINAL-BLOCK/BARRIER-STRIP CATALOG, *No. XLX-7A.* Items formerly manufactured by Excellex Electronics Inc.—**Eby Sales Co. Inc.**
Circle 96 on reader's service card

CATALOG, *No. 252,* "1965 Gift Season Specials". 82 pages, color photographs. Bargains in hi-fi, tape recorders, cabinetry, mikes, test equipment, many other gift ideas.—**Allied Radio**
Circle 97 on reader's service card

SWITCH CATALOG, 4 pages, looseleaf punched, lists *EECoSWITCH Series 700/800* sealed and lighted subminiature thumb-wheel switches. Includes specs, output code tables, and covers related mounting hardware.—**EECo-SWITCH, Div. of Engineered Electronics Co.**
Circle 98 on reader's service card

TEST AND REPAIR INSTRUMENT CATALOG, 8 pages; photos, specs, of tube testers, component substitutor, capacitor tester, signal generator, CRT tester–reactivator, color TV analyzer, multi-head pix-tube adapter, voltmeter, vom.—**Mercury Electronics Corp.**
Circle 99 on reader's service card

Write direct to the manufacturers for information on the items listed below:

TV CHASSIS SERVICE MANUAL, *Singlpak.* At 79 cents each, all the TV service manuals of top line TV set manufacturers for the years 1955 through 1965.—**Singlpak, Inc.,** 58 Stewart Ave., New Hyde Park, N. Y.

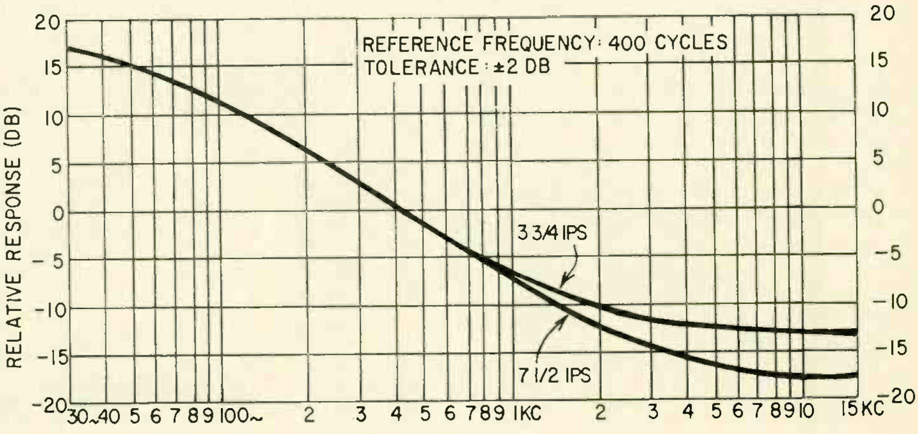
APPLICATION NOTE, *No. 69,* 40 pages, titled "Which DC Voltmeter?", explains available types of multirange analog and digital meters and the reasons for their existence, tells how to minimize the effect of unwanted signals. Analyzed from point of view of applications.—**Hewlett-Packard,** PO Box 301, Loveland, Colo. 80537 END

RIAA ISSUES TAPE STANDARD

The curves below show the new RIAA playback response standard for magnetic tape at 3¾ and 7½ inches per second. The 7½-ips curve is the same as the long-time NAB 15-ips standard; the 3¾-ips curve is new, but differs from the higher-speed characteristic only in having less high-frequency rolloff, to compensate for the poorer high-frequency response at the slower speed.

In terms of time constants, the new curves are described by the same low-frequency constant: 3,180 μsec. The high-frequency constant of the 7½-ips curve is 50 μsec; that of the 3¾-ips curve, 90 μsec.

The curve is drawn and described in the RIAA's Bulletin No. E5, issued July 15, 1965. The leaflet, titled "Standards for Magnetic Tape Records", also covers speed, dimensions, direction of tape wind, and sequence of tracks in two, four and eight-track recordings. Copies are available from the Record Industry Association of America, 1 E. 57th St., New York, N.Y. 10022



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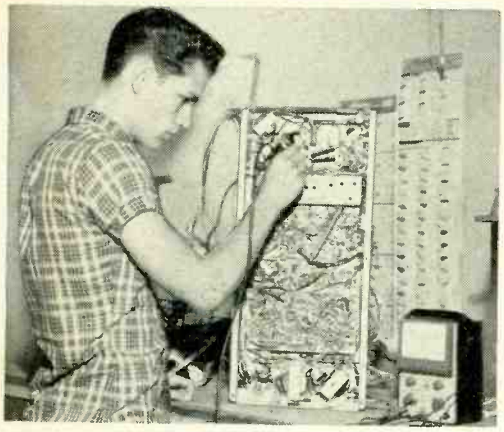
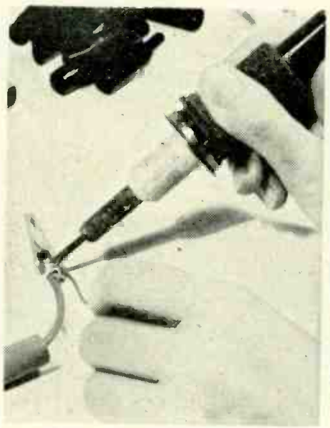
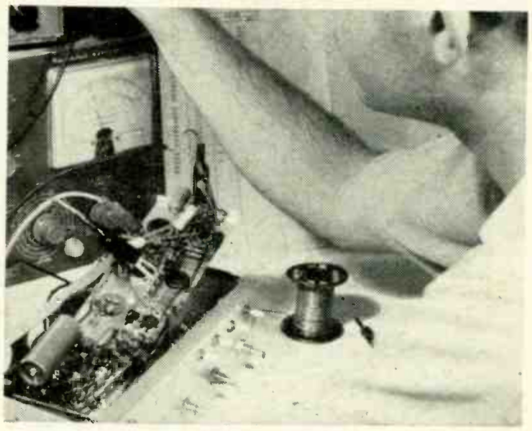

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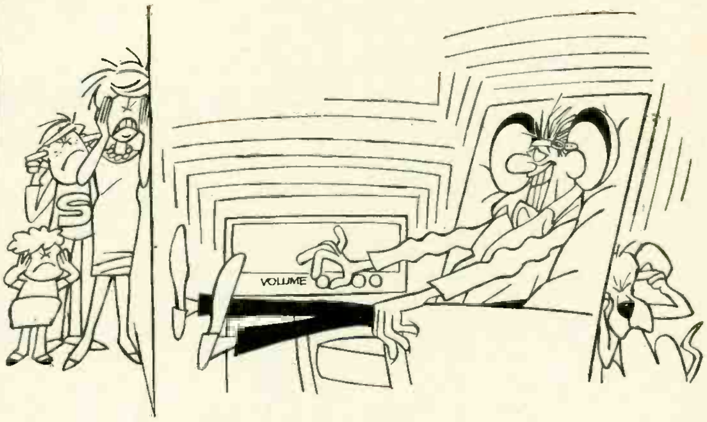

THE SEARCH FOR SOUND

By ELBERT ROBBERSON

I DON'T SEE LARRY ANY MORE. NOBODY SEES HIM. NOT EVEN his wife, Ellen. She left, taking their kids and everything in the house but the sound.

I know the mover. "The guy acted nuts," he told me. "He kept yelling, 'Don't touch this room!' I told him to cool it—I wasn't after that stuff. Another thing—why would a guy wear a hat in the house in August?"

I remember when it started. Larry came into the shop, quietly browsing around, spinning the turntables, hefting the tone arms. Then he turned to the speakers lined up open on the shelf. Lightly he tapped his fingertips on the cones. "Tump, tump," he would go, then move to the next speaker, cocking his head first one way and then the other as he tumped.

"There shouldn't be any coloration," he said. He tumped on a cone. "This one rings."

He carried out a box of Bozaks—a woofer, a squawker and a tweeter. The second load was a McIntosh preamp and 50-watter, and his third a professional turntable. He didn't raise his voice over the price, just asked me to help hook up the system.

That evening, I did. He had a nice wall-to-wall house, some fair paintings, well behaved kids, and a pleasant blonde wife. When we were finished, she offered me a drink, as Larry put a record on the turntable, set the knobs to "flat" and settled back in the deep chair with his eyes closed.

"Listen to that dynamic range," he breathed during a lull.

"But why so loud?" Ellen asked. She made a flat-handed motion toward her ears, crinkling her nose.

"Has to be, so you can get the quiet passages. Listen—did you hear that? He hums while he plays!"

Ellen winked me out the door. "He'll get over it."

"Yeah, the novelty wears off. And thanks for the drink."

The second time I visited was to bring a tape deck. There were some strays in Ellen's coif, and the kids were commandos.

"He's in there," Ellen said, jerking her head. "It's the Sound Room, now."

In the other room a steam locomotive was whistling for a grade crossing, its connecting rods clanking and the wheels clicking on the rail ends. One of the boxcar wheels thumped from a flat—they get that way when the brakes lock on a downgrade. Ellen shook her head and sighed. "I ask him why doesn't he just go down to the freight yard, if that's what he wants to hear. But that's too far from the gold-mine stamp mill on the next band."

Larry was hunched in his chair, hands cupped behind his ears. "This does things for the sound," he said to me. "Try it. You get it all—nothing goes by."

I did. "I see what you mean," I said.

"What did you say?"

"It . . ."

"It fills in the whole sound," he shouted. "Puts you right there."

I connected up the tape deck and left. Ellen waved a wet hand from the kitchen. "See you," she said.

What comes after a professional turntable, tape deck, a monaural amplifier and speakers? Stereo, naturally. This was a whole new setup: double amplifiers, new matched speakers. And Larry wanted more power.

When I came to make the hookup, Ellen was rushing out, makeup dabbed. She yelled at one of the kids. "Tie that shoelace, idiot, before you trip and break your little neck! We're off to the drive-in," she explained, then slammed the door.

Larry was in his chair, head centered between two curved reflectors that reached out like metal clam shells growing from his ears.

"Had these especially cast from my own patterns," he yelled. "Quarter-inch-thick aluminum, no resonance. Sound gathering is tremendous. Leave the stuff—I'll hook it up later."

"Why don't you get earphones," I asked. "We've got some that go from below 50 cycles to above 15,000."

"You'll have to talk louder," he yelled.

"Earphones . . ." I started.

"Can't wear 'em. Besides, you lose the depth, and the room."

As I left, I wondered what sound ¼-inch reflectors could bring out of a bank of fiddles that wasn't already present.

There was a long lapse, with no Larry. Then I got a note, asking me to drop by.

At the door, Larry yelled, "Pardon the delay—had to put a flasher on the doorbell; don't always notice it. Ellen's out, come on in."

Larry looked like the villain in a late-late movie. His head was shaved, and he had a couple of suction cups stuck to his skull.

"Bone conduction was all right for a while, but the reproducers just didn't have it. Now I'm trying electrical stimu-

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Coming next month Radio-Electronics
3rd Annual Color TV Issue

Information-packed issue, designed to bring you up-to-the-minute on everything that's happening in the field. Front-to-back, every word, picture and page will bring you facts you want to know . . . about how the color tube works, the latest sets and circuits, trends in tubes, parts, antennas, test equipment, progress and problems of color TV, how to rejuvenate old color sets, plus a valuable chart to help you spot TV color troubles in a hurry.
January Issue is on sale December 21st at your favorite newsstands and electronic parts distributors.

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lation, but the output impedance of these amplifiers doesn't match, and I wondered if you could fix me up with a couple of transformers. Wish you could hear this" he beamed. "It's the greatest! Gets the juice right to the auditory nerve without any distortion at all."

"If you step up the amplifier output impedance, the output voltage will go up, too," I told him.

"Speak into my ear," he said.

"You'll get a shock—a loud passage might knock you out."

"Oh, I know. I get some tingles now. Puts real body into it—you can really feel it!"

"The damn fool," I thought. But I connected him up to the 70-volt taps on his amplifiers.

His smile was beatific. I got out as quickly as I could.

Time passed. Then I got a note from Larry. It started: *"To get the proper stimulus, the voltage had to be too high, and it knocked me out a couple of times. I've read that doctors have been able to implant needle electrodes directly into the nerves or brain to give full stimulus at lower voltages. I thought you might know a doctor who has worked in medical electricity. . . ."*

I quit reading. Isn't there some agency, some law against driving yourself crazy? Electro-shock could make a nice quiet moron out of him. I called a doctor friend.

"As long as he's not my patient, I can't stop him," he said. "Is he hurting anybody?"

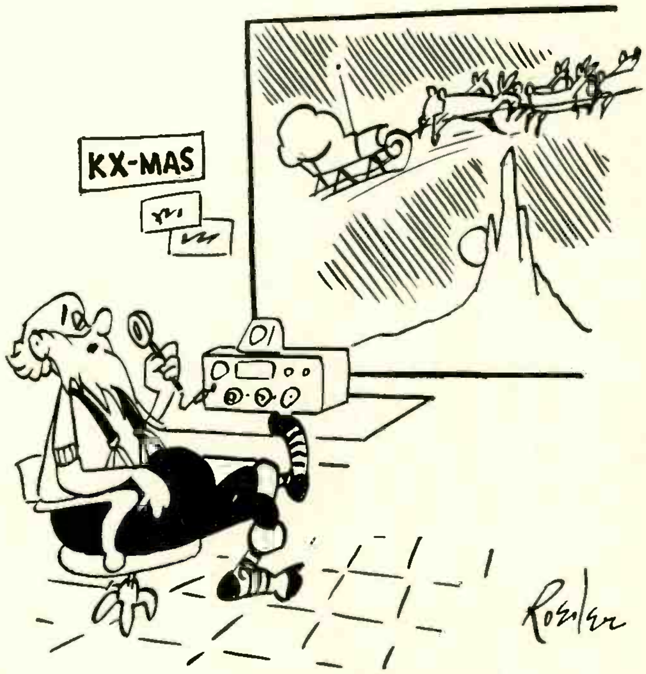
"Just himself and his family."

"Can you prove it? If they don't complain, you could find yourself in trouble, making accusations you can't back up."

"But the guy's nuts—he ought to be taken care of!"

"Aren't all of us, a little?"

I hung up. But the question still churned: there must be something that can be done before it's too late! Too late? Then I remembered the rest of what the mover had said: ". . . a hat in the house in August—with wires coming out from under!" END



"On Dancer, on Prancer, on Donder and Blitzen"

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- How you see color—an analysis of how the color tube works.
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1965 SEMI-ANNUAL INDEX

RADIO-ELECTRONICS July-December 1965 of Vol XXXVI

KEY TO SYMBOLS AND ABBREVIATIONS

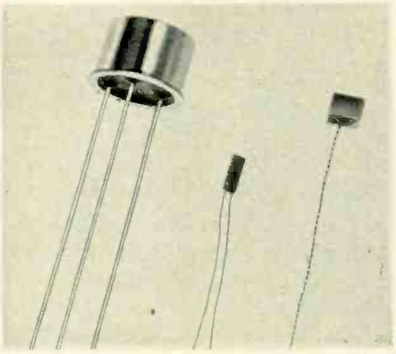
* Construction Articles
† Section of full-length article
§ Transistorized
CI .... Service Clinic
Corr .... Correction
Corres .... Correspondence
NB .... News Briefs
NC .... Noteworthy Circuits
Tech .... Technotes
TTO .... Try This One
WN .... What's New

Regular departments not itemized are New Books, New Literature, New Products, What's Your EQ?

NEW SEMI-CONDUCTORS AND TUBES

WIDE-SWING MAGNETORESISTORS

A new line of magnetoresistors with an unusually large resistance change when placed in a magnetic field has been announced by Instrument Systems Corp.



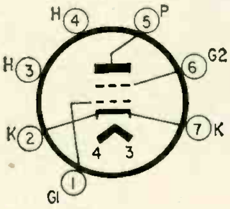
The new sensors' resistance increases from 8 to 20 times the zero-field value under the influence of a 10,000-gauss magnetic field. Previous types changed by a factor of only 2 to 3 times. The new magnetoresistors are made of combined indium antimonide/nickel antimonide. They can supplant photoconductors and magnetic reed switches in many applications. Above 3,000 gauss, the ratio of resistance under flux to zero-field resistance is directly proportional to magnetic-flux density.

The photo compares the sizes of two ISC magnetoresistors to a TO-18 transistor case.

LOW CROSS-MODULATION TUBES

One of the most serious problems in designing sensitive, wide-band front ends is *cross-modulation*, created when an undesired signal is strong enough—even after tuning and preselection—to swing an amplifier stage into a nonlinear part of its characteristic. The nonlinearity causes the signals to intermodulate, or cross-modulate, rather than simply mix. They can then no longer be separated by tuned circuits, and the result is a whopping case of incurable interference.

The usual approach to preventing this has been to use elaborate tuned preselector circuits, which are expensive to design and manufacture, and difficult to make track. Recently, Westinghouse Electronic Tube Division announced two miniature tetrodes designed so that an undesired signal of 5 volts peak-to-peak amplitude will produce only 1% cross-modulation. One of the tubes, the WX-4733A, is intended as an rf amplifier up to 100 mc; the other, the WX-4733D, is good to 300 mc. Both were designed expressly to permit using simple, conventional circuitry.



WX-4733A
WX-4733D

Both tubes have comparatively low transcondnctance: 2,000 μmhos for one and 2,700 for the other. This appears to be the price paid for the low cross-modulation factor.

Cross-modulation factor, by the way, is defined as the percentage of modulation transferred from an undesired carrier modulated 30% to an unmodulated, desired carrier.

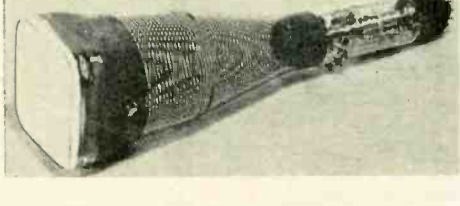
LOW-NOISE GERMANIUM AUDIO TRANSISTORS

Texas Instruments sends word of a new line of p-n-p alloy-junction germanium transistors for low-noise audio-amplifier applications. They are inexpensive (around 50 cents in small quantities) and have a high breakdown voltage—50 volts between collector and base. They are named TIXA01 and -02.

Their low noise (noise figure of 4 db maximum at 1 kc) makes them attractive for low-level audio preamp service, while the high breakdown voltage makes them useful as higher-level driver stages, or even possibly as output stages for low-power amplifiers of the switching, or pulse-width-modulated, design.

Common-base alpha cutoff is 4 mc; typical beta is 180 at 6 volts between collector and emitter with 1 ma flowing. Dissipation is 150 mw; maximum collector current, 150 ma.

LOW-HEATER-POWER CRT



Powder metallurgy and other recent technologies have made possible a family of low-heater-power cathode-ray tubes, which, according to the manufacturer, will run for 400 hours off a 1½-volt No. 6 dry cell.

Developed primarily for portable transistor oscilloscopes and similar equipment, tubes in the new line of Sylvania CRT's consume less than 6% of the heater power of conventional CRT's. Their heaters are rated at 1.5 volts 140 ma, compared to the usual 6.3 volts 600 ma. A further benefit of the reduced power is less heat to be dissipated in the equipment. END

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I certify that the statements made by me above are correct and complete.

(Signed) M. Harvey Gernsback
Editor

TECHNOTES

TEKTRONIX 561-A SHOWS FLICKERING OR INTERMITTENT TRACE

A particularly baffling trouble on a Tektronix 561-A oscilloscope appeared regularly in the shop but was never to be seen when the instrument was sent out for service. As soon as the scope came back, the trouble reappeared. The trace would flicker erratically.

The cause was finally traced to an intermittent insulation failure in the high-voltage oscillator coil. The leakage or arcing depended on the humidity of the air—and apparently the air in our shop was wetter than the air in the efficiently air-conditioned service shop center.

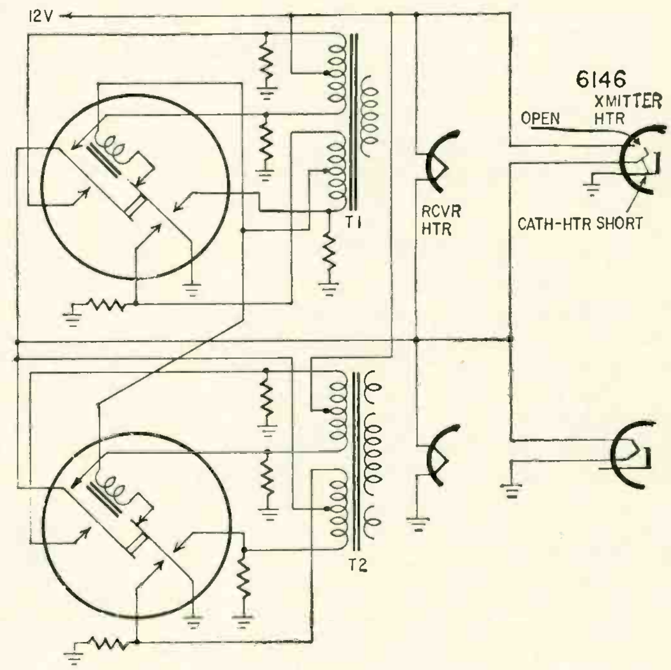
The same scope once showed a horizontal trace only half the width of the screen. After replacing many tubes and checking many voltages, someone discovered that one of the leads to the deflection-plate pins on the CRT envelope was loose enough to interrupt the circuit to that plate.—*Frederick W. Chesson*

MOTOROLA T51GGV TWO-WAY-RADIO

A Motorola two-way model T51GGV radio had no squelch or audio, intermittently. Flicking the switch off and on could make the set work. The unit worked more than 50% of the time; when it didn't work the vibrator for the receiver B-plus did not function. Tapping it would cause it to start up; however, a new vibrator did not cure the difficulty. Neither did a new buffer capacitor or anything else I replaced.

Half of the heaters were not lit, and some were too bright. Hitting the vibrator, or switching the set off and on, would start the vibrator and light the rest of the heaters.

The 1701 vibrator needs a 6-volt source, which is derived from the heater string. The heaters are wired in series-parallel and the 6 volts obtained by the drop across them. A

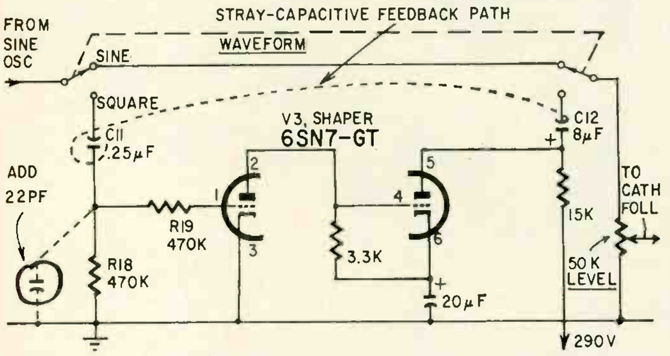


tube check showed the 6146 had an open heater with a short to cathode. However, when the vibrator was working, the heater in the 6146 would light, and the tube had normal power output. How about that! Just what was happening, I don't know, but when the vibrator worked, it appeared to supply 6 volts to the other heater. Possibly the vibration made the filament ends weld together temporarily?—*Don Dudley*

SPURIOUS OSCILLATIONS IN EICO 377

An Eico model 377 Sine-Square Audio Generator, wired from a kit, began to show a parasitic oscillation riding on sine waves only, regardless of their amplitude or frequency. The generator worked perfectly in every way, except for this "fuzz" on the waves or parts of them, that hampered fine measurements.

A little investigation showed that oscillations appeared



in the output even when the WAVEFORM slide switch was halfway between SINE and SQUARE. The cathode-follower output stage, right after the switch, couldn't possibly oscillate. The sine-wave oscillator portion was producing sine waves with no fuzz, so that left only the square-wave shaper, V3.

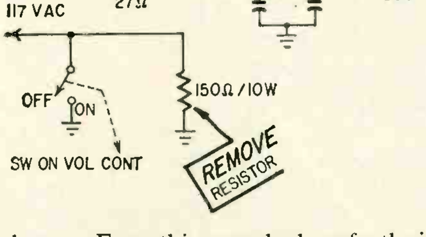
A scope at the switch terminal connected to C12 (switch set halfway between positions) showed approximately square "blobs" of high-frequency oscillation, recurring at about a 10-kc rate. Much the same waveform appeared at the junction of R18 and R19. Apparently the shaper was acting as a free-running multivibrator, all by itself! Moving C11 or C12, both physically large and close together, affected the oscillation. Separating them a little removed the capacitive feedback path from V3 pin 5 to V3 pin 1. A ceramic capacitor of 22 pf connected with short leads from the junction of R18 and R19 to ground stabilized the circuit completely without affecting square-wave quality.—*P. E. Sutheim*

VISCOUS-DAMPED TONE ARMS

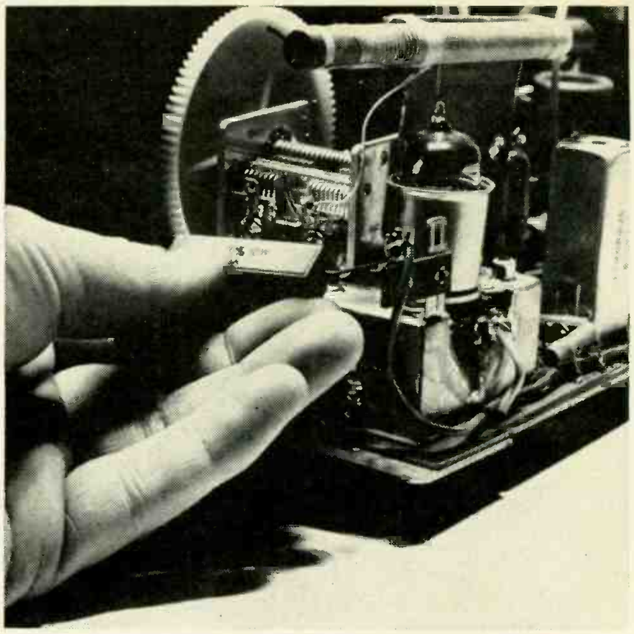
Viscous-damped tone arms need very little attention as a rule except when the unwary audiophile attempts to move his player, spilling the oil. When you refill the ball chamber, screw the container tube right into the refill plug thread. The hard machine threads will tap the soft metal tube of the container and hold it firmly while the contents are squeezed out. This prevents a loss of fluid from spilling caused by air bubbles in the chamber.—*Steve P. Dow*

THE RADIO THAT WOULDN'T SHUT UP

We installed a phono jack in a Sylvania FT24BK table radio. An spst switch was added to switch in the radio or the



phono attachment. Everything worked perfectly in the shop. But in the customer's home the local radio station would

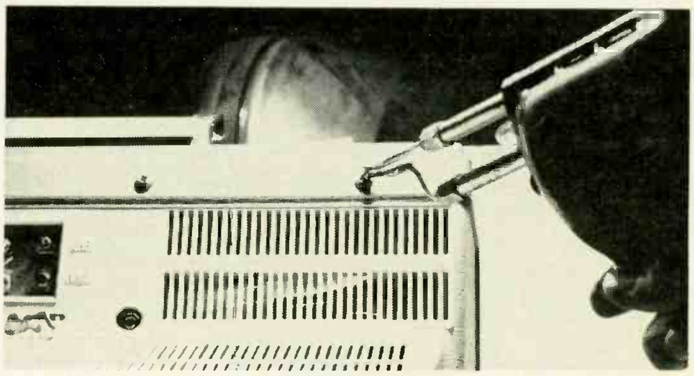


come in when the radio switch was turned off. The tubes went out when the switch was off, as far as the eye could see. It didn't seem possible that music could still come from the radio.

In the shop, it was found that the heaters *seemed* out, but there was voltage on the tubes. We found that a 510-ohm 10-watt resistor was wired across the ac switch to keep the tubes warm for a quick warmup when the radio is switched on. With the tubes partly warmed up, a local station was able to get through via the new audio wiring. Since the shop is shielded, this did not occur while the radio was there. We cut out the resistor.—*Homer L. Davidson*

HEAT LOOSENS PHILLIPS SCREWS

To remove machine-tightened Phillips head screws from plastic TV-set backs or other assemblies, try holding a



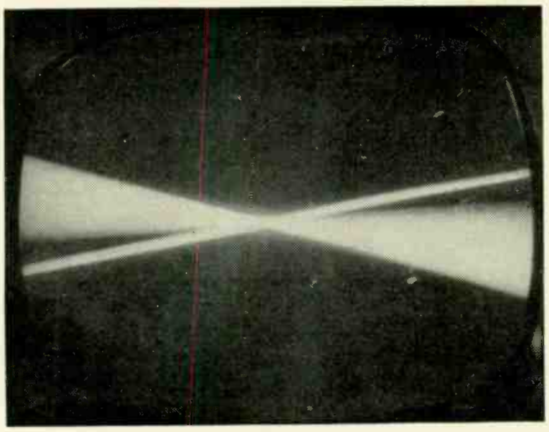
hot soldering iron against the head for a few seconds. Then use the correct size Phillips driver to loosen the screw. Don't hold the iron on too long: the plastic will melt around the screw.—*Homer L. Davidson*

HUM AND RIPPLES IN CCTV

In a closed-circuit TV system, ripples and hum bars will sometimes drift up or down the screen. This occurs in better-grade systems where a master oscillator is divided down to provide vertical sync. The master oscillator drifts out of the range of the automatic frequency control circuit, so that the vertical sync is no longer in phase with the ac line.

The remedy, in most cases, is simple—open the camera control unit, find the master oscillator frequency control, and adjust it until the ripples and bars disappear. Find the range of adjustment over which the afc will hold the oscillator locked to the correct frequency, and set the frequency control to the middle of this range.—*Charles Erwin Cohn*

A BUTTERFLY STORY

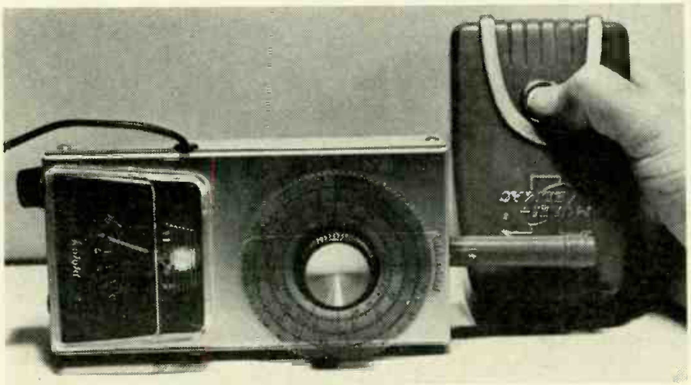


A few days ago I came upon a service case which apparently called for an entomologist rather than a TV service tech. The customer had a Zenith model D 2315 receiver, and the defect, when I saw the set, was a trapezoidal picture such as you often find with a shorted deflection yoke coil. I had no replacement yoke with me, so I decided to take the defective yoke to the workshop, hoping to be able to repair it. The customer agreed very quickly to this; the repair would cost him less than a new yoke. (Original service parts are rather expensive here in Argentina.)

In the workshop I changed the defective vertical coil and made a quick resistance check. Everything seemed all right. I went back to the customer's home and put the repaired yoke into the set. Much to our surprise we saw a picture like the one in the photograph. We had a perfect television butterfly. The cause of this defect was a reversed vertical deflection coil. Transposing its connections fixed everything very quickly.—*Egon Strauss*

CHECKING PORTABLE DOOR-OPENER TRANSMITTER

You can check your portable door-opener transmitter with a grid-dip oscillator, if one is handy. Set the grid-dip oscillator around 27 mc and set the meter to full scale. Place



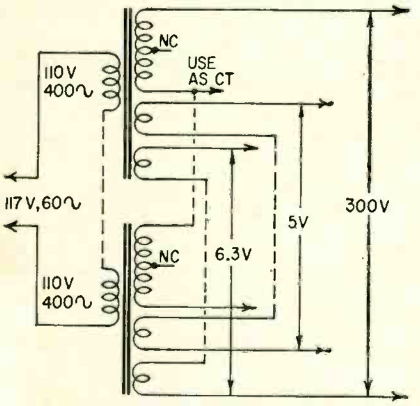
the portable door transmitter unit next to the grid-dipper's coil. Point the transmitting coil in the door opener toward the grid-dip coil.

Press the button on the door opener; the meter pointer should fall back. Adjust the grid-dip oscillator for deepest null, then let up on the button. This will show you that the transmitter is operating, and also the transmitter's operating frequency.—*Homer L. Davidson* END

TRY THIS ONE

USING SURPLUS 400-CYCLE TRANSFORMERS

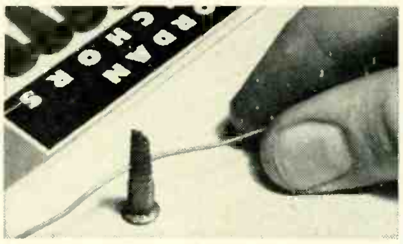
Most experimenters discard 400-cycle transformers when they remove them from surplus equipment. But, by connecting their primaries in series with a 120-volt 100-watt bulb, you can use them on 117-volt 60-cycle ac. You will get half the rated secondary voltage of the transformer.



Another trick is to connect two identical transformers with their primaries in series across 117 volts 60 cycles, and all corresponding secondaries in series (see diagram). The output voltage is approximately equal to the rated output of one of the transformers. Current capacity remains at the rated value in all cases.—*Milton Lenheim*

SMALL WIRE STANDOFFS

To avoid undesirable coupling, it is often wise to prevent certain leads from getting too close to each other, or too close to the chassis. Jordan plastic screw



anchors cemented to the chassis make good wire standoffs. Simply wedge the wire in the anchor slot as shown.—*John A. Comstock*

MODIFYING THE HEATH CT-1

This capacitor tester is a unique and helpful instrument. With a few simple modifications, it can be made even handier around the shop.

To keep the 1629 "eye" tube from being pushed back, wire it to its mounting clamp through the upper hole in its socket.

The spring-return switch is not very handy for testing a large number of capacitors. The shaft and bearing assembly may be replaced with a positive-action mechanism from an old rotary switch. Be sure not to disturb the wafer.

One side of the ac line is connected through a .02-μf capacitor, making the chassis slightly "hot." Cure this by putting the grounded side of the capacitor either to the other side of the transformer or the other side of the switch.

On occasion, in two separate instruments, the "eye" tube has "overlapped". This has been due, in both cases, to excessive leakage in 0.1-μf capacitor across the pins 3 and 4 of the 1629 tube. Replace it with a good-quality paper or plastic capacitor.

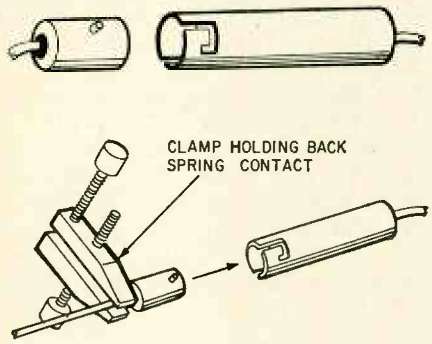
Other modifications include adding a neon pilot lamp and wiring in the test leads permanently.—*Allan Glaser*

SLIP-ON TV SIGNAL INJECTION

If a TV set is dead or intermittent somewhere in the rf, i.f. or video section, connect the ground lead of your signal generator to the TV chassis. Tune the TV to an unused channel. Connect the generator output lead to a spare tube shield. Tune the signal generator to the operating frequency of the stage, with the modulation on. Place the shield over each of the i.f. and rf stages in turn, not letting it touch chassis. The capacitance between the shield and the tube electrodes will inject the generator signal into the stage. If the stage and all following are OK, the usual bar pattern will appear on the screen. This technique is faster than pulling tubes.—*Charles Erwin Cohn*

HANDLING IN-LINE FUSE RETAINERS

Fuse retainers of the in-line type can be difficult to put together if they are in a tight spot that can be reached only with one hand. To simplify cou-



pling, first pull back the wire with the spring contact and hold it with a small clamp. The two sections may then be easily put together, and the clamp removed.—*Hugh Lineback*

TOOLBOX SOLDER BOTTLE

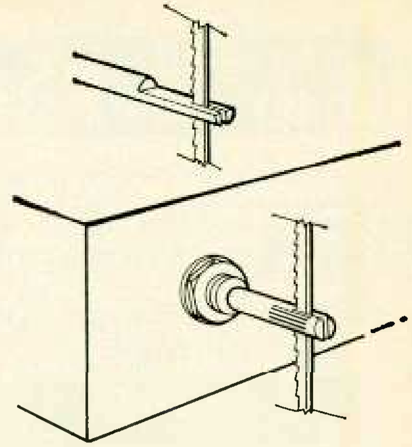
Dropping small bits of solder into your toolbox for field jobs is wasteful, but not having any solder is worse. A plastic solder container slips into a pocket, drops into a toolbox or stays handy on the bench and contains enough solder for any dozen jobs you're likely to encounter.

To make it, get a small pill or throat lozenge vial from your druggist and drill a ⅛-inch hole centered in the bottom. Now wind 2 or 3 inches of solder neatly around a pencil and leave a 2- or 3-inch "tail". Push the tail back through the coil so it sticks out about an inch at the other end. Drop the coil into the pill bottle, making the end come out through the hole, put the cap back on the bottle, and your solder bottle is finished.

Pick a vial that's sturdy enough to withstand banging around with heavy tools in your toolbox. I used one that contained Tracinets sore-throat tablets. —*Charles A. Brunjes*

TIGHTEN KNURLED OR FLATTED KNOBS

When radio or TV push-on knobs on knurled or flatted shafts get too loose, slot the shaft for ¼ inch with a jeweler's saw and spread the slot. Knobs will now fit tight and can be tightened



again and again if necessary. Be careful not to mar the cabinet with the saw.—*Tom Jaski*

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NOTEWORTHY CIRCUITS

CENTER CHANNEL FOR STEREO

A number of methods have been developed for adding a third- or center-channel speaker to a stereo system. Several were described in "Add a Third Speaker the Easy Way" in the October 1960 issue. The Merit A-4110 and Microtran HM-90 mix/match audio transformers were developed to simplify connecting a third speaker while maintaining correct impedances, signal polarities and power levels.

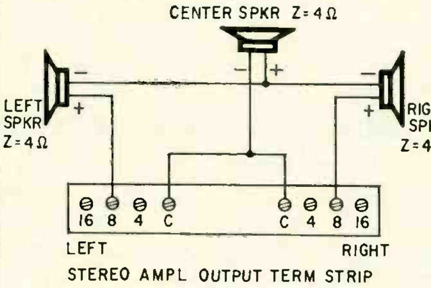


Fig. 1

Fig. 1 shows a recent patent-pending development by David Hafler of Dynaco. The three speakers should have the same impedance and efficiency. The outside ones are connected in *series-opposing* across the two output terminals for speakers of twice their impedance. The third speaker is bridged between the common or ground terminal on the amplifier and the common return lead from the outside speakers.

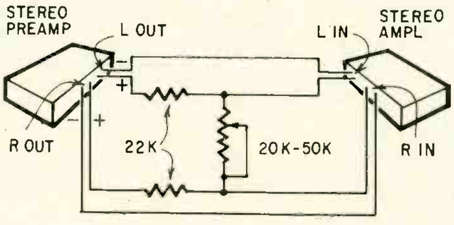


Fig. 2

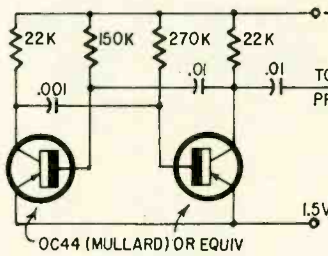
Mr. Hafler notes that this system may degrade separation and cause some crosstalk. This can be eliminated by a resistive bridge network—also covered in the patent application—connected between the preamps and power amplifiers or between two identical high-impedance points in the circuit. The resistive network is shown in Fig. 2.

To adjust the bridge, connect only one channel of a stereo pickup to one amplifier channel, the *left* one for example. Play a mono record and adjust the pot for *minimum* output from the *right* speaker. Switch the phono plug to the right channel. The control setting should be correct for minimum output from the left speaker. If not, then correct it with the amplifier's balance and tone controls.

Plug both phono channels into the amplifier and carry on from there. Incidentally, the center output can be used to feed a mono (L+R) signal to the patio, basement or any other remote point.

TRANSISTOR SIGNAL INJECTOR

A simple untuned af–rf signal generator is handy for tracking down inoperative or defective audio and low-frequency rf circuits. You can use it on the bench, in the field and even in a well equipped lab. The diagram shows a simple multivibrator that Pye Telecommunications engineers use for rapid troubleshooting in radiotelephone transceivers. It was described in *Industrial Electronics* (London, England).



The circuit develops a 1-kc square-wave signal of about 0.5 volt peak to peak and rich in harmonics to about 500 kc. The tester was built on a tiny circuit board and installed in a penlight case along with the 1.5-volt battery. END

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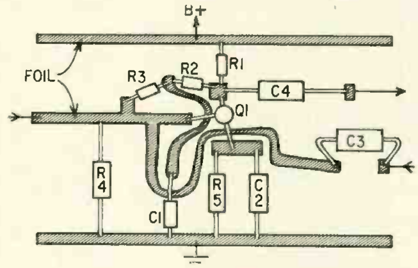
Printed Circuit

The trick to the solution is that the components are on one side of the board while the foil permits running a lead



This method permits running a lead "through" any component. Therefore it is not necessary to redraw the circuit to avoid crossovers.

How Many Ohms?

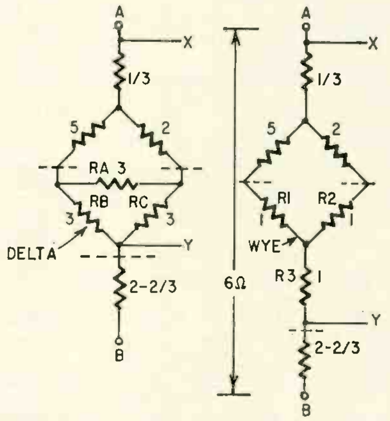
This one has a built-in joker. The center tie between the bridges can be disregarded; it connects corresponding points. Probably the easiest solution is to simplify by means of the Delta-Wye transformation. By opening the circuit at X—Y, we can find the resistance first of one bridge and then the other.

$$R1 = \frac{RA\ RB}{RA + RB + RC} = 1 \text{ ohm}$$

$$R2 = \frac{RA\ RC}{RA + RB + RC} = 1 \text{ ohm}$$

$$R3 = \frac{RB\ RC}{RA + RB + RC} = 1 \text{ ohm}$$

The total resistance for this bridge is 6 ohms. In the same manner, the other bridge is found to be 3 ohms and the two paralleled equal 2 ohms.



With the center tie open, connect a voltage source (say 6 volts) to A—B. Determine voltage at center tie points. In this case, they are both 2⅔ volts. So, any connection between these points has no effect on terminal resistance.

Wave-Shaping Circuit

Here's how it operates: The self-potential (Edison effect) between the right-hand diode plate and the common cathode causes direct current to flow through the 220,000- and 1,000-ohm resistors. This dc causes a drop of 0.3 volt across the 220,000-ohm resistor, thus a potential difference of 0.3 volt between A and B. The direction of current makes terminal A negative to terminal **B.**

The left-hand section of the tube operates as a half-wave rectifier. It is, in effect, an ac electronic switch that controls the flow of dc through the right-hand diode circuit. During positive half-cycles of the input voltage, a rectified voltage pulse is developed across the 1,000-ohm resistor. When this voltage exceeds + 0.3 volt, the 1,000-ohm resistor does not conduct dc from the right-hand circuit and, as a result, the voltage between A and B is zero. During negative half-cycles of the input voltage, no rectified voltage opposes the dc through the 1,000-ohm resistor; therefore, dc flows through the right-hand circuit and the voltage between A and B is 0.3 volt.

By using half-wave rectified voltage pulses to switch the right-hand circuit on and off, a near square-wave output is developed between A and B. The pulse repetition rate equals the frequency of the ac input voltage. END

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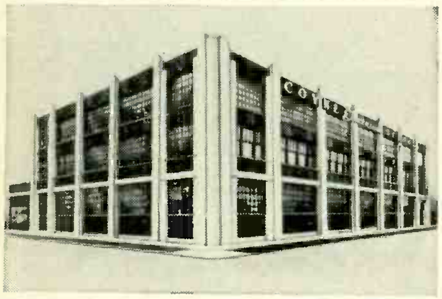

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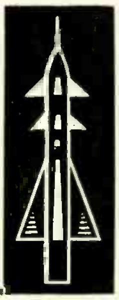

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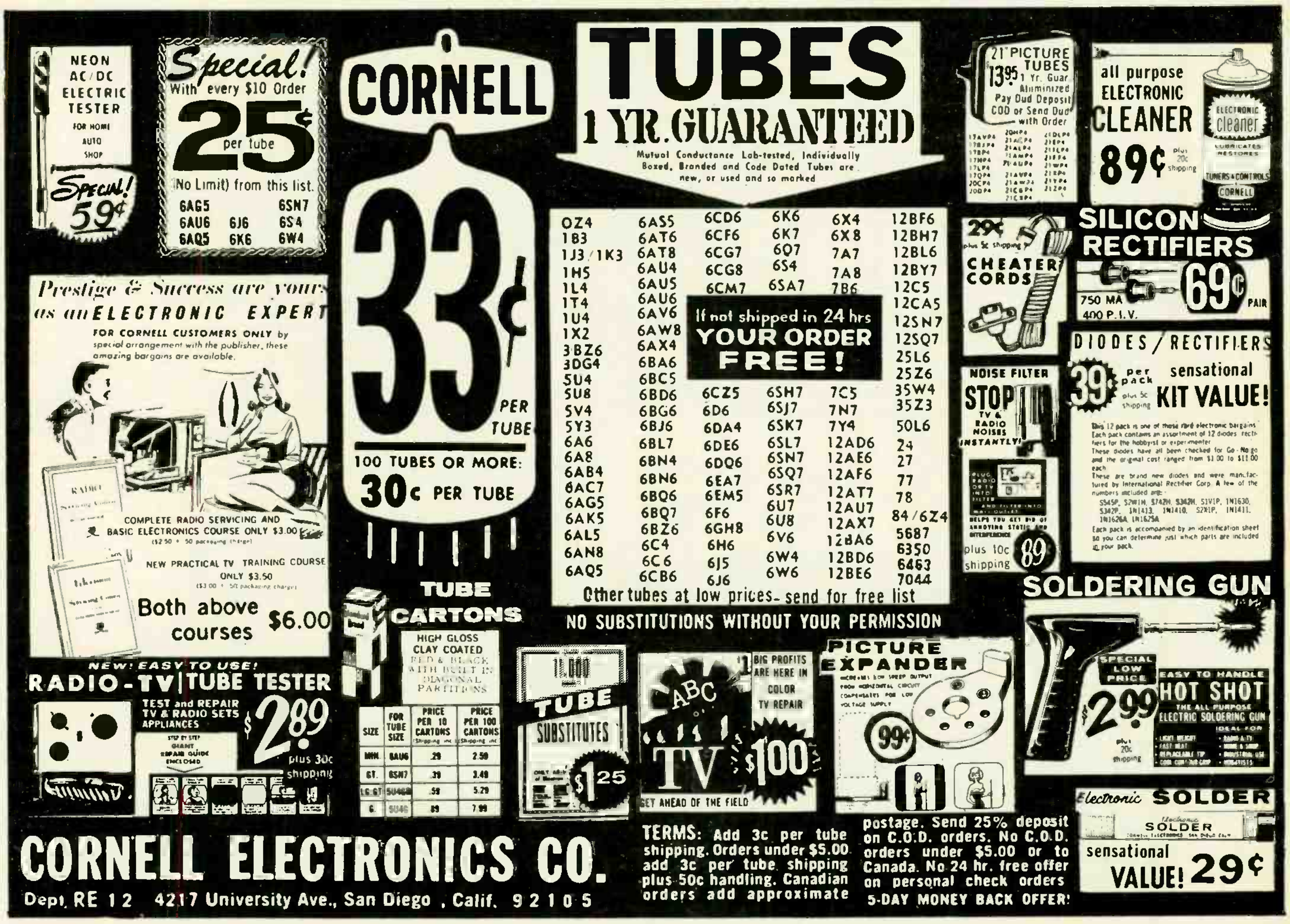

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LOW LOW QUOTES, DYNA. A.R. GARRARD E.V. **HI-FI,** Roslyn, Pa. 19001

Rectifiers & Transistors

750 Ma-Silicon Diodes "Epoxy" or "Top Hat"

PIV		PIV		PIV		PIV	
50	5¢	300	12¢	600	21¢	900	40¢
100	7¢	400	14¢	700	25¢	1000	55¢
200	10¢	500	18¢	800	32¢	1100	70¢

Full Leads, All tests, Guaranteed, American made

Silicon Power Diode Studs

Amps	50 PIV	100 PIV	150 PIV	200 PIV
3	8¢	14¢	16¢	22¢
15	25¢	50¢	65¢	75¢
18•	18¢	40¢	60¢	70¢
35	60	80	1.15	1.30

Amps	300 PIV	400 PIV	500 PIV	600 PIV
3	25¢	28¢	35¢	40¢
15	90	1.30	1.40	1.65
18•	85	1.25	1.35	1.60
35	1.90	2.25	2.50	2.90

•Press Fit Package for Alternators
10 Watt Sil. Zener Stud 12-200 v, 20% ...... 95¢ ea.
1 Watt Zener diode, axial leads 8-200v, 20% .. 50¢ ea.
Sil. diode Stud, 1500 PIV, 300ma .... 50¢ ea.
Sil. diode, 1500 PIV, 50ma, axial leads ..... 35¢ ea.
Hi-Voltage-Silicon epoxy diode, 2½" x ⅜" x ½"
Hoffman—3000 PIV-200ma .... $1.49 ea.
Hoffman—6000 PIV-200ma .... $3.49 ea.
Thermistor, bead, 900 or 1200 ohms, 600°F, 2/$1.00

20 Watt Ger. (Int & Ext heat sink)
150 w Ger Power TD-3

2N1044	60¢	2N1045	80¢
2N457A	80¢	2N1022	1.25
2N458A	90¢	2N511B	1.50
2N1021	1.00	(25 amp)	

Silicon Power Transistors, 85 w, 2N1724 ..... $1.50
Philco Sil., NPN, 2N2479, new .... 3 for $1.00
HF Silicon, 2N702, 100 mc 40¢; 2N703-150 mc .. 60¢

Light Sensitive Resistor
75 ohms—10 meg, 100 volts, 150mow .. $1.75 ea.

Sil. diodes, 1N200 series, asst'd., new .... 15 for $1.00
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Nickel-Cadmium Battery, 9½ oz., 8 amp-hr. $1.95

Varicap-Voltage Variable Capacitor
27, 47, or 100 pf, 4v, 4:1, new .... $1.25 ea.

Silicon Controlled Rectifiers

PRV	.75A	1A	7A	16A	PRV	.75A	1A	7A	16A
25	—	.20	.28	.48	200	.80	.90	1.05	1.70
50	—	.40	.48	.70	300	1.20	1.30	1.60	2.20
100	—	.55	.70	1.20	400	1.70	1.85	2.10	2.70
150	.60	.70	.80	1.50	500	1.95	2.05	3.80	3.30
					600	2.30	2.50	3.00	3.90

75A Tophat—1A T0.5—7A & 16A Stud

Money back guarantee. $2.00 min. order, include postage. Catalog 25¢.

Electronic Components Co.
Box 2902B Baton Rouge, La. 70821

Circle 133 on reader's service card

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NON-COMMERCIAL RATE (for individuals who want to buy or sell personal items): 30¢ per word . . . no minimum.
Payment must accompany all ads except those placed by accredited advertising agencies. 10% discount on 12 consecutive insertions, if paid in advance. Misleading or objectionable ads not accepted. Copy for February issue must reach us before December 10th.
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Add programs of commercial-free music thru your FM tuner. Detector, self-powered, plugs into multiplex output of tuner or easily wired into discriminator and permits reception of famous background music programs now transmitted as hidden programs on the FM broadcast band from coast to coast. Use with ANY FM tuner.

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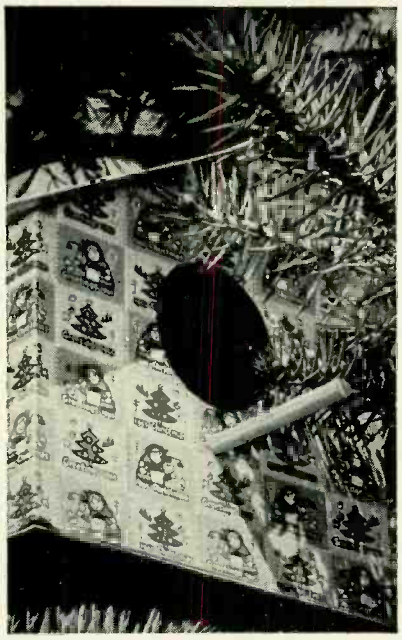

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$25 WORTH OF
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- RECTIFIERS
- RESISTORS
- CONDENSERS
- DIODES ■ ETC

PLUS CHOOSE ANY $1.00 ITEM FREE

Add 25¢ for handling

BOTH FREE WITH ANY $10 ORDER

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DELCO $1 HIGH POWER

PNP 100Watt/15 Amp HIPower TO36 Case! 2N441, 442, 277, 278, DS501 up to 50 Volts

WORLD'S MOST POPULAR **$1 PARTS PAKS**

☐ 3-TRANSISTOR AUDIO AMPLIFIER **1.00**
- Printed Circuit
- With Transistors
- Subminiature
- Wired

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- ☐ 4 TRANSISTOR TRANSFORMERS, asst. worth $25 $1
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- ☐ 3 INFRA-RED DETECTORS, with leads $1
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85 WATT NPN SILICON MESA

☐ 2N1212 Drift. 10 mc
☐ 2N424

$1.00 EA

HIGH VOLTAGE RECTIFIERS

-6000 piv 200 ma.
$1.99

FACTORY TESTED **SEMI-KON-DUCTORS**

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- ☐ 8, 2-6Amp RECT's, studs, silicon, 50 to 400V .$1
- ☐ 4—2N170 TRANSISTORS, by GE. rf, npns $1
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- ☐ 3 2N711 300MW. 300 MC, PNP MESA, TO18 ..$1
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1000 PRV **3** *Full Leads* **for** **$1** *Factory Tested*

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- ☐ 30 POWER RESISTORS, 5 to 50W. to 24 Kohms. $1
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- ☐ 30 "YELLOW" MYLAR CONDENSERS, asstd val $1
- ☐ 60 CERAMIC CONDENSERS. discs. npo's. to .05 $1
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- ☐ 40 PRECISION RESISTORS. ½, 1, 2W: 1% values $1
- ☐ 60 DISC CONDENSERS. 27mmf to .05mf to 1KV $1

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- ☐ 3 SILICON NPN 'PLANAR' RHEEM 2N697, 100mc $1
- ☐ 3 40-WATT TRANSISTORS PNP, stud, b 80 B Volts $1
- ☐ 25 GERMANIUM & SILICON DIODES. no test ..$1
- ☐ 4 2N213 TRANSISTORS, mixer-conv, TO22 ....$1
- ☐ 30 PRINTED CIRCUIT SWITCHING TRANSISTORS, $1
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3 for $1

Volts	Volts	Volts	Volts	Volts	Volts		Volts	Volts
6.8	10	15	22	33	47	68	100	150
7.5	11	16	24	36	51	75	110	160
8.2	12	18	27	39	56	82	120	180
9.1	13	20	30	43	62	91	130	200

100's SOLD AT 4:05

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☐ **100 for 2.98**

POWER, RF, IF, AUDIO, SWITCHING no test

SPECIAL SALE

500 MC Silicon Planar **POWER TRANSISTOR $1.49**

(ACTUAL SIZE) Fairchild

	Watts	V	h_{FE}	ma
☐ PNP ☐ NPN	3	25	35-140	1100

TRANSITRON

TESTED SILICON CONTROLLED RECTIFIERS

PRV	7A AMP	16A AMP	25A AMP	PRV	7 AMP	16 AMP	25 AMP
25	.30	.50	.85	250	1.75	2.15	2.50
50	.45	.75	1.00	300	2.00	2.40	2.75
100	.80	1.25	1.50	400	2.40	2.75	3.25
150	.90	1.60	2.00	500	3.20	3.40	3.80
200	1.25	1.80	2.25	600	3.40	4.00	4.50

Space Saver, 3 Amp Switching

POWER TRANSISTORS ☐

2N1755
2N1760

3 for $1

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10¢ FOR OUR "SPRING" BARGAIN CATALOG ON: ☐ Semiconductors ☐ Poly Paks ☐ Parts

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TERMS: send check, money order, include postage—avg. wt. per pak 1 lb. Rated, net 30 days. CODs 25% down.

P.O. BOX 942R
SO. LYNNFIELD, MASS.

Circle 135 on reader's service card

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Torrance: 22519 Hawthorne Blvd.
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Santa Ana: Bristol Plaza Shop. Ctr.,
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Stamford: 29 High Ridge Rd.
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Chicago: Evergreen Plaza at 95th St.
MAINE
Portland: Pine Tree Shop. Ctr.
MARYLAND
Langley Park: Hampshire-Langley Shop. Ctr.
MASSACHUSETTS
Boston:
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110 Federal St.
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Brockton: Westgate Mall
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Framingham: Shoppers' World
Lowell: Central Shop. Plaza
Saugus: N. E. Shop. Ctr.
Springfield: 1182 Main St.
West Springfield: Century Shop. Ctr.
Worcester: Lincoln Plaza
MINNESOTA
St. Paul: 473 North Snelling
MISSOURI
St. Louis: 1125 Pine St. (Walter Ashe Div.)
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Manchester: 1247 Elm St.
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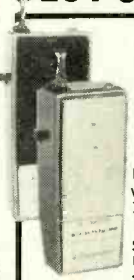

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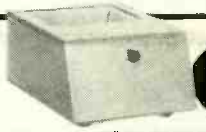

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AC/DC POWER SUPPLY CONVERTER
Operate any of the 100 mw. Walkie-Talkies above on 117 VAC house current. Conserve battery power. Sturdy table-top stand for base station operation. 2x3½x4½". #21-1002.

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ADD 50¢ PER ORDER FOR PACKING AND SHIPPING

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STREET________________

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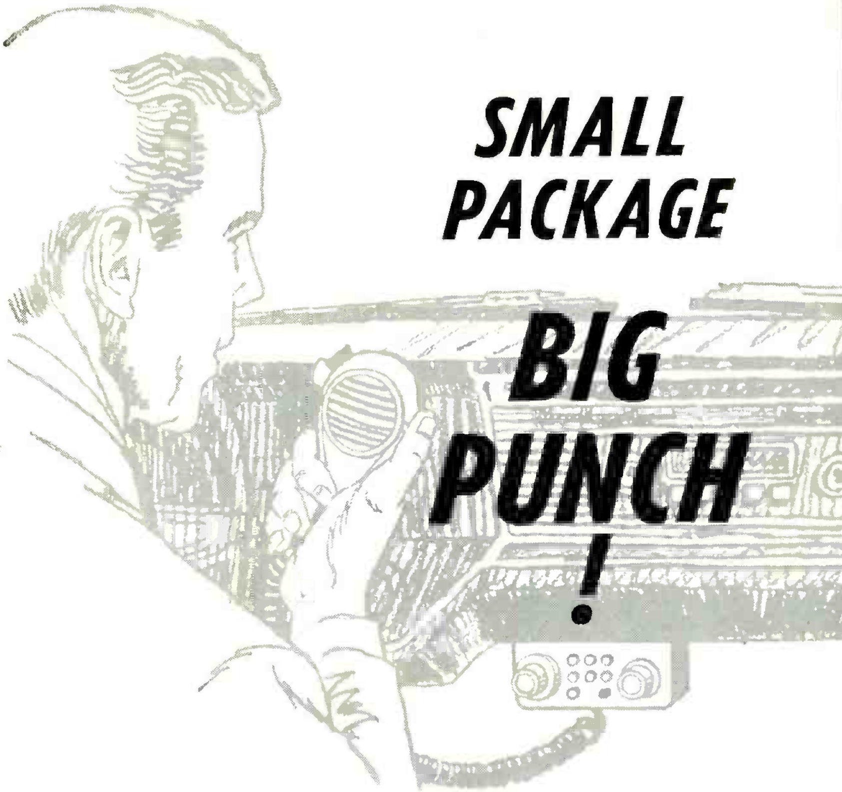
☐ 60-3030, Space Patrol
☐ 21-906, TRC-33
☐ 21-904, TRC-22
☐ 21-1139, TRC-1
☐ 21-1001, TRC-2
☐ 21-1002, Converter

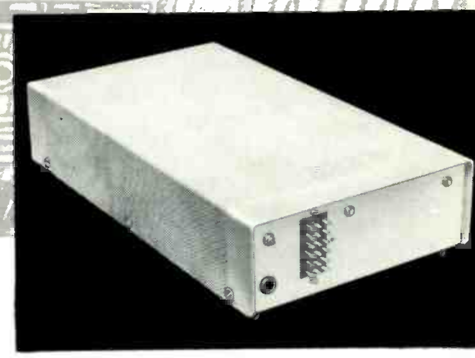
RE-1265

Circle 136 on reader's service card

SMALL PACKAGE

BIG PUNCH!





INTERNATIONAL Model MO TRANSCEIVER For CITIZENS RADIO SERVICE

- New Compact Size
- New Solid-State Crystal Switching Circuit
- New Photo-Control Volume Circuit
- New Remote Control With Matching Microphone

The International Model MO Citizens Radio transceiver, custom designed for mobile installation, provides instant push-to-talk crystal controlled operation on any 6 channels with full 5 watts power input. The new compact control head provides complete remote controlled operation. All circuits are dc using solid-state crystal switching. The operating channel is indicated by an illuminated button on the control head. Tubes and silicon transistors are combined to provide a rugged trouble-free circuit.

FCC Citizens Radio license required. All use must conform with Part 95, FCC Rules and Regulations.

The complete transceiver includes: a remote control head (about the size of a cigarette package), matching white microphone, new compact transmitting / receiving unit which may be conveniently installed in the trunk, and a matching white speaker which mounts under the dash. Operates from 12 vdc negative ground power source. Other power input units are available on special order.

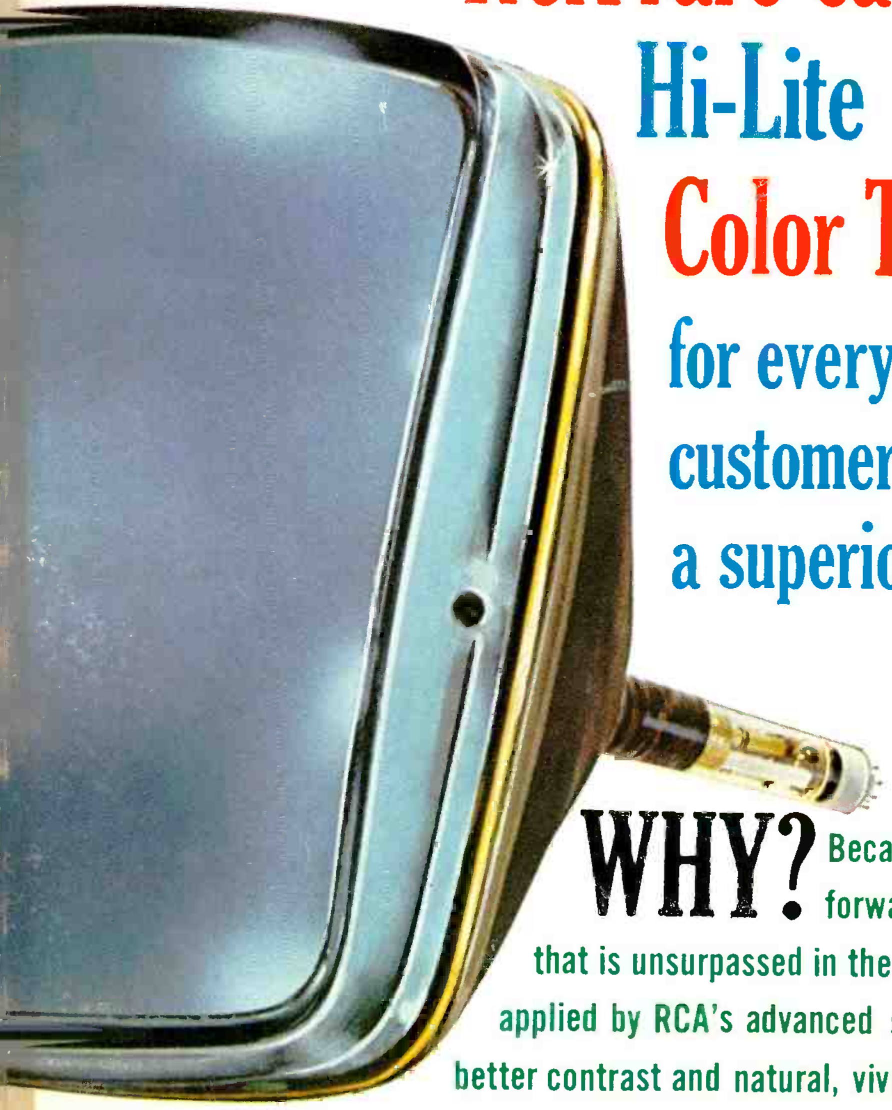
See the "all new" International Model MO at your dealer today.

INTERNATIONAL

CRYSTAL MFG. CO., INC.

18 NO. LEE · OKLA. CITY, OKLA. 73102

Circle 149 on reader's service card



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